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ASSESSMENT OF THE COAL RESOURCES OF THE KYRGYZ REPUBLIC

by
Coal Resource Assessment Team

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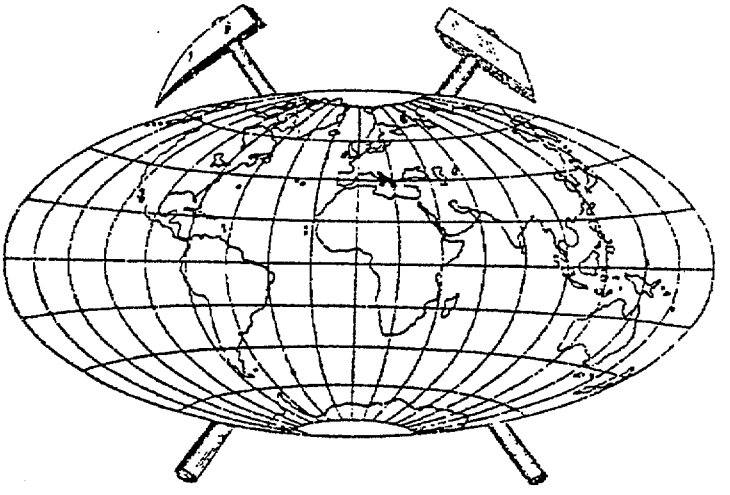

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ASSESSMENT OF THE COAL RESOURCES OF THE KYRGYZ REPUBLIC:

COAL CHARACTER AND DISTRIBUTION, GEOLOGY, MINING, AND IMPORTANCE TO THE NATION'S FUTURE

by Coal Resource Assessment Team

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This report is preliminary an has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature

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ОЦЕНКА УГОЛЬНЫХ РЕСУРСОВ РЕСПУБЛИКИ КЫРГЫЗСТАН:

геология, характеристики угла, добыча, распределение запасов и важность проблемы для страны

Подготовлена группой специалистов в области оценки угольных ресурсов в составе

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I. EXECUTIVE SUMMARY

This analysis of the coal industry in the newly-independent Kyrgyz Republic (formerly part of the U.S.S.R.) was done by a team composed of geologists, a mining engineer and a coal utilization specialist under sponsorship of the U.S. Agency for International Development. In Kyrgyzstan the members of the team analyzed coal resources and the mining practices in thirteen mines (in six mining regions), visited major thermal and electric stations that use coal, and consulted technical and management people in laboratories, ministries and in state and private mining companies.

This report, available from the U. S. Geological Survey in English and in Russian, contains this executive summary, the large main body of the report, and appendixes. The executive summary first lists the conclusions and suggestions for action and follows with the background and methods of the study and with description of the present situation of the state and private coal industry in Kyrgyzstan.

A. CONCLUSIONS AND SUGGESTIONS FOR ACTION

The preferred future energy budget of the Kyrgyz Republic requires commitment to mining and utilization of the coal resources of the nation. Without domestically-produced coal, future energy budgets of the Republic will depend on imported fuels to satisfy much or most of the energy requirements of Kyrgyzstan.

In the most recently available energy policy planning document (Amanaliyev, 1993), it was expected that coal would satisfy a substantial portion of the Republic's energy budget for the foreseeable future. In 2010, eight million tonnes of coal would be required, and coal and hydrocarbon products would satisfy 57 percent of the total energy demand, with hydroelectricity providing the remainder. Obviously, this scenario may change as a result of the recent drop in total energy supply/demand and the drastic decrease in coal production in recent years. The desirability of satisfying domestic energy requirements with indigenous energy sources will remain.

In order to help the coal industry of Kyrgyzstan satisfy its responsibilities in the future energy budgets of the nation the following suggestions for action are offered:

1.-- **Resume exploration and development of the nation's coal resources.** Coal exploration peaked several decades ago and has been conducted at a very low level of effort in recent years. Both exploration and development activities have apparently been concentrated in past and present mining areas, and as a consequence so are a large portion of the estimated potentially recoverable reserves of the country. Some mining areas reportedly still have considerable mining potential and may be worthy of exploration to evaluate the amount of remaining reserves that might be available for mining. Some known coal areas that might be important for future mining have been inadequately explored and require exploration and development studies to determine their resource potential. In some known coal regions of the country, coal mining has

apparently never been seriously considered and the quantity, quality and distribution of the coal resources is poorly known. Coals are not presently selected for low sulfur content, and increased environmental concerns may require this. Informed planning for the nation's energy future requires more information than is presently available.

2.-- **Evaluate the amount of coal available and economically recoverable from a market-economy viewpoint in the coal areas of the country.** Economic factors previously used in the evaluation of Kyrgyzstan's potentially recoverable reserves are no longer valid. Up-to-date classification from a free market-economy standpoint is needed. The studies should provide basic data about the coal resources that are recoverable at a cost that the economy of Kyrgyzstan can accept. Studies of this type are required before investment of time, energy and capital in elements of a coal industry can be further justified.

3.-- **Gather and organize the presently available information that can affect the future coal industry of Kyrgyzstan.** As a minimum, the location of such information should be recorded. Ideally, the information should be gathered and organized so duplication might be avoided with considerable savings in time and money in the future.

4.-- **Encourage mines with depleted reserves and worn out equipment to produce as much coal as possible for as long as possible with a minimum of capital investment until safety and efficiency require closure.** Support changes in mining methods that may extend the life of such mines.

5.-- **Determine which mines and mining areas can increase coal production in a short time. Provide solid, market-economy-based data on their coal availability and recoverability.** Establish the engineering and economic parameters for successful operation of such short-term elements of the future coal mining industry. Seek capital investment for development of such areas.

6.-- **Increase production to satisfy local demand in all parts of the country that contain economically recoverable coal by assisting the Private Enterprises Mining Program.** The Private Enterprises Mining Program is the successor to the Small Enterprises Mining Program that was initiated a few years ago to satisfy critical domestic coal needs. This program needs assistance and training in resource understanding, engineering technology, marketing concepts and techniques as used in a free-market-economy. The 15 licensed small private mines in the program were responsible for more than one-eighth of the total coal production of the Republic in 1995. The small private miners should be encouraged and assisted in their efforts to become responsible members of a free-enterprise, market-economy system.

7.-- **Research and test the feasibility of briquetting as a solution to the problem of coal fines.** Because of the friability of the coals of Kyrgyzstan a large proportion of the coal produced is of fine-size (13mm or less). At the present time, only coarse coal has a ready market. Aggregation of the otherwise useless fine-sized coal into a coarser product is worthy of investigation. Demonstration of the technical feasibility of making usable briquettes from

the variety of coal ranks, grades, types and available binder materials is required. Of equal importance and need is informed evaluation of the economics of production and the size, location and financial capabilities of potential markets for the briquettes.

8.-- **Investigate the possibility of increasing coal production at the Dzhergalan mine in the Issyk Kul coal region to supply coal to the Chu Valley Region.** The present dependency of northern Kyrgyzstan on imported coal might be at least partially alleviated by supplying better-quality domestic coal to the district heating and electricity-generating plants at Bishkek and Kara Balta.

9.-- **Increase the routine maintenance of existing roads used to haul coal and extend the railroad system of the Republic.** The road and railroad network that was inherited from the former Union has declined severely. The existing rail network was not designed to serve the economy within the present national borders. An expanded railroad transportation system is needed to help solve the problem of transporting domestically-produced coal for use internally, and perhaps for export.

10.--**Schedule periodic, preferably annual, reviews of the coal industry of the Kyrgyz Republic to provide a continuing update and analysis of the progress of coal exploration, mining, marketing and utilization.** Reviews by country-knowledgeable specialists would be a source of unbiased, reliable information for those developing the coal industry of the Republic, for those contemplating investing in the industry, and for those interested in assisting and supporting the coal industry as a vital part of a sound market-oriented economy.

More than 50 percent of the energy resources of Kyrgyzstan are embodied in its coal resources--hydropower constitutes the bulk of the remainder. A significant part of the energy to be consumed by Kyrgyzstan in both the short-and long-term future is projected to be provided by coal. If coal is not produced domestically it must be imported, as are most oil and gas, with the attendant international exchange and dependency problems.

Inherent in the previous suggestions is the requirement for training of various kinds. Training and practical experience are needed in mine management, mine planning and design techniques, financial systems and marketing. The small private coal-mining enterprises need assistance specifically in understanding geologic and mining engineering factors, mining technology, development and maintenance of markets, and training in the basic economics, legal requirements and societal responsibilities of private enterprises.

B. BACKGROUND

Assessment of the coal resource situation in Kyrgyzstan was identified by representatives of the United States Agency for International Development and officials of the Kyrgyz Republic (Kyrgyzstan) as a useful area for collaboration. The study was conducted by the United States

Geological Survey and consultants provided by IDEA , Inc. of Washington, D.C. with the assistance of counterpart personnel of agencies of the Government of Kyrgyzstan, particularly the Ministry of Industry, Material Resources, and Trade, the Ministry of Geology and Mineral Resources and the Institute of Geology of the Academy of Sciences.

The rugged, mountainous country of Kyrgyzstan contains about one-half of the coal resources of the Central Asian Republics (exclusive of Kazakstan). The geological coal resources of the country are estimated to total about 31,000 million tonnes. However, the amount and distribution of coal resource information allows less than eight percent of the total to be categorized as technically recoverable reserves and the amount that is economically recoverable is unknown.

Coal is present in eight regions in Kyrgyzstan in at least 64 different, named localities. Historically, the coal industry first developed around the periphery of the Fergana Valley of Kyrgyzstan, Uzbekistan, and Tadjikistan where the industry had access to the transportation facilities that served the valley and consequently could serve coal markets in those republics and in Kazakstan. Eventually, two mining areas were opened in the northeastern part of Kyrgyzstan to satisfy local demand there.

During the Second World War, exploration of the coal resources of Kyrgyzstan received emphasis that continued for two decades. Preliminary exploration of the coal resources of the Uzgen basin established the presence of high-quality coals with a range of ranks from subbituminous-A through anthracite, but development for extraction has not followed to the extent possible. Only in recent years have two mining areas discovered in the early '50s been operated in the coal-rich Kavak region of central Kyrgyzstan, but the few roads in the region limit extraction and transportation capabilities. The coal resources of south-central Kyrgyzstan have not been explored beyond reconnaissance stage efforts and only two small mines are present. Exploration and development efforts in Kyrgyzstan have been local and on a reduced scale since the end of the 1960's. The main coal deposits and reserves are summarized already in Gavrilin and Kuznetsov, 1968.

C. THIS STUDY

A summary of this assignment is as follows: (a) Gather, interpret, and summarize available information on the coal resources of Kyrgyzstan; (b) Complement the existing data through field observations and cooperative studies; (c) Identify needs and opportunities for expansion of the resource database; and (d) Identify and recommend activities to assist and support short and long-term resource expansion, recovery, marketing and utilization.

A team of four geologists, a coal mining engineer and a coal utilization specialist worked in Kyrgyzstan during October and part of November, 1994. They sampled coals and analyzed engineering practices at thirteen mines (in six of eight coal regions of the country), visited four major thermal and electric stations that use coal, and consulted with technical and management people in laboratories, ministries and other components of the coal industry. Three members of the

team returned to Kyrgyzstan in May, 1996 to discuss the findings presented in a preliminary report with counterparts and update the contained information. This report, with its appendixes, contains the information and recommendations from the field work and also analytical data and other results of work conducted in the U.S.

The coals of Kyrgyzstan are widely scattered in a geologically complex terrain; they are all of Jurassic age. They are probably similar in general to Jurassic coals in other parts of Central Asia, in China, and in southern Russia. The largest area of coal-bearing formations that remains intact is in the Uzgen Basin in the East Fergana coal area, other known Jurassic rocks are fragmented and scattered.

The reserves and resources of coal have been appraised according to Soviet systems. Commercial (balance) reserves are estimated (in million tonnes) as about 1250 million tonnes brown coal and 1000 million tonnes bituminous coal and some anthracite. The mining method indicated for these reserves is 300 million tonnes by opencast and 1950 million tonnes by underground mining. Most exploration at a detail needed to define reserves has been at existing mines, with the consequence that reserves are less than ten percent of the estimated geological coal resource of about 31,000 million tonnes.

The coals classed as brown coal B3 are subbituminous in U.S. terms and the long flame coals are mostly high-volatile C bituminous in U.S. terms. The heat yield of produced coals is 20 to 25 MJ/kg (8500-11000 Btu/lb) except where excess rock contaminates the product, and some coals with higher heat could be produced. Over many years most mines have produced coal with 10-20% ash. The petrographic composition ranges to higher inertinite content than in most U.S. and European coals, and associated with this is a generally lower hydrogen content. The samples collected by the team included three with sulfur greater than 2%, but older recorded data show that values over 2% are the exception. Excluding the one high rank coal sampled (low-volatile bituminous), coals sampled by the team are representative of most coals reported produced in Kyrgyzstan and have 8 to 28% bed moisture, 33-51% volatile matter (daf), 71-83% elemental carbon (daf) and 0.3-0.8% vitrinite reflectance. The USGS analyses supported older Soviet work in most respects, but lower hydrogen and lower sulfur were reported in some older work -- possibly a result of selective sampling, not analytical errors.

The USGS trace element data show little that is remarkable in view of typical world-wide values and show no likely problems for coal utilization. Elements like chlorine, selenium and mercury, which may be of concern in some forms of utilization, are notably lower in Kyrgyz coals than in many coals of the world.

D. THE COAL INDUSTRY AT PRESENT AND IN THE NEAR FUTURE

As recently as 1990 the annual coal production of Kyrgyzstan was about 4 million tonnes, but in the last few years coal production has drastically decreased and the production in 1995 was only about 455 thousand tonnes. Reasons for the decrease are given as depletion of reserves in old mine

areas, obsolete and worn-out equipment, shortages of fuel, uninspired and unpaid miners, loss of experienced management and technical personnel by emigration, loss of markets by intra- and extra-national decisions, poor transportation infrastructure, and other problems inherent in transition from a centrally-planned economy to a market-based national economy.

The coal industry inherited with independence is in the process of restructuring itself. The previously monolithic government coal company, KYRGYZKOMUR, is in the process of spawning thirteen or more subsidiaries. As the subsidiaries are created, they operate under the overview of newly-created KYRGYZKOMURHOLDING. The subsidiaries, called State Stock Societies, presumably will have more opportunity for individual success or failure than was previously possible. Coordination of effort among the State Stock Societies is apparently the responsibility of KYRGYZKOMURHOLDING; the amount of direction is unclear.

Tenders were recently accepted from the German firm Rheinbraun Engineering und Wasser in response to a request for tenders regarding a coal industry support program for KYRGYZKOMURHOLDING. The start date is about October, 1996. The program will be sponsored by EUROPEAN UNION/TECHNICAL ASSISTANCE CONFEDERATED INDEPENDENT STATES (EU/TACIS). As described in the request for tenders, the program comprises training of one-year duration with emphasis on financial systems, mine management, marketing, and mineplanning and design techniques. As much as fifteen percent of the total program funding may provide equipment, perhaps mostly computers. Whether any of the training will be available to private mining enterprises is unknown.

An earlier change in the structure of the coal mining industry in the Republic was the initiation of the Small Enterprises Mining Program with its inherent possibilities of true privatization. Recently the Small Enterprises Mining Program changed to the Private Enterprises Mining Program. The change is from a program initiated as a humanitarian response to energy shortages in parts of the nation, to a program emphasizing the acceptance of production responsibilities by privately-funded and operated enterprises. Private enterprises supplied about 1/8th of the coal produced in the Republic in 1995. The transition to market-responsive, privately-owned, free-enterprise small coal mining companies would be assisted by advice and training in technology, marketing, and small-business operations.

II. INTRODUCTION

A. BACKGROUND

In August of 1992, as a result of discussions between a United States Agency for International Development (USAID) Energy Mission and officials of the Kyrgyz Republic (Kyrgyzstan), a memorandum was signed in which useful areas for collaboration between USAID and the Government of the Kyrgyz Republic were identified for further consideration. One of the identified areas was an assessment of the coal resource situation in Kyrgyzstan. The results of such an assessment could become a key factor in considerations of the future of the coal industry in energy policy and planning for the nation.

A reconnaissance visit to Kyrgyzstan in February, 1994, identified counterparts for the collaborative effort and technical expertise needed in the USAID-sponsored assessment team, and resulted in a mutually acceptable activity implementation plan. The team formed for assessment of the coal situation in Kyrgyzstan formally initiated operations on October 2, 1994. The team comprised four members of the U.S. Geological Survey (USGS) and two consultants under contract to IDEA, Inc. of Washington, D.C. The USGS team members operate under provisions of Participating Agency Service Agreement (PASA) No.CCN-0002-P-ID-3097-00 between the USAID and the Department of the Interior-United States Geological Survey.

The objectives and scope of study for the USGS team members are outlined in Annex 4 of the PASA, and in a scope of work statement dated September 20, 1994, are as follows: (a) to gather, interpret, and summarize available information on the country's coal resources; (b) to complement the existing data through field observations and cooperative studies; (c) to identify needs and opportunities for expansion of the resource database; and (d) to identify and recommend activities needed for assistance and support of short and long-term resource expansion, recovery, marketing and utilization.

The USGS personnel on the assessment team collaborated with the coal mining consultant and the coal utilization specialist supplied by USAID who worked simultaneously on tasks relevant to the overall evaluation of the current and prospective future of the coal mining industry of Kyrgyzstan. The work of the consultants was integrated in the common team effort.

B. SUMMARY OF FIELD ACTIVITIES

During the period October 7 through November 12, 1994, the assessment team was in Kyrgyzstan and Kazakstan. Much of the time was spent in discussions with counterparts and others, gathering information from a wide range of sources, and organizing the data. Part of the time was spent in field site visits to thirteen coal deposits in six of the eight regions where coal has been reported in Kyrgyzstan. In addition, four facilities using coal for electric power generation and production of steam for heat were also visited, and three coal analytical laboratories were visited.

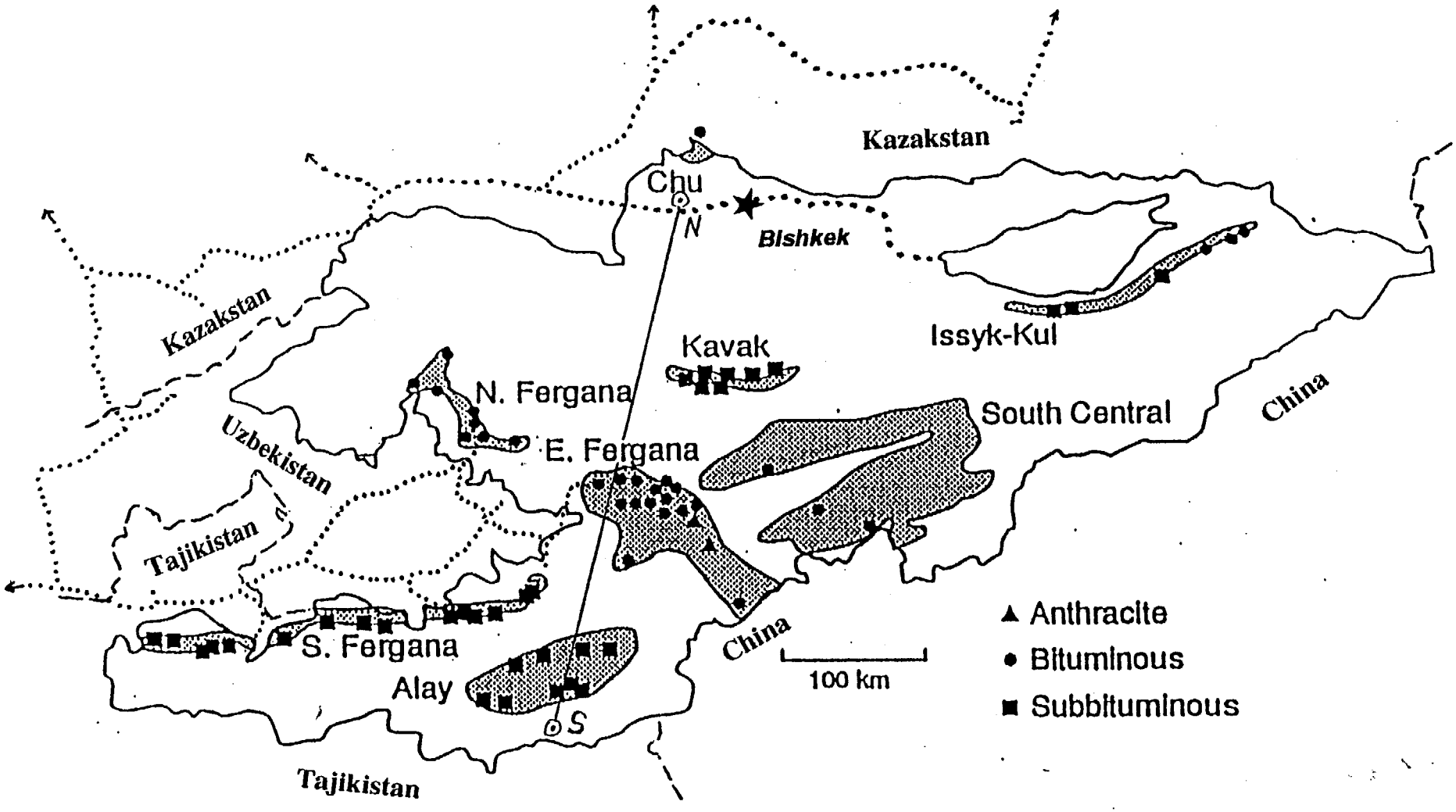

Figure II-1. The coal regions of Kyrgyzstan and railroads of the FSU (dotted lines) and borders dividing other countries adjacent to Kyrgyzstan (dashed lines). The line N-S shows the position of the section Fig. III-1.

Attached are maps (figures II-1 and II-2) showing the eight coal regions of Kyrgyzstan and the field localities visited by personnel of the team. Before the field studies, the team had learned of only about 45 localities; now we know of 64 localities. Some of the additional 20 localities are subdivisions of previously identified areas, but many were previously unreported in literature available outside of Kyrgyzstan.

English and Russian versions of a draft final report were transmitted for comment and suggestions in April and July, 1995, respectively. Three team members returned to Kyrgyzstan in May, 1996, to discuss the final report with counterparts and USAID personnel, and to update information as needed.

C. KYRGYZSTAN -- THE LAND AND PEOPLE

Most of Kyrgyzstan is ruggedly mountainous and only about seven percent of the country is classified as arable land. Much of the remainder is marginally usable for grazing of sheep and goats. Most of the country is at altitudes between 500 and 3,000 meters above sea level and more than one-third of the country is between 3,000 and 4,000 meters above sea level. Mountain peaks reach altitudes of more than 7,000 meters and more than 8,000 square kilometers are covered by glaciers. The climate ranges from subtropical to polar but is largely arid temperate continental and features warm summers and cold winters. Much of the population of about 4.5 million lives in valleys and foothills at lower altitudes. Most of the country at higher altitudes is very sparsely populated except during the summer grazing season.

Kyrgyzstan has a total area of about 198,500 square kilometers, comparable to the state of South Dakota in the U.S.A., and is divided into seven oblasttar for administrative purposes (figure II-3). Railroads total about 370 kilometers in length and highways - paved, graveled, and unpaved - total about 30,300 kilometers.

D. COAL REGIONS AND RESOURCES OF KYRGYZSTAN

The bulk of the existing coal industry is concentrated in the southwestern part of the country, peripheral to the Fergana Valley. Here, the coal industry has access to many highways and railroads (Fig. II-1). Most of the Fergana Valley and the highway and railroad systems therein are in Uzbekistan and Tadjikistan. Use of the transportation net in the Fergana Valley has become increasingly difficult for Kyrgyzstan since independence. The existing coal industry in the central and northeastern parts of Kyrgyzstan is dependent on roads for transport of coal to markets. Recent proposals to build a railroad connecting the southwestern and northern parts of Kyrgyzstan deserve serious consideration.

The coal of Kyrgyzstan is mostly of good quality, but only of medium rank (and medium heating value) -- that is, subbituminous and high-volatile bituminous rank. Coals of higher rank, some with coking qualities, are present in one region. Many deposits of coal are known but

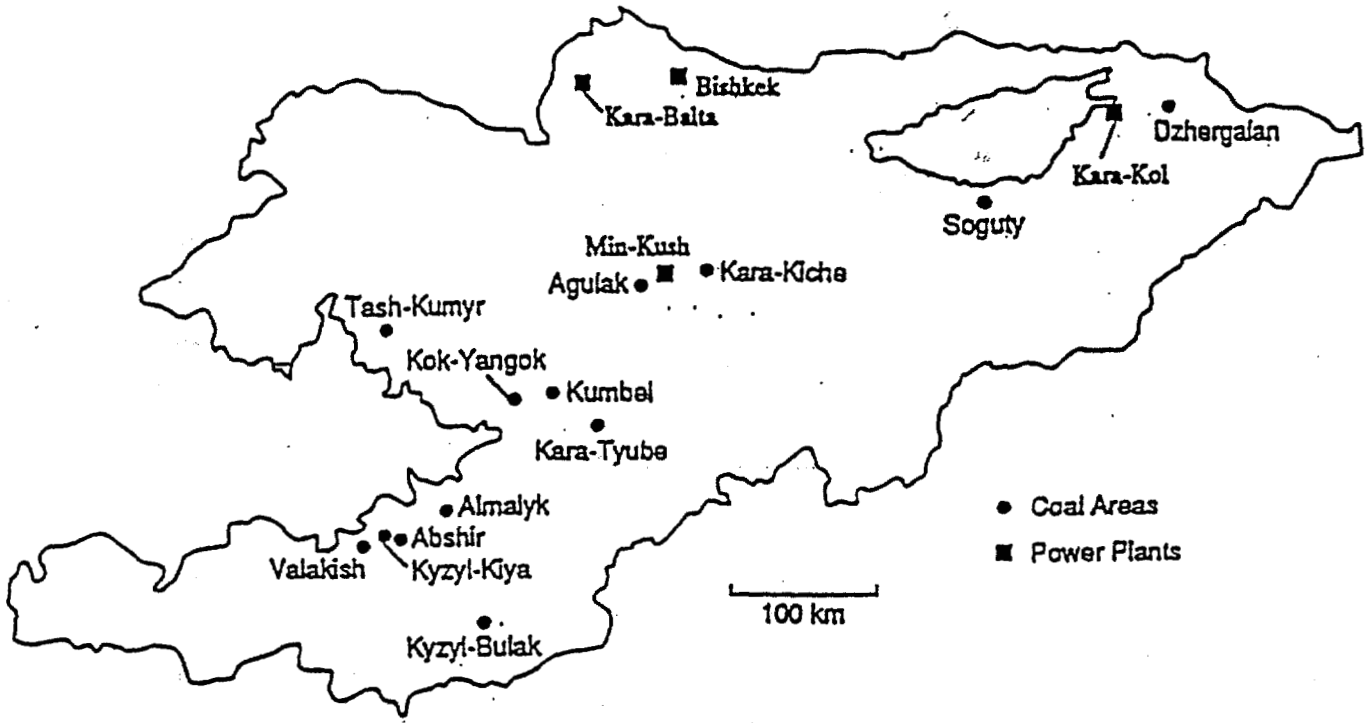

Figure II-2. Kyrgyzstan, showing the coal areas and power plants visited by the assessment team.

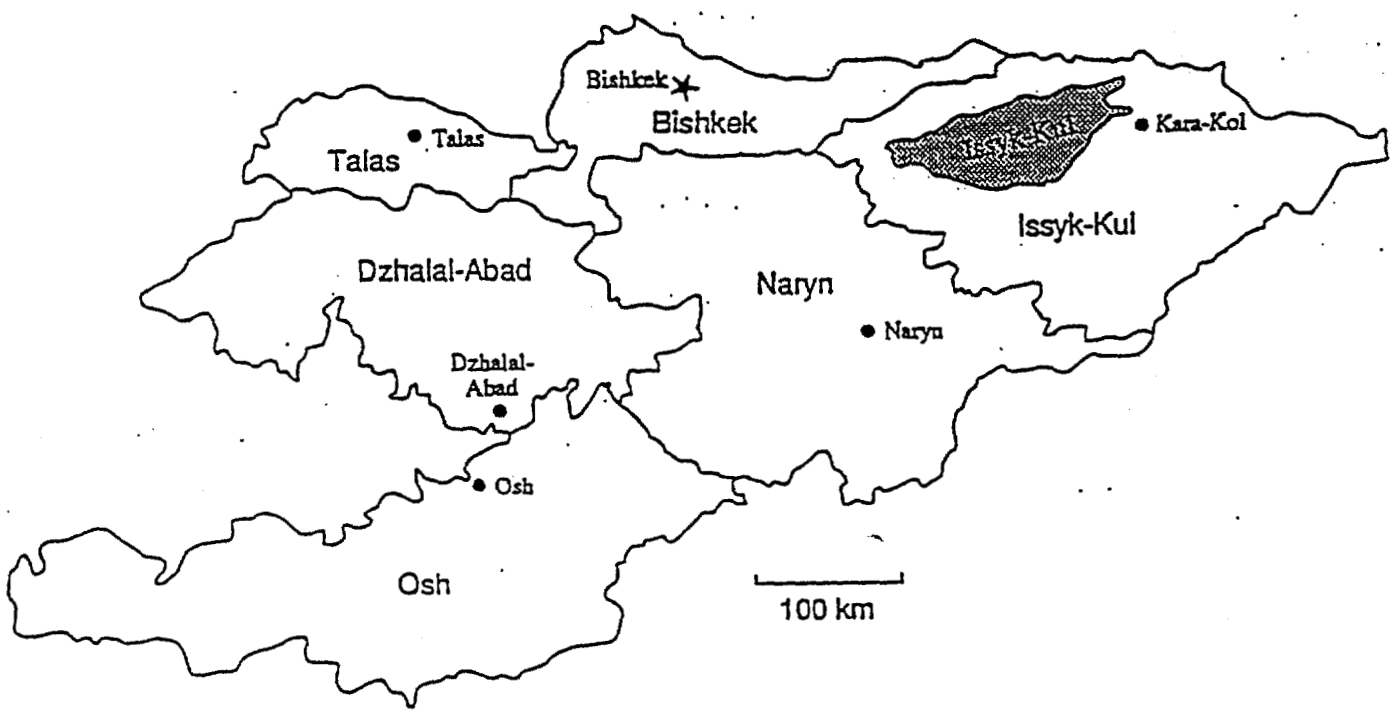

Figure II-3. Kyrgyzstan, showing the six political subdivisions (oblasts) with their principal cities. Issyk-Kul is a large land-locked lake.

undeveloped because the valleys and mountains of Kyrgyzstan are physiographically and geologically complex, transportation infrastructure is poorly developed, and population is sparse in many areas. In this report we will group the mines and other occurrences in the following regions (Figure II-1):

1. Issyk-Kul region in the northeastern part of the country.
2. Kavak region in the center.
3. North Fergana region in the western part.
4. South Fergana region in the southwestern part.
5. East Fergana (Uzgen Basin) region in the southern part.
6. The Alay region (including the mountains north and south of it) in the southwestern part.
7. South Central region, the coal deposits isolated east of the Fergana Range in the south central part of the Republic.
8. The Chu region (near the Kazakstan border north of Bishkek).

Shallow excavations for local use have yielded coal at several localities in the South Central region and one small mine is operating. The Chu region is unexplored.

The overall resources (geological reserves) of coal in Kyrgyzstan have been reported as about 31,000 million tonnes. Of vastly more importance is the amount economically recoverable in the next few years and during the next decade or two, detailed later in this report. In some of the reported localities the coal resources are known and adequately explored and large quantities of coal await decisions necessary for recovery. In other parts of the republic, particularly in previously remote areas, the coal resources are inadequately understood or largely unexplored. The resource and reserve inventory of Kyrgyzstan is at best incomplete, and for some purposes, such as short-term local and long-range national planning, it may be inadequate.

E. OTHER FOSSIL FUELS

In addition to coal, the Kyrgyz Republic has limited known resources of conventional oil and associated gas, natural gas , and unevaluated potential resources of coalbed methane.

Prior to dissolution of the USSR, oil and gas exploration of the Fergana basin of Uzbekistan, Tadjikistan and Kyrgyzstan resulted in finding more than fifty fields, most of which are in the margins of the basin. A study of the oil and gas resources of the Fergana basin published by the Energy Information Administration (1995) states that 14 of the 53 discovered oil and gas fields in the basin (26 percent), about 16 percent of the ultimate oil recovery from discovered fields, about 9 percent of ultimate associated-dissolved gas from discovered fields, and about 44 percent of ultimate non-associated gas from discovered fields are in Kyrgyzstan. Bazarbaev, E. G., and others, (1993) stated that the oil and gas industry of the nation was producing from 13 fields with "industrial " reserves of about 102 million barrels of oil (14.6 x 10^6 tonnes) and 172,000 million cubic feet of gas (4.9 x 10^9 m^3). Operating wells totalled 438 with an average production of 6.3 barrels of oil per day. They further stated that four of the main fields are in the last stage of

development, with decreasing production, and that another five fields are almost completely developed and that production is decreasing there also.

Ulmishek and Masters (1993) estimated that the total undiscovered oil resources of the Fergana basin were about 3,000 million barrels, the total undiscovered natural gas resources of the basin were about 3 trillion cubic feet, and that as much as 20 percent of the undiscovered oil and gas resources were in Kyrgyzstan. No estimates for undiscovered resources in other parts of Kyrgyzstan are available. Ulmishek and Masters (1993) recognized two other basins in Kyrgyzstan that might be petroliferous and Bazarbaev, E. G., and others, (1993) point out that there are more than 10 intermontane basins in the Republic with varying prospects for oil and gas. The latter further state that "...they have all ...been extremely poorly studied by oil and gas prospecting operations, and in some of them no such work at all has been carried out."

To the team's knowledge, no exploration for coalbed methane resources has been conducted in Kyrgyzstan. There may be coals of appropriate rank and depth present in the Republic but the presence, and amount, of gas available for recovery from the coal of the Kyrgyz Republic can only be determined by further specific studies.

F. ACKNOWLEDGEMENTS

An assessment necessarily requires gathering information from a wide range of available sources and receiving fact, opinion, and advice from a wondrously-assorted spectrum of groups and individuals. It is impossible to here record individual thanks to all who have helped us, but we do wish to express a sincere collective thanks to the people of Kyrgyzstan. Their hospitality, knowledge, helpfulness and good humor are unmatched.

We especially must thank Charles Bliss and Rolf Manfred of IDEA Inc./USAID for technical management support, and Paul Hearn, Lisa Martin and Robert Milici of USGS for their guidance and help. Most particularly, we thank K.M. Mukambetov, D.K. Kamchybekov. N.T. Kozhomatov, M.M. Khudoyarov and A. P. Pakhridinov of the Ministry of Industry, Material Resources and Trade. The enthusiastic and knowledgeable assistance of T.D. Sadabaev, G.T. Izumov and I. Bekishev, of KYRGYZKOMURHOLDING, was very helpful. In addition we thank K. Kakitaev, T.S. Solpuyev and T. Kydyrbaev of the Ministry of Geology and Mineral Resources, and Dr. Apas Bakirov of the Institute of Geology of the Academy of Sciences. Without the cooperation, participation and patience of these gentlemen this assessment would not be possible.

III. COAL IN KYRGYZSTAN

A. GEOLOGIC SETTING

Coal in Kyrgyzstan is of Jurassic age. That is, the coal is younger than the main bituminous coals of Europe, eastern North America, South America, Australia and India. The Kyrgyz coals are, however, older than the low rank coals of western North America. Significant coals of about the same age as those in Kyrgyzstan are present in other Central Asia countries, China, and Russia.

In central Asia the rocks of Jurassic age are overlain unconformably by a variety of rock types ranging from marine Late Cretaceous sedimentary rocks to non-marine thick wedges of fan-type coarse clastics shed by the up-lifted mountains being formed during the ongoing Alpine Orogeny. The net effect of Late Cretaceous, Tertiary, and Quaternary geologic history has been concealment of the Jurassic coal-bearing rocks, though exhumation by recent erosion is presently occurring.

Kyrgyzstan and adjoining parts of Central Asia have had a very complex geologic history, and much of that history is preserved in the rocks comprising the country. Bakirov and Burtman (1984) recognize four megastages in the geological history of the area. Each megastage is either geosynclinal- orogenic or platform-orogenic in character. From the standpoint of coal geology, only the history of the last megastage, the Mesozoic-Cenozoic platform-orogenic megastage, directly affects the presence and distribution of coal-bearing rocks in the country.

The coal-bearing rocks of Kyrgyzstan are of continental origin and were deposited north of the Tethyan Sea that formerly occupied a large area in central and southern Asia. At least four transgressive-regressive cycles of the seas occurred between Late Triassic age and Late Jurassic age in southwestern and southern Asia (Poliansky, 1980). As much as 6,000 meters of Late Triassic and Jurassic rocks of both continental and marine origin were deposited in localized sedimentary basins on the periphery of the Tethyan Sea. The Jurassic rocks that are preserved in Kyrgyzstan were possibly deposited during the middle two of the above-mentioned cycles. Most occurrences of the Jurassic rocks in the country seem to be tectonically separated remnants of formerly more extensive bodies of Jurassic rocks (Fig III-1).

The Jurassic rocks of the Uzgen Basin are one of the largest occurrences of Jurassic sedimentary rocks exposed in central Asia. Solpuyev and Bakirov (oral communication, 1994) state that the Jurassic rocks are thinner and mostly of continental origin in the northern part of the Basin where coals occur, and increasingly thicker and more marine in origin in the southern part of the Basin. Faulting, folding and erosion, all mostly related to the latest cycle of mountain building, the Alpine Orogeny, have locally displaced or removed segments of the Jurassic rocks in the Basin. The rank, type, and quality of the coals in the Basin reflect their depositional history and subsequent geologic events in the area.

Figure III-1. Simplified vertical section of sedimentary basins and terrain south-to-north across Kyrgyzstan, viewed from the east at the eastern end of the Fergana Valley, center left, and near Bishkek, at the right (See line on Fig. II-1). Paleozoic and older rocks (mostly metamorphic and igneous basement) are unshaded. J = Jurassic (coal bearing), K = Cretaceous, P = Paleogene, N = Neogene, Q = Quaternary. From Adyshev, and others, 1987. Vertical exaggeration 6:1.

B. COAL REGIONS AND AREAS

1. Alay Coal Region

The Alay coal region comprises a west-trending, discontinuous series of subbituminous coal deposits just north of the Tadjikistan border in southwestern Kyrgyzstan (Fig. II-1). The area extends from Sary Tash on the east down the Kyzyl Suu River valley to the border with Tadjikistan on the west. There are seven named coal localities in the region and the resource potential of the region is poorly understood because of a lack of exploration. Most of the known coal localities are in the foothills of the Alay Range and access for exploration may be difficult because of lack of roads. Two small surface coal mines in the Kyzyl-Bulak area are presently in operation and another in the Noruskul area recently started operations (Fig. II-2).

2. South Fergana Coal Region

Coal has been mined in the South Fergana coal region since at least 1866. The region extends along the south side of the Fergana Valley from the southwestern end of Kyrgyzstan to near the city of Osh. Fifteen named coal deposits are known in the region (Fig. II-1). Many of them have been or are being mined and some have been only partially explored. All of the coals in the region are of brown coal rank, perhaps largely of subbituminous B rank in American classification. Most of the deposits are of relatively small size because the Jurassic-age coal-bearing rocks are preserved in folded and faulted segments of the southern edge of the Fergana basin.

A major portion of the coal formerly produced in the region was destined for industrial and boiler fuel and domestic use in adjoining parts of Tadjikistan and Uzbekistan. That market has at least partially disappeared because of national / economic borders that now dissect natural regions, but various types of barter arrangements exist.

3. East Fergana Coal Region (Uzgen Basin)

The East Fergana coal region contains seventeen named coal localities in a belt of Jurassic rocks that extends from near Dzhalal Abad southeast to the border with China (Fig. II-1). The region contains the largest block of coal-bearing Jurassic rocks in the Republic and the rocks are all believed to have been deposited in the same depositional basin, the Uzgen Basin (Kashirin, Ibragimov, and Karabalayev, 1975). Folds and faults are common and some parts of the block are now isolated from the main mass. The Jurassic rocks are thinnest in the northwestern part of the region and there are more coal beds in that area. The Jurassic rocks are as much as 5,000m thick in the southern part of the region but there are fewer coal beds. All of the coal-bearing rocks of Jurassic age are preserved on the southwest flank of the Fergana Range. The Fergana Range is the site of the Talas-Fergana fault, a striking structural feature of Central Asia with lateral displacement of as much as 180 km with movement continuing at the present time. A member of the Institute of Geology called it their San Andreas fault.

The coal in the region ranges in rank from bituminous to anthracitic. Some of the coal is

reported to have coking characteristics but there is no market demand for this coal at present. Some places in the region have long mining histories but many areas are poorly explored and undeveloped. Several localities in the region are presently producing coal from mines opened as part of the Private Enterprises Mining Program and some other areas might be suitable with more exploration and access.

4. North Fergana Coal Region

The North Fergana coal region comprises a northwest-trending belt of Jurassic rocks that extends from the small village of Avletim on the north to the Kara Unkyur River on the southeast. Coal of subbituminous-A and -B rank (long-flame rank) is present at seven different localities in the region. Although Dzhal-Abad is the main city of the region, Osh is the major city servicing the coal industry, and the headquarters of both the KYRGYZKOMUR and the Association of Small (Private) Enterprises are located there. Direct access to the region is by good roads that cross Uzbekistan. The coal deposits of the North Fergana Region were selected for early development in energy budget planning for the central Asia region of the former Soviet Union because of their location relative to transportation infrastructure and to areas of energy need. The mining complex headquartered at Tash-Kumyr includes The Kara Tut and Tegenek mines. In this general area the coal-bearing sequence contains several seams that are mined in different parts of the area. In some localities, such as the Severnay underground mine, two or more coal beds contained major reserves.

Most of the coal localities are located in the foothills of the Fergana Range near or in the valley of the Naryn River. Near here the Naryn is joined by other streams and, named the Syr Darya, extends northwest as the major source of water for the irrigated farming areas of Uzbekistan and Kazakstan and eventually to the dwindling Aral Sea.

In the past, the North Fergana Region produced much of the coal that was transported by railroad to destinations in Kyrgyzstan, Uzbekistan, and Kazakstan. For a variety of reasons these markets no longer exist or are only partially accessible.

5. South-Central Coal Region

Coal is known to be present in three deposits in the South Central coal region. The known deposits are all in small exposures of the coal-bearing rocks of Jurassic age. The rocks of Jurassic age are only exposed at a few places in the region but could from a geological perspective be present underneath younger rocks at other places as well. Exploration of all types is needed to allow even a preliminary understanding of the coal resource potential of the region. The rank of averaged samples reported from two sites is subbituminous-C (B3 rank).

The lightly-inhabited region is poorly connected by roads to the remainder of Kyrgyzstan. A ready market exists there for coal hauled into the region from the Kavak coal basin. A new mine in the Turuk area was inaugurated by the President of the Republic in December, 1995. Reportedly, attempts are underway to open a mine in the Aksay area. The region is suffering an energy shortage and the team received reports from diverse sources that residents were starting to cut the existing

trees for winter fuel. Exploration of more of the known coal deposits to assist Private Enterprises mining should be undertaken as soon as possible.

The very limited exploration done to date provides small basis for resource evaluation in the area, but the Aksay area is estimated to contain as much as 121 thousand tonnes of coal, all in the inferred category (but not approved by a central commission), and the Turuk area is predicted (P3) to contain about 5 and a half million tonnes of coal, of which 62 thousand tonnes are in the balance category (but not officially approved) and the rest, 5.4 million tonnes, in the speculative category. There are no available resource estimates for the Turugart area but thin lenticular bodies of poor quality coal are reported at several places in an area 1km by 17km. Coal is reportedly present at least one more place in the region but no information is available.

The region contains the upper part of the Naryn River, the site of numerous hydropower development proposals. Supplemental sources of energy in the region will be needed during development if it proceeds. Whether coal can provide that other energy must be determined by exploration.

6. Kavak Coal Region

The Kavak coal region is located in the central part of Kyrgyzstan 130 km south of Bishkek. The six named coal localities in the region are in the foothills of several discontinuous mountain ranges that occupy much of the central part of Kyrgyzstan. In particular, most of the region lies between the Dzhumgoltau on the north and the Moldotau on the south. To reach the Kavak region from Bishkek one must travel east to Balykchy near the western end of Lake Issyk Kul and then proceed southwest an equal distance to the region. Alternatively, the Kavak region can be reached over a precipitous road over the Kyrgyz Range south of Kara Balta, which is west of Bishkek.

The coal occurs within a discontinuous, west-trending belt of Jurassic rocks in the general vicinity of Min Kush. Two operating coal mines are located in the Kavak region, Kara-Kiche and Agulak. The two mines are separated areally by about 42 km, but by road the distance is about 90 km. Both mines are administrated from Agulak. In addition to these two mines, at least four undeveloped coal occurrences are reported to be present in the area. Development and recovery of coal in the region has largely taken place in the past few years but geologic understanding of the area is well advanced because the Jurassic rocks that contain the coal also contain uranium that was intensively mined a few decades ago. Recently, a private enterprise mine has been developed in the Kara-Kiche area. The coals are subbituminous-B in rank (B3 rank).

Total resource estimates for the region are about 812 million tonnes. This is probably a conservative figure that would be increased if exploration was resumed to increase the recoverable reserves of the region .

7. Issyk-Kul Coal Region

A narrow belt of Jurassic sedimentary rocks, including coals, extends nearly the entire length

of Issyk-Kul' (lake) along its south shore and an equal distance farther east past the border into Kazakstan nearly to China. In parts of this belt of rock many coal beds have been reported, but only two sites with adequate thickness, extent, and access are known to date. Soguty, at the town of Kadzhi-Say on the south shore of Issyk Kul, is subbituminous coal, mined both for energy and, in the 1940's, for uranium from ash concentrates; Soguty closed in 1995-96. Dzhergalan, east near the Kazakstan border, is mined for high-volatile bituminous coal (long-flame coal).

Both of the mines formerly supplied coal to the district heat plant at Kara Kol (Przhevalsk) at the east end of Issyk Kul. The mine at Soguty is in the process of deactivation because the recoverable reserves are reportedly depleted. The present mine at Dzhergalan still has minable reserves to recover and in addition there is an estimated 12 million tonnes of proven and probable reserves nearby that could be mined if new inclined shafts were built.

8. Chu Coal Region

The Chu region is located in the northernmost part of Kyrgyzstan about 40 km northwest of Bishkek. Chu is the name of the westward-flowing river that forms a portion of the country's border with Kazakstan. A coal-mining complex is located just across the border in Kazakstan where Jurassic coal-bearing strata are exposed at the surface. Currently, mining activity is in suspension because of economic competition with the more extensive and better developed coal deposits in central Kazakstan. The reason Chu is discussed in this report is that it is possible that the coal-bearing strata exposed in Kazakstan are present in the subsurface of Kyrgyzstan below Quaternary deposits in the area north of Bishkek. Seven oil and gas exploration holes have been drilled just southeast of Bishkek on an anticlinal structure. None of these holes encountered coal. At the time of our visit in the fall of 1994, an oil and gas exploration hole was being drilled near Kara Balta, about 60 km west of Bishkek. The hole had reached a depth of 1,500 m but was still in the Tertiary part of the section. The hole is scheduled for completion in Paleozoic strata at a depth of 3,000 m. The resource potential of the Chu region cannot be evaluated without exploration drilling for coal in the area immediately south of the border with Kazakstan.

C. RESOURCES AND RESERVES

1. Classification

There is no standard coal resource and reserve classification system that is applied worldwide. Two of the most widely used are the system adopted by the U.S. Geological Survey for use in the United States (Wood and others, 1983), and the system used in the former Soviet Union (Bybochkin and others, 1983; Modelevsky and others, 1979). In the USA system, resources are deposits of coal in such forms and amounts (thickness and depth) that economic extraction is currently or potentially feasible and identified resources are those resources whose location, rank, quality and quantity are known or estimated from specific geologic evidence. Reserve base is those parts of identified resources that meet specified minimum physical and chemical criteria related to current mining and production practices, including criteria for quality, depth, thickness, rank, and distance from points

of measurement. Reserves are the parts of a coal reserve base which could be economically extracted or produced at the time of determination considering environmental, legal, and technologic constraints, and include only recoverable coal. An important point is that reserves are time-dependent -- todays' resources may be tomorrow's reserves, and some of today's reserves may fail to be qualified for future economic conditions. In contrast, estimates of resources are relatively stable and are not necessarily responsive to changing technology, economics or politics.

In the former Soviet Union (FSU) system, the term "resources" is rarely used, and only in the sense of total geological resources (and reserves is the preferred term). Usually, the term "reserves" is used, with modifiers, throughout the classification system. Because an elephant is an elephant, there are general equivalencies between the USA and FSU systems. The major difference is that reserves in the western sense are dependent on the price of coal. In contrast, in the FSU classification system, the concepts of coal "price" and "value" are not as important and the term "reserves" may not imply economic recoverability today. The FSU term "reserves" (zapasy) does not necessarily mean that the market price of the coal equals or exceeds the cost of mining it.

In the FSU system "total geological reserves" are divided into "identified reserves" and "undiscovered reserves". "Identified reserves" are divided into "balance reserves" and "out-of-balance reserves. "Balance (commercial) reserves", are potentially recoverable and may be roughly equivalent to the economic portion of the identified resource category in the USA system. "Out-of-balance (noncommercial) reserves" are probably roughly equivalent to the subeconomic portion of the identified resource category of the USA system (figure III-2).

Balance (commercial) reserves are further subdivided into categories A, B, C_1 and C_2 according to reliability of reserve estimation, and coal quality, and of mining conditions."(Kamenov and Zheleznova, 1984; Modelevsky and others, 1979).

Resources

In 1983, Dzhamanbayev reported the total energy resources of Kyrgyzstan, in percent, as follows:

Coal----------52.97 percent
Shale---------- 0.25 percent
Peat----------0.06 percent
Water Resources--------45.21 percent
Other----------1.51 percent

"Other" is mostly oil and gas, described in section II.E. --OTHER FOSSIL FUELS. The cited percentage represents more than 31,000 million metric tonnes of coal originally in place, and indicates that Kyrgyzstan contains more than 50 percent of the coal in central Asia (Kazakstan not included).

Dzhamanbayev further states that the general geological reserves (resources) of Kyrgyz coals

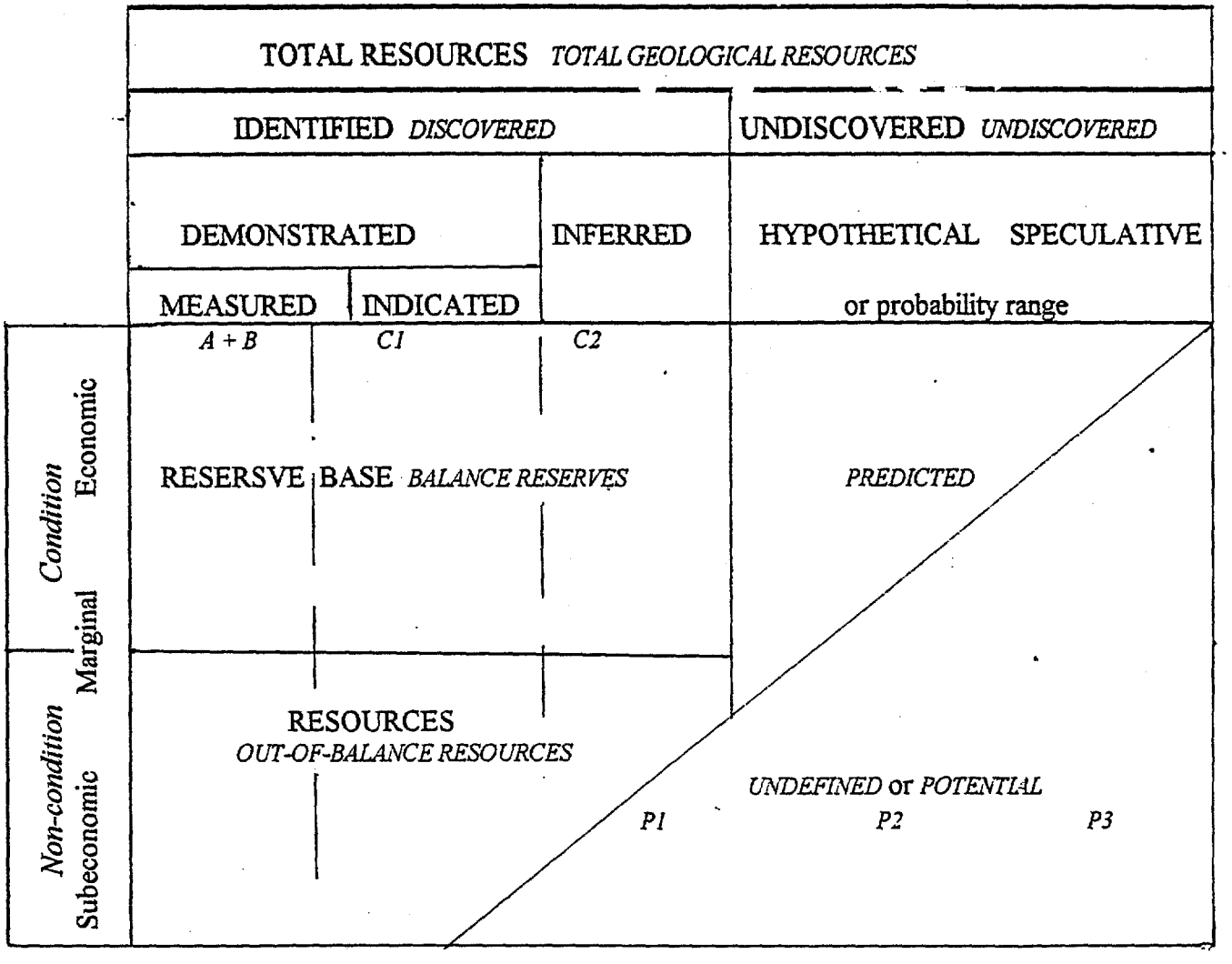

Figure III-2. Approximate relationship of balance reserves and letter-designated reliability categories of the former Soviet Union resource classification system *(italics)* to equivalents in the U.S. Geological Survey system.

in 1982 amounted to 31, 415 million metric tonnes, of which the balance reserve is 2,429 million tonnes. Kopylov (1977) presented an estimate of 28,352 million tonnes of total geological reserves with 2,236 million tonnes in the balance reserve group. Other available estimates do not differ significantly.

The relationship of the estimated total geological reserves of an area to the portion of the total that can be reliably categorized as balance reserves varies according to the amount and distribution of accurate information that is available. Matveev (1976) recognized large differences in the degree of coal exploration that has been conducted in various parts of the world and stated that the coal resources of the former Soviet Union and of the United States were both relatively poorly explored compared to the coal areas of Europe. For comparison, only about 8 percent of the total geological reserves of Kyrgyzstan are in the balance reserve category, about the same as the former Soviet Union, and about 11 percent of the total estimated coal resources of the United States are categorized as demonstrated reserve base (reserves that may be economically recoverable). Perhaps areas such as the FSU and USA, each with more than 400,000 million tonnes of well-defined reserves, can afford to be poorly explored. If coal is to continue to contribute a major portion of the energy budget of Kyrgyzstan, the country must evaluate its resources and actively explore for easily exploited reserves.

2. Coal availability

The numbers cited in the preceding paragraph indicate, at first glance, that there are ample available coal resources in the areas discussed. However, it has long been recognized in the United States and elsewhere that if the effects of mined-out prime coal reserves, and environmental, industrial, economic, and social considerations are "priced" and the value of the coal is considered, the amount of coal that would be available and economically recoverable would be far less than the amount classed as "demonstrated reserve base" [or as "balance reserves"] (Rohrbacher and others, 1993).

The U.S. Geological Survey, Kentucky Geological Survey and the U.S. Bureau of Mines have jointly addressed the problems of coal availability and recoverability in pilot programs designed to produce results of wide-ranging applicability. To date, eleven areas in the Central Appalachian Coal Field, each area a quadrangle about 150 square kilometers in size, have been studied. Results of the studies show that 1.6 to 36.4 percent of the original coal resources have been mined and lost-in-mining, but that only 13 to 35 percent remains as a recoverable resource, and that only 1.6 to 23.1 percent of the original resource can be classed as economically recoverable reserves (Rohrbacher and others, 1994 and Scott, D.C., 1995) (figure III-3).

The above cited sources conclude that:, "*These results suggest that there may be several orders of magnitude of difference between coal resources and the amount of coal that can be economically recovered. If similar results are found in subsequent investigations, a strong argument can be made that traditional coal producing regions may experience resource depletion problems far greater and much sooner than previously thought. This will affect not only the coal industry, but the entire social and economic infrastructure of large areas.*"

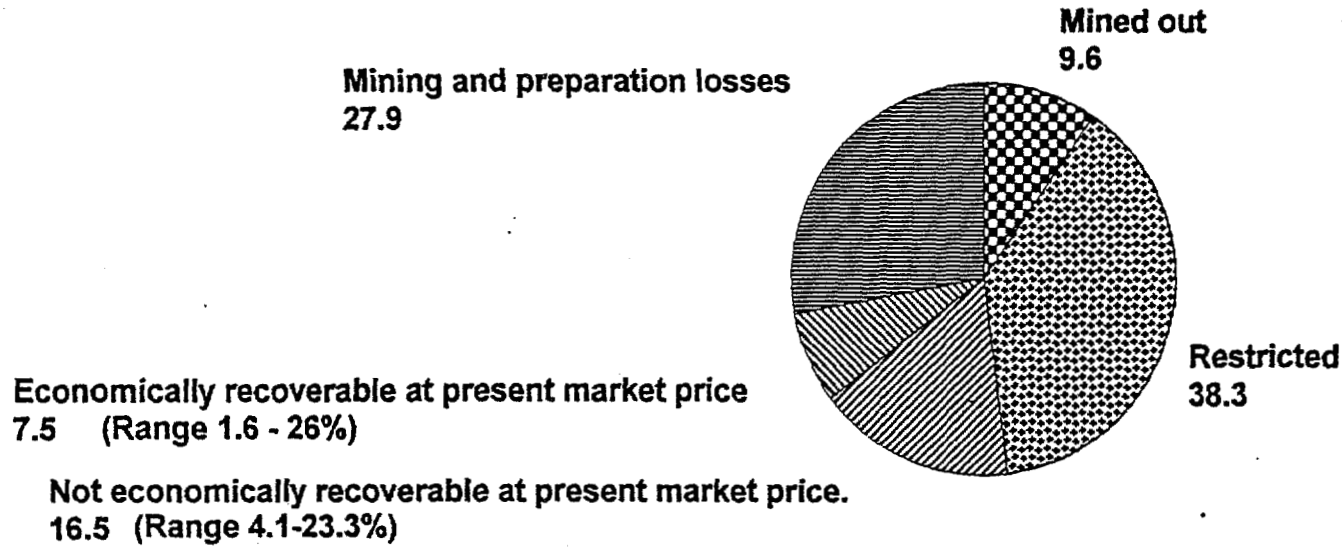

Figure III-3. Percentage of original resources of 11 quadrangles of the central Appalachian coal field, U.S.A., in different recoverable and nonrecoverable categories (see text citations for sources).

Availability and recoverability studies of the coal areas in Kyrgyzstzan could be equally as enlightening and provide reliable data for energy and social planning for the future.

3. Area and Region Reserve Estimates

Estimates of the quantities of coal that are present in the known deposits in the former Soviet Union (FSU) have long been conducted under a uniform methodology designed to provide quantified understanding of the available coal resources according to physical and chemical categories. Other similar classification systems are used elsewhere in the world. The system used by the USGS (Wood and others, 1983) is widely accepted in concept and practice in various countries around the world.

The FSU estimation system and the USGS system are philosophically similar but methodologically different. The FSU system is somewhat more rigid and tends to deprecate extrapolation of data from known to unknown areas. The USGS system allows and encourages extrapolation. No comparative estimates were made for this study but examination of maps showing resource and reserve areas indicates that the two systems produce somewhat comparable results, especially for areas where there are more data. The FSU categories A plus B are approximately equivalent to the USA category "measured". The FSU category C_1 is approximately equivalent to the USA category "indicated". The FSU category C_2 is approximately equivalent to the USA category "inferred". The FSU categories P_1, P_2, and P_3 are approximately equivalent to the USA categories "hypothetical" and "speculative" (Figures III-2 and III-4).

A very recent estimate of the amount of balance (commercial) and non-balance (noncommercial) reserves of Kyrgyzstan is as follows, in million tonnes:

Groups	Balance		Non-Balance
	$A+B+C_1$	C_2	
Brown coal	849	389	102
Bituminous coal and anthracite	431	593	84
Surface-mine reserves	305	31	15
Underground-mine reserves	989	951	171
Total	1294	982	186

The above estimate may reflect recent production and unspecified engineering parameters. All of the estimates indicate that the balance reserves of Kyrgyzstan, roughly equivalent to USA identified resources, may be dangerously small.

Table III-1 is one of many attempts to summarize various bodies of information regarding the estimated reserves of the better-known coal areas in Kyrgyzstan. Some of the estimates have been updated periodically and reflect increased knowledge as exploration and development is conducted

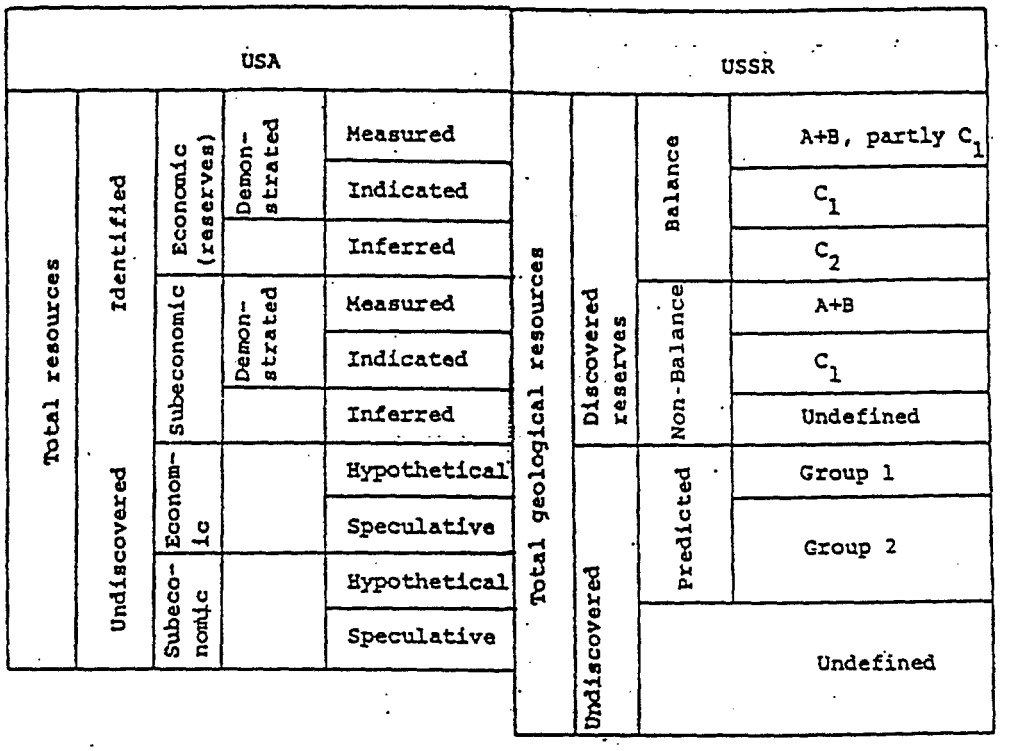

Figure III-4. Comparison of terminology of coal resource/reserve classification systems of the U.S. Geological Survey and the former Soviet Union (after Modelevsky and others, 1979).

Table III-1. Estimated balance reserves in coal areas in Kyrgyzstan (millions of metric tonnes, rounded).

	$A+B+C_1$	C_2	Total
South Fergana Coal Region			
Kyzyl-Kiya	92	19	111
Abshir	10	3	13
Valakish	2	1	3
Sulyukta	193	14	206
Almalyk	20	0	20
Total	317	37	353
East Fergana Coal Region			
Kok-Yangak	123	15	138
Kumbel-surface	11	0	11
Kumbel-underground	18	11	29
Tuyuk	31	83	114
Kargasha	100	70	170
Beshterek	7	4	12
Kara-Tyube	33	66	99
Kok-Kiya	0	114	114
Zindan	17	31	48
Chitty	0	9	9
Total	340	403	744
North Fergana Coal Region			
Tegenek-surface	7	0	7
Tegenek-underground	48	4	52
Kara-Tut-surface	30	0	30
Kara-Tut-underground	12	6	18
Tash-Kumyr(Severnaya)	14	0	14
Tash-Kumyr(Other)	31	14	45
Total	142	24	166
Kavak Coal Region			
Agulak	48	18	67
Min-Kush(3 areas nearby)	38	125	164
Kashkasu	5	7	12
Kok-Maynok	61	69	130
Kara-Kiche-surface	194	1	195
Kara-Kiche-underground	118	125	244
Total	464	345	812
Issyk-Kul Coal Region			
Soguty	10	2	12
Dzhergalan	3	0	3
Dzhergalan(extended)	12	4	16
Total	25	6	31
Grand Total-above listed areas	1288	815	2106

and mining proceeds. How closely they represent remaining economically recoverable reserves in a western context is unknown.

Many relationships are apparent in table III-1. For example, 61 percent of the total of the $A+B+C_1$ (demonstrated) balance reserves are in mined areas (older 42% and newer 19%), and still 41 percent of the total reserves are in the mined areas. In contrast, in the USA, demonstrated reserves are about 25 percent in mined areas. The ratios cited for Kyrgyzstan suggest that most past exploration has been concentrated in direct support of mining. The total balanced reserves listed above are only about 7 or 8 percent of the total geological reserves of the country. Exploration to increase the balanced reserves of the nation appears necessary.

Table III-2 is an attempt to separate total estimated balance reserves into the portion that has been or is now closely involved in mining operations (and therefore may not be available for future use) and into the portion that has been explored but not exploited (and therefore may still be available for future use). The table shows some interesting relationships: 1) 62 percent of the total balance reserves are in the $A+B+C_1$ (demonstrated) category. The same high proportion of demonstrated reserves persists in the active sectors but is somewhat relieved in the inactive sectors where the ratio between reserves in the $A+B+C_1$ category and in the C_2 category is about 1:1. In other parts of the world the ratio would probably be 1:3 or more. 2) 65 percent of demonstrated reserves are in "explored only" sectors; and 3) 80 percent are reserves for underground mining.

D. PHYSICAL AND CHEMICAL CHARACTERISTICS

1. Chapter summary and the concept of coal quality

The "quality" of coal depends on many things that influence how easily and profitably the coal can be produced and used. The location, quantity, position in the earth and ownership are considered elsewhere in this report. Physical and chemical properties of the coal are described here. These properties must be addressed systematically in their entirety; they can not simply be evaluated as "good" or "bad", for that depends on the particular time and situation and on the particular use.

The general nature of Kyrgyz coals is summarized here, and the systematic details are presented later.

a. Rank

Most Kyrgyz coals are subbituminous or high-volatile C bituminous rank in U.S. terms. In Kyrgyz terms they are brown-coal 3 or long-flame. In the international classification established after WW-II, and used still in Europe, their rank (class number) is "8". In the East Fergana (Uzgen Basin) region are coals with much higher rank, ranging up to anthracite.

Parameters described later in this chapter that may be used for various rank classifications are vitrinite reflectance, volatile matter (mineral-free or ash-free), heating value (various bases), and

Table III-2. Kyrgyzstan balance coal reserves in areas developed for mining in contrast to balance reserves in explored but undeveloped areas.

Type of Reserves	Underground			Surface			Total		
	A+B+C1	C2	Total	A+B+C1	C2	Total	A+B+C1	C2	Total
Explored and Confirmed	901	749	1650	368	35	403	1269	784	2052
Within active shafts and pit sectors	342	40	382	315	31	346	657	71	728
Explored ONLY sectors	559	708	1264	53	4	57	612	712	1324

moisture content (inherent bed moisture). Some data on tar extracts and humic materials are available in the literature on Kyrgyz coals; these data have been used for ranking brown coals (Mironov, 1982; Taits and Andreyeva, 1983).

b. Heat yield

On an as-received basis most Kyrgyz coals can be produced with heat yields of 20 to 25 MJ/kg (4700-6000 kcal/kg, 8500-11000 Btu/lb). Some production is known to fall below 15 MJ/kg because of dilution with rock. Several mines yield coal with heat value slightly higher than the above ranges, and coals occur in the East Fergana (Uzgen) region with 30 MJ/kg and probably higher. This chapter lists heat values in MJ/kg, kcal/kg, and Btu/lb, on as-received and dry bases, and calculated to mineral- and ash-free bases.

c. Mineral and rock content, and ash fusion properties

The mineral and rock contents of coal are usually reported somewhat indirectly, as weight percent ash after high-temperature ashing, dry-coal basis. Data over many years show that the Kyrgyz mines produced coal with ash values as low as 3% and as high as 40%, but most mines were able to produce coals with 10-20% average ash through much of their history. In this chapter we have data on ash, both dry and as-received basis and some values of calculated mineral content. We report 4-point softening and fusion data for ash from our samples, under both reducing and oxidizing conditions, but we do not yet have information on boiler practice in heat or electricity stations in Kyrgyzstan with which to evaluate these ash data with respect to fouling of combustion chambers.

d. Organic type of coal

Two very different ways of reporting organic type are common: 1) Visible identification of macerals under the petrographic microscope, 2) Indirect indication from chemical analysis, usually just by ratios of hydrogen, carbon and oxygen. This chapter gives both maceral group petrographic analyses and chemical analyses.

Petrographically, Kyrgyz coals have a greater range of composition than most U.S. and European coals -- mainly a greater content of inertinite. We did not find coals with large amounts of liptinite in our samples nor in the literature. The Kyrgyz coals with high inertinite content appear to be similar to some other high-inertinite coals in the former Soviet Union; they may be similar to many high-inertinite coals of India, Australia or South Africa.

Chemically, the Kyrgyz coals have lower H/C ratios for a given rank than many North American and European coals, and some Kyrgyz coals have element compositions that place them clearly in the "fusinization development line" which characterizes development of coals under oxidizing conditions.

e. Sulfur and other inorganic elements

The sulfur content of Kyrgyz coals is relatively low, with major coals reported to have not over 2% on average, but the range is very great, with individual values from several important mines as high as 7%. Three of our samples slightly exceeded 2%. We report data on three forms of sulfur in the coal (pyritic, organic, sulfate) , but comparable data from the literature on Kyrgyz coals are sparse. We report the major and minor elements in coal ash, which range greatly, but that is not unusual. Similar older data from Kyrgyzstan are reported. We report trace element content of our samples and explain their environmental significance, but have not yet found comparable older data on Kyrgyz coals.

2. Data and samples of this study

a. Kinds of raw data included

This chapter lists basic properties that characterize coals in Kyrgyzstan based on fifteen mine samples collected by the USGS at twelve separate deposits representative of existing mines and several potentially significant new mines. The data include the following which are commonly requested internationally to evaluate coals for utility combustion (Unsworth and others, 1991).

Heat Value (Specific Energy)
Total Moisture
Ash
Volatile Matter
Total Sulfur
Nitrogen
Chlorine
Hardgrove Grindability
Ash Fusion Character
Ash Major and Minor elements

In addition, we provide data used to evaluate processing and industrial use and environmental consequences of coal use.

Forms of sulfur
Free swelling index
Equilibrium moisture

Maceral group composition
Apparent specific gravity
Thirty two trace elements in the ash
"Environmentally sensitive elements" (chlorine, selenium and mercury), whole coal.

On numerous graphs we show the relationships between various parameters and also their

general validity. Additionally, we compare these data with some published and unpublished older data on Kyrgyz coals, mostly from the Soviet era, so that the large body of older information on coal quality can be judged by our data.

b. Information not included

There is a significant amount of information on Kyrgyz coals which we do not present or discuss here because it is beyond the scope of this preliminary survey. For example, tests of pyrolysis behavior and products, mineral transformations at high temperature, semicoke and coke formation, sorptive properties, tar production and type, briquetting and pelleting tests, extraction with organic solvents, humic acid fractionation, etc. The potential value of such information is difficult to judge, for in the most accessible sources the data are usually presented isolated from the basic information about the character of each sample. However, the systematic field and laboratory records from the Soviet era appear to be preserved in large measure -- though the loss of access because of retirements, switching jobs, and emigration and even the physical loss or disorganization of records may be happening at an accelerating rate.

c. Source and nature of samples

The USGS team sampled coals from fresh mine faces at most sites (Table III-3). Where possible, channels of consistent depth across the exposed coal were cut and bagged at the face. At several sites only grab samples were obtainable. Rarely was the entire seam sampled, however, because it was not exposed entirely or because hazardous and precipitous walls overhung it in surface pits. In several underground mines the samples represent nearly the entire mined seam. Samples were put in heavy plastic bags which were folded and sealed with tape; then each bag was put in a second bag and taped again. The intention was to make possible "bed moisture" determination. In this we succeeded well as judged by comparison of "as received" and "equilibrium" moisture, Fig. III-5.

3. General coal chemistry (USGS samples)

Data from the basic analyses of coal are listed in Table III-4. They are repeated in figures with other data farther in this chapter.

Various coal users in different countries are accustomed to reporting data on different basis, for example "as-received" and "as-analyzed"; "with inherent moisture", "bed-moist" and "in-mine"; "working","as-shipped" and "as-delivered"; "air-dry" (room temperature) and "air-dry" (107C); "ash-free" and "mineral matter-free" (calculated from ash or weight of low-temperature ash). It is beyond the scope of this report to report data on all bases used, and in many cases it is difficult to determine accurately the true basis of an analysis. We attempt to present data in several forms 1) Common U.S. practice, 2) Common practice in the former Soviet Union (the basis of most Kyrgyz data), 3) Common international trade practice. Most of the basic analyses of the USGS samples were done under ASTM standards, as listed on the sheets of raw data in the appendix.

Table III-3. Regional location, latitude-longitude, and name of sites sampled by the USGS in October, 1994. The coal seam sampled and the interval, if a channel sample, are listed along with the label put on the sample bag.

ID	Rgn[1]	Site name	Lat. - N	Long. - E	Seam - sample type	m[2]	Bag label
K-1	SF	Abshir	40-12	72-24	? - grab (chunks)	—	Abshir
K-2	Kv	Ag-Ulak	41-42	74-3 2	6 - run of mine	—	AgUlak #1a+#1b
K-3	SF	Almalyk	40-18	72-42	? - chan : top 1/3	8	Almalyk
K-4	IK	Dzhergalan	42-30	78-48	V - chan : top 1/4+bot. 1/2	6	Dzhergalan #1
K-5	IK	Dzhergalan	42-30	78-48	IV - channel	3	Dzhergalan #2
K-6	EF	Kara-Tyube	40-48	73-48	III - channel (~1/2)	1.2	Dara-Dobo
K-7	Kv	Kara-Keche	41-44	74-48	Osn. - chan : <1/10	3	Kara-Keche #1A+1B
K-8	NF	Kara-Tut	41-25	72-14	? - chan : bot. 1/4	1.2	Kara-Tut #2
K-9	NF	Kara-Tut	41-25	72-14	? - chan : top 3/5	3	Kara-Tut #1
K-10	EF	Kok-Yangak	41-00	73-12	6 - chan : mid. 4/5	2	Kok-Yangak
K-11	EF	Kum-Bel	41-00	73-30	22 - grab	—	Kum-Bel
K-13	Al	Kyzyl-Bulak	39-42	72-56	? - channel	2	Sary-Mongol
K-14	NF	Tash-Kumyr, Severn.	41-18	72-12	3 - chan : upper	1	Tash-Kumyr #1
K-15	NF	Tash-Kumyr, Severn.	41-18	72-12	3 - chan : lower	1	Tash-Kumyr #2
K-16	SF	Valakish	40-12	72-06	? - chan : mid 3.4m	3.4	Valakish

[1]Regions: Al - Alay, SF - South Fergana, NF - North Fergana, EF - East Fergana (Uzgen), SC - South Central (Alabuga-Chatyrkyol), Kv - Kavak, IK - Isyk-Kul', Ch - Chu.

[2]Approximate stratigraphic thickness of sampled coal, meters.

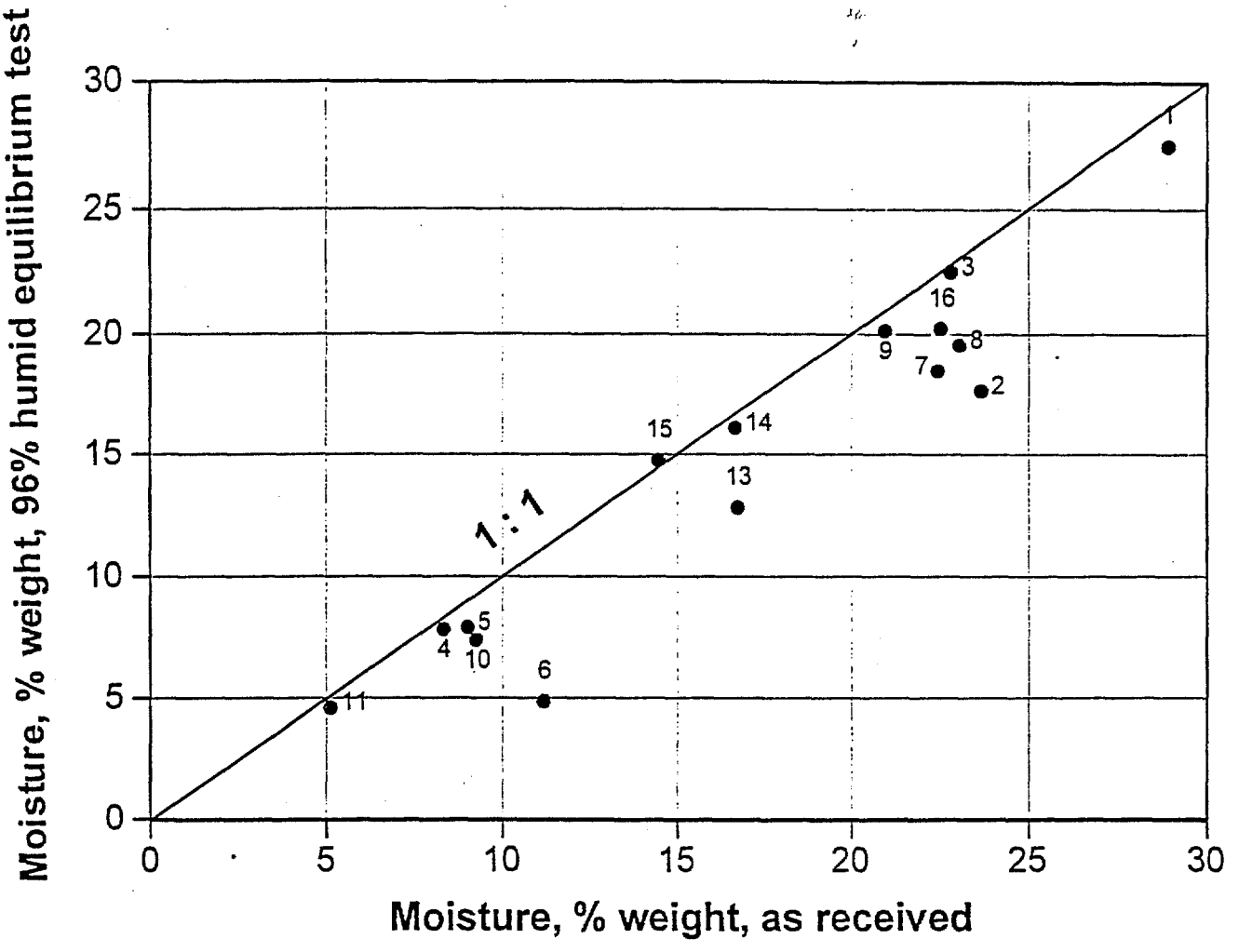

Figure III-5. Equilibrium moisture in relation to as-received moisture of Kyrgyz coals sampled by the USGS.

Coal Analysis Report													
Sample	Location		Proximate Analysis, % weight									H/C atomic	O/C atomic
Id #	Site Name	$\%W_{eq}$	W_{ar}	A_{ar}	VM_{ar}	FC_{ar}	A_d	VM_d	FC_d	VM_{daf}	FC_{daf}	$(12 \times H)/C$	$(12 \times O)/(16 \times C)$
K-1	Abshir	27.47	28.92	4.69	31.58	34.81	6.60	44.42	48.98	47.56	52.44	0.821	0.129
K-2	AgUlak	17.64	23.68	11.18	24.28	40.86	14.64	31.81	53.55	37.27	62.73	0.692	0.119
K-3	Almalyk	22.54	22.83	27.17	25.50	24.50	35.21	33.05	31.74	51.00	49.00	0.898	0.192
K-4	Dzhergalan	7.81	8.33	6.61	35.27	49.79	7.21	38.47	54.32	41.46	58.54	0.723	0.117
K-5	Dzhergalan	7.89	9.02	8.92	29.58	52.48	9.80	32.51	57.69	36.04	63.96	0.656	0.118
K-6	Kara-Tyube	4.85	11.19	19.56	13.74	55.51	22.03	15.47	62.50	19.84	80.16	0.457	0.074
K-7	Kara-Keche	18.47	22.45	6.83	25.71	45.01	8.81	33.15	58.04	36.36	63.64	0.554	0.151
K-8	Kara-Tut	19.56	23.07	14.17	29.27	33.49	18.42	38.05	43.53	46.64	53.36	0.773	0.140
K-9	Kara-Tut	20.14	20.96	13.34	29.83	35.87	16.88	37.74	45.38	45.40	54.60	0.785	0.151
K-10	Kok-Yangok	7.37	9.27	11.64	25.87	53.22	12.83	28.51	58.66	32.71	67.29	0.554	0.098
K-11	Kum-Bel	4.60	5.13	8.31	37.13	49.43	8.76	39.14	52.10	42.89	57.11	0.765	0.092
K-13	Kyzyl-Bulak	12.81	16.76	3.18	31.26	48.80	3.82	37.55	58.63	39.04	60.96	0.681	0.130
K-14	Tash-Kumyr, Severn.	16.09	16.69	6.81	31.88	44.62	8.18	38.26	53.56	41.67	58.33	0.772	0.128
K-15	Tash-Kumyr, Severn.	14.75	14.46	13.13	31.52	40.89	15.36	36.85	47.79	43.54	56.46	0.787	0.135
K-16	Valakish	20.24	22.54	8.88	29.69	38.89	11.47	38.34	50.19	43.30	56.70	0.804	0.154

Sample	Ultimate Analysis, % weight					Gross Heating Value (isoperibol)						Forms of Sulfur, % weight			
Id						Btu/lb		Kcal/kg		MJ/kg					
#	H_{daf}	C_{daf}	N_{daf}	S^{org}_{daf}	O_{daf}	Q_{ar}	Q_{daf}	Q_{ar}	Q_{daf}	Q_{ar}	Q_{daf}	S^{tot}_d	S^{pyr}_d	S^{sul}_d	S^{org}_d
K-1	5.23	76.42	1.39	2.27	13.15	8927	13447	4959	7471	20.76	31.27	3.56	1.34	0.10	2.12
K-2	4.62	80.16	1.02	0.74	12.76	8812	13527	4896	7515	20.49	31.46	1.23	0.55	0.04	0.64
K-3	5.32	71.09	0.78	2.16	18.20	6154	12308	3419	6838	14.31	28.62	2.98	1.49	0.10	1.39
K-4	4.86	80.67	1.01	0.26	12.56	11759	13824	6533	7680	27.35	32.15	0.83	0.58	0.02	0.23
K-5	4.45	81.37	1.02	0.17	12.75	11353	13834	6307	7686	26.40	32.17	0.37	0.11	0.11	0.15
K-6	3.30	86.71	0.94	0.39	8.59	9799	14151	5444	7862	22.79	32.91	0.36	0.03	0.02	0.31
K-7	3.65	79.03	0.84	0.34	15.88	8991	12714	4995	7063	20.91	29.57	0.55	0.19	0.04	0.32
K-8	4.91	76.18	1.15	1.20	14.23	8420	13417	4678	7454	19.58	31.20	2.88	1.84	0.06	0.98
K-9	5.01	76.61	1.20	1.00	15.41	8747	13313	4859	7396	20.34	30.96	1.47	0.55	0.09	0.83
K-10	3.86	83.54	0.83	0.21	10.92	10966	13866	6092	7703	25.50	32.25	0.74	0.49	0.06	0.19
K-11	5.26	82.51	1.17	0.77	10.14	12482	14420	6934	8011	29.03	33.53	0.84	0.08	0.05	0.71
K-13	4.56	80.33	0.74	0.23	13.91	10914	13632	6063	7573	25.38	31.70	0.44	0.17	0.05	0.22
K-14	5.09	79.11	1.14	0.51	13.54	10340	13516	5744	7509	24.05	31.43	1.02	0.54	0.02	0.46
K-15	5.09	77.60	1.24	0.73	13.98	9779	13506	5433	7503	22.74	31.41	1.77	1.12	0.03	0.62
K-16	5.17	77.17	0.69	0.48	15.85	9025	13161	5014	7312	20.99	30.61	0.99	0.53	0.03	0.43

A = Ash
FC = Fixed Carbon
Q = Heating Value (calorific value)
VM = Volatile Matter
W = Moisture

C = Carbon
H = Hydrogen
N = Nitrogen
O = Oxygen
S = Sulfur

$_{ar}$ = As Received
$_d$ = Dry
$_{daf}$ = Dry Ash Free
$_{eq}$ = Equilibrium Moisture

^{org} = Organic
^{pyr} = Pyritic
^{sul} = Sulfate
^{tot} = Total

Table III-4. Basic chemistry of coals sampled in October, 1994, by the USGS team in Kyrgyzstan.

4. Coal rank / Organic maturation

a. Standard ASTM rank: Heat value and volatile matter (or fixed carbon)

In US practice, "rank", the degree of metamorphism or progressive alteration in the natural series from lignite to anthracite, is used in a restricted way for multiple channel samples that represent a seam (or designated part) in a particular region. None of our samples, and probably none of the samples listed in the literature, fit that restriction. However, the ASTM term *Apparent Rank* is valid for our samples since we describe the conditions of the sampling. The apparent ASTM rank of our samples is on Table III-5. We use "rank" also as a geological term equivalent to "organic maturation", but only the rank on Table III-5 is ASTM apparent rank.

b. USSR rank of coals sampled by the USGS

With the exception of Kyzyl-Bulak (sample K-13), rank of coals at all the sites sampled by the USGS has been reported in the literature, and summarized recently by Solpuyev (1994). His USSR rank designation is in the right column on Table III-5. Most coals mined in Kyrgyzstan are the highest brown coal rank (B3) or the lowest stone coal rank (D, Long Flame). Our samples are representative, and five of the mines we sampled are cited as " B3" coal and seven are cited as " D" coal.

Because most coals of Kyrgyzstan are low rank (subbituminous and high volatile C bituminous [B3 and D]), the apparent rank is measured by heating value (calculated mineral-free). Only one of our samples, K-6, has relatively high rank and hence in the ASTM system is classified by volatile matter. Other parameters, such as elemental carbon, bed moisture, and vitrinite reflectance, are good measures of geological rank and are included in our characterization of Kyrgyz coals.

c. Rank by elemental carbon, %Cdaf

Elemental carbon is a good chemical measure of rank, with perhaps the widest useful range of the chemical parameters. It is useful through the entire range of bituminous coals and anthracites, though volatile matter is better in the medium- and low-volatile bituminous range. The relationship between elemental carbon and heat value, plotted on figure III-6, forms a fairly narrow band which shows the consistency of our sampling and our analysis.

d. Rank by vitrinite reflectance, %Ro

Vitrinite reflectance indicates rank over a wide range like elemental carbon does; reflectance has the additional advantage that it is more independent of coal type, and it is not influenced by minerals so can be used to rank coaly shales (but not reliably oil shales). The vitrinite reflectance of our Kyrgyz coals is on table III-6 and is plotted against other rank measures: elemental carbon, figure III-7; heat value, figure III-8; and fixed carbon, figure III-9.

Table III-5. Apparent rank according to ASTM analyses and the ASTM ranking standard -- coals sampled in Kyrgyzstan in October 1994 by the USGS. An additional column shows ranking of coals from the same mines (in some cases the same seams) as evaluated by Solpuyev (1994), where B = brown coal, D = long flame coal, G= gas (flame) coal, T = lean coal. Another column shows separation of brown and stone coals according to their vitrinite reflectance -- one of the parameters used in the former USSR for ranking brown coals.

Field Sample Number	Name of site	D-MM-F Fixed Carbon	M-MM-F Btu / lb	Rank (ASTM)	USSR rank	
					by Ro	Solpuyer '94
K-1	Abshir	53.28	9408	Subbituminous C	B	B3
K-2	AgUlak	63.89	10028	Subbituminous B	B	B3
K-3	Almalyk	51.88	8703	Subbituminous C	B	B3
K-4	Dzhergalan	59.06	12679	hvC Bituminous	>	D
K-5	Dzhergalan	64.60	12570	hvC Bituminous	>	D
K-6	Kara - Tyube	82.15	12431	lv Bituminous	>	T
K-7	Kara - Keche	64.27	9709	Subbituminous B	B	B3
K-8	Kara - Tut	54.89	9954	Subbituminous B	B	D
K-9	Kara - Tut	55.78	10228	Subbituminous B	B	D
K-10	Kok - Yangok	68.29	12557	hvC Bituminous	>	D
K-11	Kum - Bel	57.70	13735	hvB Bituminous	>	G
K-13	Kyzyl - Bulak	61.24	11307	Subbituminous A	B	-
K-14	Tash - Kumyr, Severn.	58.94	11171	Subbituminous A	B	D
K-15	Tash - Kumyr, Severn.	57.65	11417	Subbituminous A	B	D
K-16	Valakish	57.49	9987	Subbituminous B	B	B3

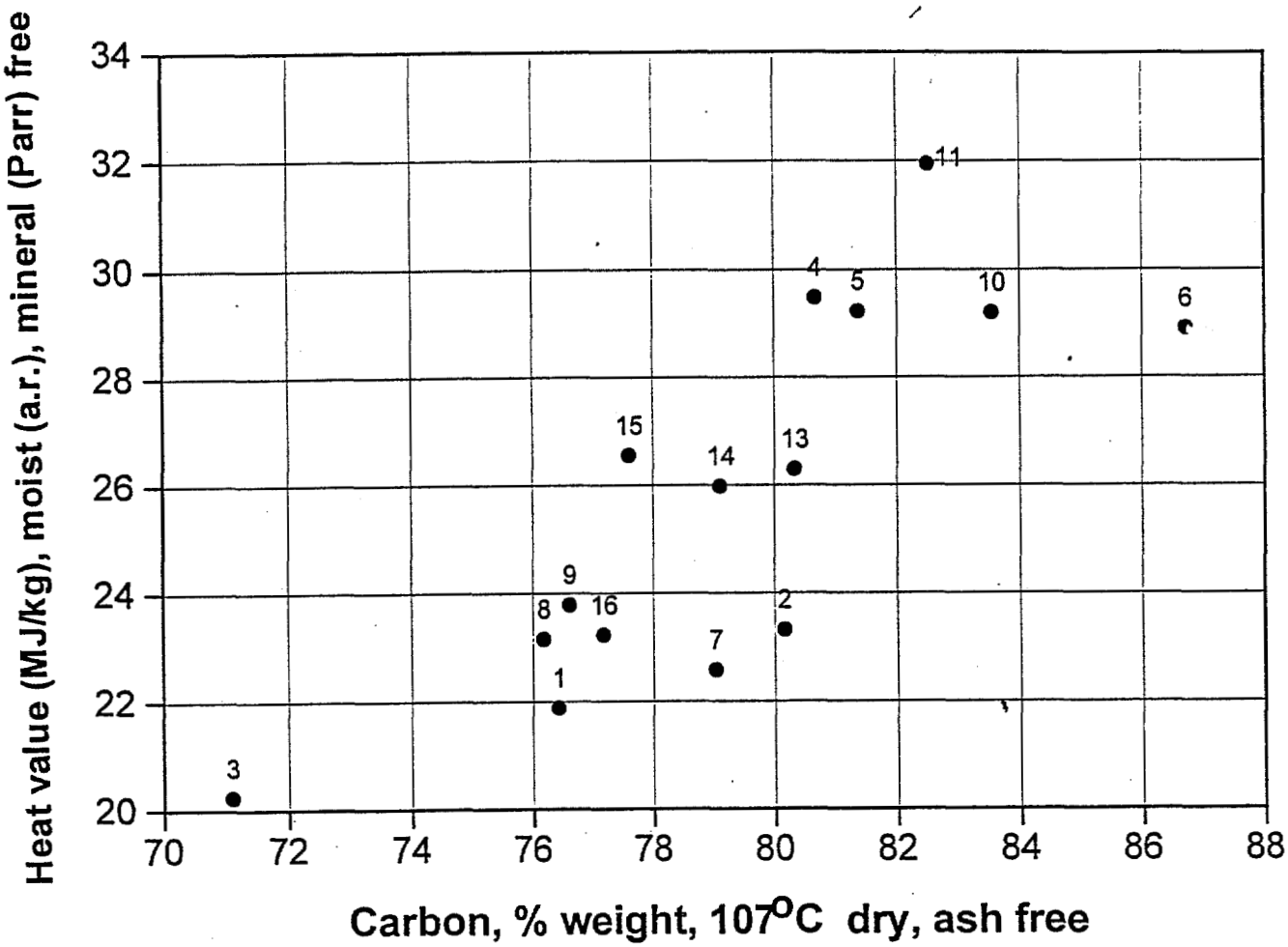

Figure III-6. Heat value in relation to elemental carbon of Kyrgyz coals sampled by the USGS.

Sample	Location	USGS						USGS	Literature		
Id	Site	$\%R_o$	$\%C_{daf}$	%FC	$Q_{w,mf}$			Q_{daf}	Q_{daf} (Kcal/kg)		
#	Name			d,mmf	Btu/lb	MJ/kg	Kcal/kg	Kcal/kg	minimum	maximum	average
K-1	Abshir	0.33	76.42	53.28	9408	21.88	5227	7471	5200	7400	6515
K-2	AgUlak	0.44	80.16	63.89	10028	23.33	5571	7515	6438	7446	6954
K-3	Almalyk	0.38	71.09	51.88	8703	20.24	4835	6838	4513	7993	7061
K-4	Dzhergalan	0.50	80.67	59.06	12679	29.49	7044	7680	7191	7884	7549
K-5	Dzhergalan	0.57	81.37	64.60	12570	29.24	6983	7686	7286	7788	7573
K-6	Kara-Dobo	1.86	86.71	82.15	12431	28.91	6906	7862	8103	8770	8603
K-7	Kara-Keche	0.47	79.03	64.27	9709	22.58	5394	7063	4998	7802	6902
K-8	Kara-Tut	0.40	76.18	54.89	9954	23.15	5530	7454	6111	7986	7180
K-9	Kara-Tut	0.39	76.61	55.78	10228	23.79	5682	7396	6111	7986	7180
K-10	Kok-Yangok	0.65	83.54	68.29	12557	29.21	6976	7703	4109	8123	7550
K-11	Kum-Bel	0.75	82.51	57.70	13735	31.95	7631	8011	7501	8457	7931
K-13	Kyzyl-Bulak	0.43	80.33	61.24	11307	26.30	6282	7573	4535	4989	4794
K-14	Tash-Kumyr, Severn.	0.49	79.11	58.94	11171	25.98	6206	7509	6945	7554	7360
K-15	Tash-Kumyr, Severn.	0.45	77.60	57.65	11417	26.56	6343	7503	6859	7597	7215
K-16	Valakish	0.40	77.17	57.49	9987	23.23	5548	7312	6047	7900	6558

Table III-6. Chemical parameters used to measure coal rank; vitrinite reflectance and heat value from USGS analyses, plus heat value of coals from the same sites from the literature for comparison.

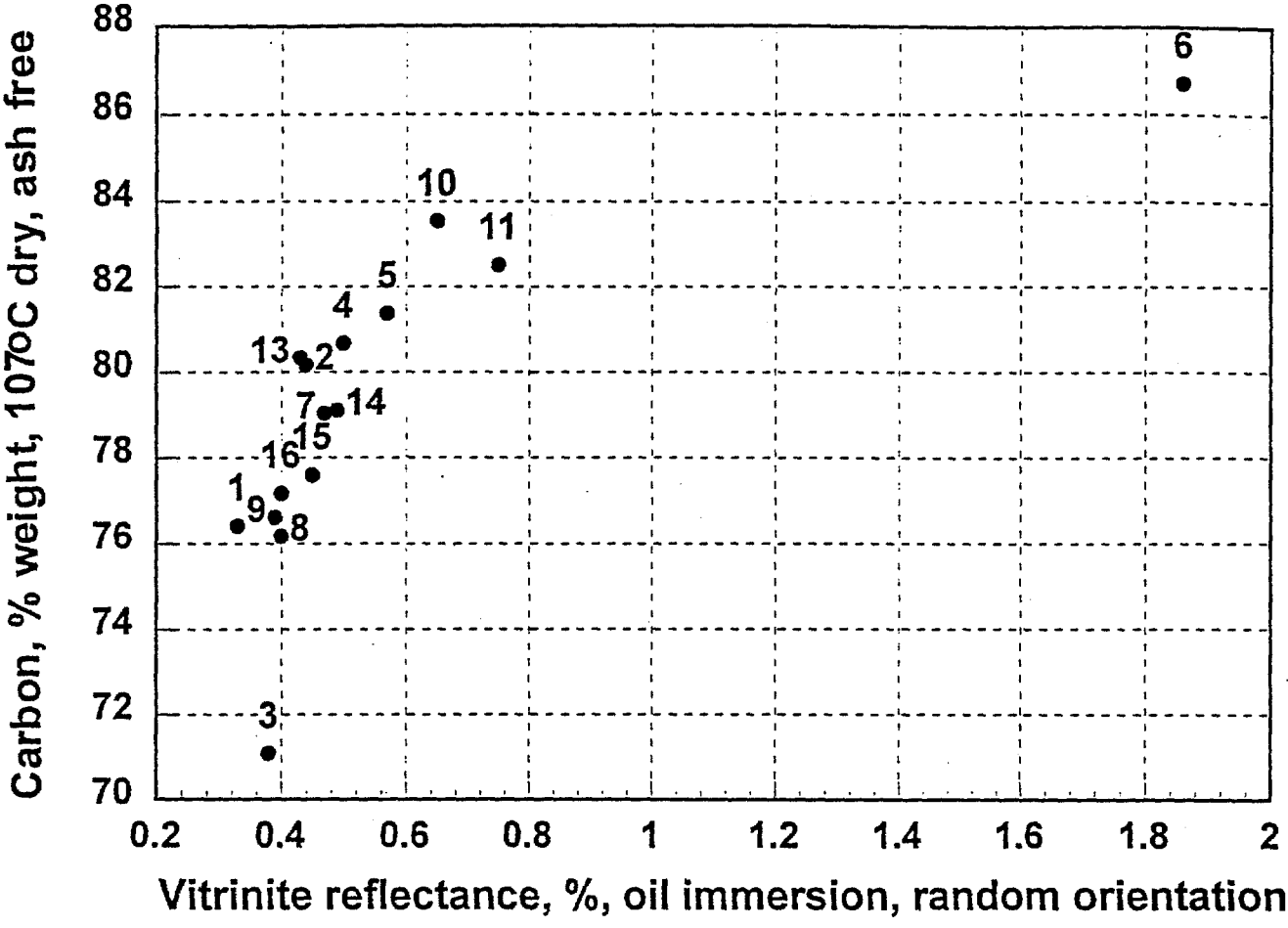

Figure III-7. Elemental carbon in relation to vitrinite reflectance of Kyrgyz coals sampled by the USGS.

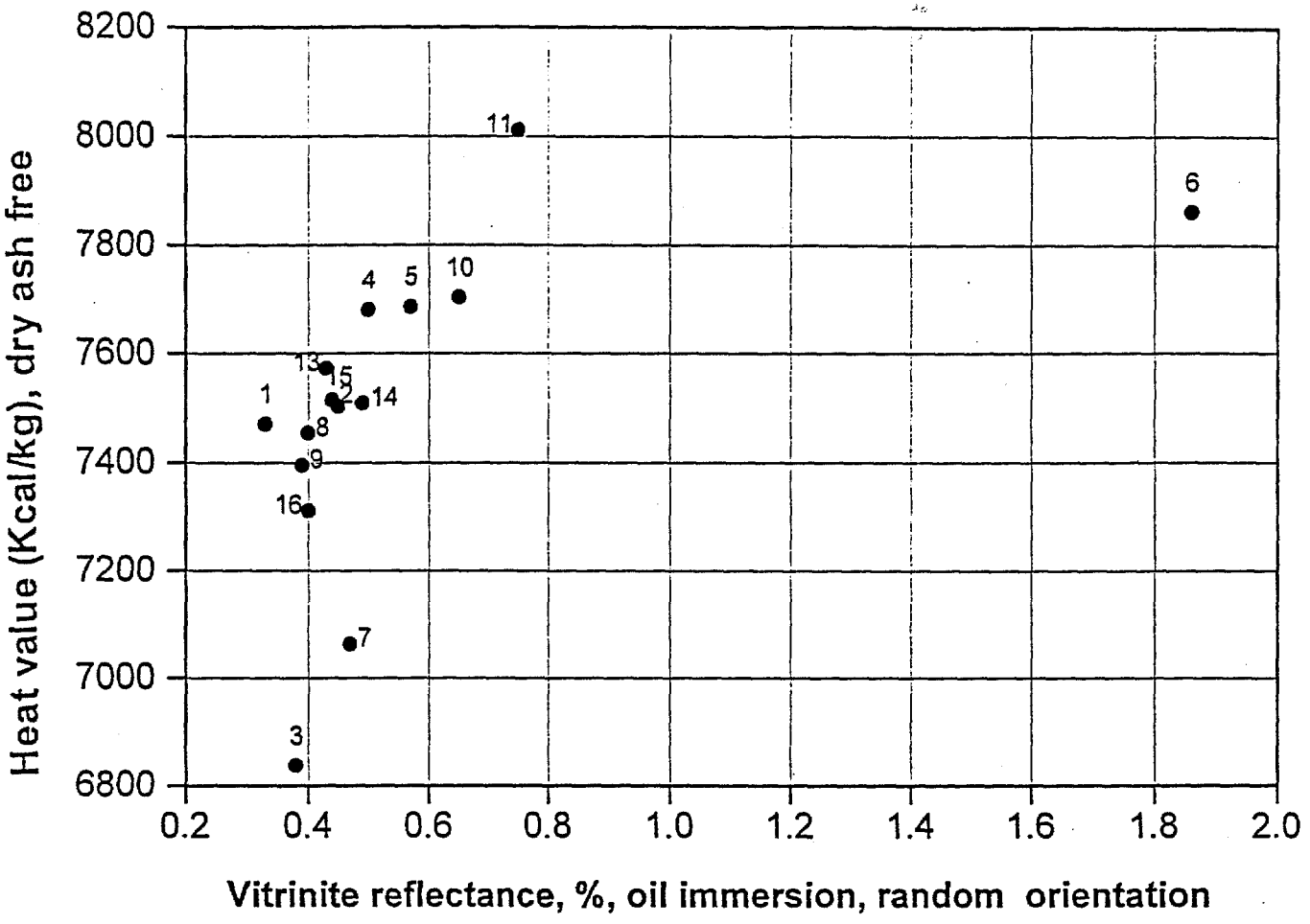

Figure III-8. Heat value in relation to mean random vitrinite reflectance of Kyrgyz coals sampled by the USGS.

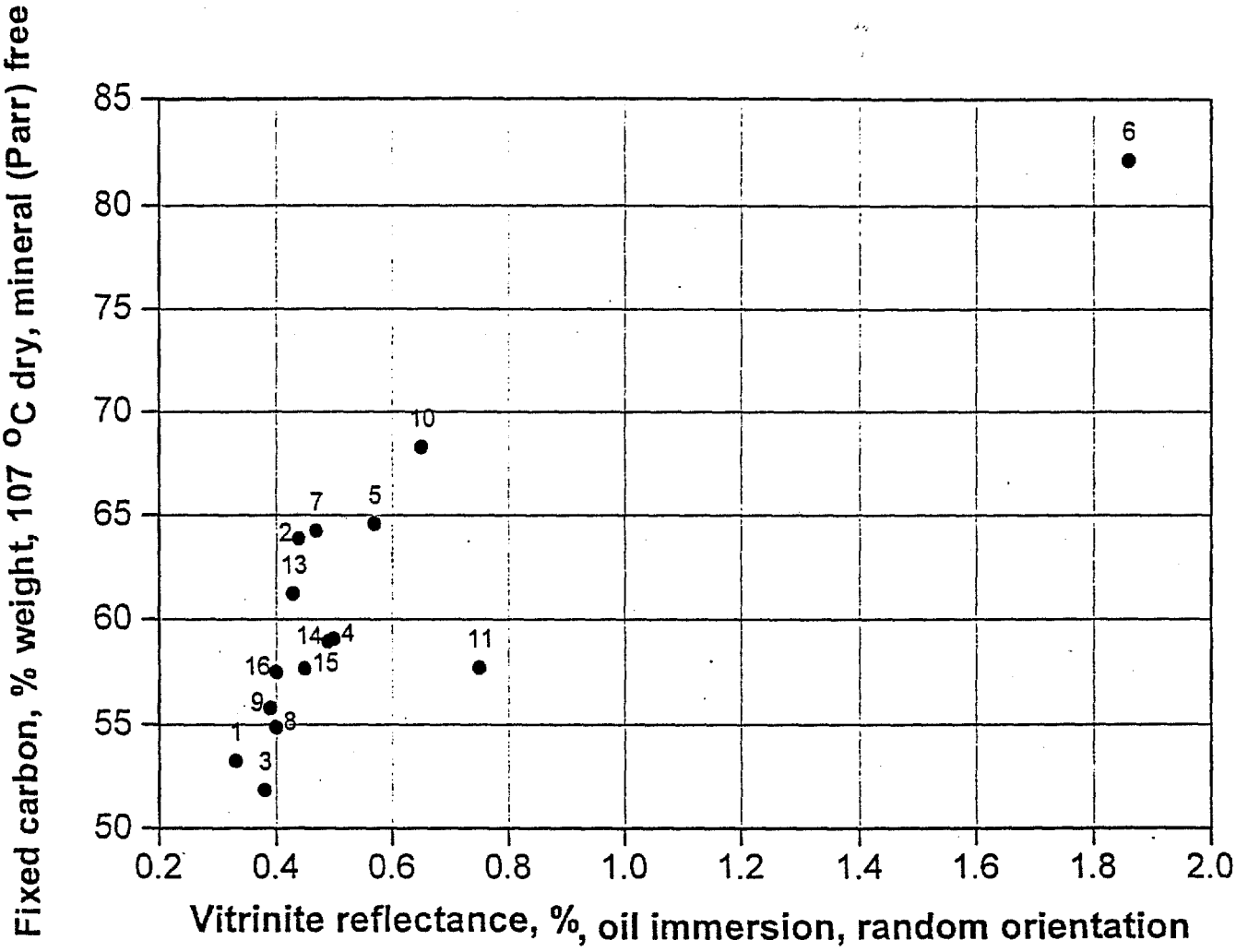

Figure III-9. Fixed carbon in relation to mean random vitrinite reflectance of Kyrgyz coals sampled by the USGS.

Table III-7. Main data from proximate and ultimate analysis of coals sampled by the USGS and data from the literature on the same mines, in some cases stated to be from the same seams sampled by the USGS.

Sources of literature data (page where most data is found given for each row): 1=Kamenov B 1984; 2=Dzhamanbayev 1983; 3=Solpuyev 1994, Vol.1; 4= Solpuyev 1994, Vol.2

W,r = "rudnichnaya" (= in situ), or sometimes "rabochaya" (= as produced) moisture, whole coal.
W,a = "as analyzed", or ASTM "as-received" moisture, whole coal

TbCh9.wpd {t9}

Source	Site	Seam	%W,r	%Wa	%A,d	%S,d (total)	V,daf	Q,daf (kcal/kg)	%C, daf	%H, daf	N+S+ O,daf
USGS k-1	Abshir		29		7	3.6	48	7471	76	5.2	17
3p111	Abshir	Osn.[1]		5-19 11	5-30 18	0-8 3.0	25-65 43	6000-7400 6246			
3p110[2]	Abshir	Osno vnoy	27-29 28/5		19-24 22/5	1.3-2.6 1.8/5	39-45 41/5	5213-6648 5806/5			
3p111	Abshir	Mono klinal		3-11 7	10-30 20	0-9 4.5	15-60 44	6100-7100 6658			
3p111	Abshir[3]	Osn.[4]		5-15 9	0-30 19	0-7.0 3.4	35-60 45	5400-7400 6515	50-76 68/68	2.0-5.94.2/68	13-49 27/68
USGS k-2	AgUlak	6	24		15	1.2	37	7515	80	4.6	14
2p16	Agulak	Verc hnyy		13	8	1.9	36	6708	77	4.6	-
2p16	Agulak	7		7	-	1.4	36	7300	77	5.3	18
2p16	Agulak	6		8-10	16-18	1.0-1.7	34-37	7395	78	3.8	18
3p73	Agulak[5]	6		4-10 7/128 6	5-32 16/12 86	.4-3.0 1.4/11 67	29-39 34/116 6	6438-7446 6954/1085	70-80 76/16	2.8-4.7 4.1/16	16-29 23/16
4p70	Agulak[6]	6	20-21/4		14-15/4	0.8-0.9/4	38-40/4	5760-5800/4			
USGS k-3	Almalyk		23		35	3	51	6838	71	5.3	21

[1]Osnovnoy from eastsern pit.

[2]1984 Data from KNIUI and VUKhiN; location details given & thickness

[3]Proximate source not given; Ultimate from Topl. Lab. BPI, but seam and location not stated.

[4]Osnovnoy from western pit

[5]Corehole samples: p.73, line 2, Seam 6 only; Ultimate p.75; NSO by Stot. addition.

[6]Listed as one of Minkush sectors (Tura-Kavak, Agulak, Lzapadnyy and Vostochnyy); here samples "central part of pit", southern also given.

Source	Site	Seam	%W,r	%Wa	%A,d	%S,d (total)	V,daf	Q,daf (kcal/kg)	%C, daf	%H, daf	N+S+ O,daf
2p43	Almalyk			12	23-25 23	1.3-2.0 1.9	44-45 45	6800	74	4.8	21
3p120	Almalyk[7]		22-30 28		20-35 30/23	1.7	43-47 46/4	7099			
3p124	Almalyk[9]	Osnovnoy	23-24		27-35	1.3-1.6	46-47	4840-4902			
3p120	Almalyk[10]		25-31 27/114		17-34 25/114[11]	0.2-7.0 1.5/1297	24-60 44/1869	4513-7993 7061/939	55-80 73/126	3.1-9.2 6/132	17-36 22
2p47	Beshterek. (Rn=K-PZh)		4-6	0-4	28-29	1.4-2.8	31-34	8614-8664	86-88	5.0-5.7	
USGS k-5	Dzhergalan	IV	9		10	0.4	36	7686	81	4.4	14
USGS k-4	Dzhergalan	V	8		7	0.8	41	7680	81	4.9	14
4p118	Dzhergalan	IV		04-3.0 1.5/166	3-30 12/94	0-1.8 0.6/149	32-46 38/101	7286-7788 7573/78	75-82 79/10	4.3-5.6 4.8/10	12-22 16/7
4p118	Dzhergalan	V		0.5-4 1.9/401	3-30 12/94	0-2 1.1/320	30-46 38/343	7191-7884 7549/293	69-85 79/57	3.1-5.4 4.5/57	8-22 16/35
2p26	Dzhergalan		8-12 10	3-6 4	4-17 10	0.6-2.1 0.8	35-44 40	7350-7770 7560		4.8	
USGS k-6	Kara-Tyube[12]		11		22	0.4	20	7862	87	3.3	10
3p219	Kara-Tyube	[13]									
3p219-220	Kara-Tyube	III		0-12 2/51	3-29 10/51	0.4-1.1 0.7/16	4-13 8/43	8103-8770 8603/7	85-93 91/5	3.4-4.4 3.8/5	3.15
3p221-222	Kara-Tyube	III	1	1	6	0.4	9	8763	93	4.2	3

[7]Mine sample; may be source of ultimate analysis.

[8]Mined coal + rock

[9]Three face samples, 1984; 14-29m seam

[10]Borehole samples, but source of ultimate analyses not clear

[11]Coal without rock that might be mined.

[12]Kara-Dobo

[13]219-221 gives Prox/ult for 4 seams in two sectors; See USGS sample notes to see which to use.

Source	Site	Seam	%W,r	%Wa	%A,d	%S,d (total)	V,daf	Q,daf (kcal/kg)	%C, daf	%H, daf	N+S+ O,daf
2p47	Kara-Tyube (Rn=PS-1)			0-11	7-19	1.0-1.1		8103-8845	86-94	3.2-4.3	
USGS [illegible]	Kara-Kiche [illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4p86	Kara-Kiche	Slozhnyy		8-20 13/108	6-39 18/160	.2-8.0 2.2/155	25-50 39/155	5151-7325 6546/152	52-87 70/102	2.5-5.2 4.3/102	18-52 27/61
2p23	Kara-Kiche	Osn.	4-35 20		4-25 9	0.1-1.8 0.8	25-45 34	Qr/n	56-90 77	3.1-6.2 4.6	+
2p23	Kara-Kiche	Slozh.	11-24 17		9-26 17	0.2-2.9 1.5	25-50 39	Qr/n	63-78 73	2.5-5.0 4.2	+
2p26	Kara-Kiche		25-32 27	11-14 14	6-11 9	0.4-1.8 0.8	35-46 42	6010-7200 6605		3.6	
4p86	Kara-Kiche	Osnovnoy		4-18 12/1088	4-30/12/2175	0-2.3 1.0/21 21	21-49 36/2013	4998-7802 6902/2031	55-90 76/1036	2.2-6.2 4.3/1036	6-38 22/994
USGS [illegible]	Kara-Tut [illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
USGS [illegible]	Kara-Tut [illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4p31	Kara-Tut	Osnovnoy[14]	15	7	19	0.8	39	7406	77	4.4	18
4p30	Kara-Tut[15]			10-12 11/10	11-19 16/10	1.0-3.9 2.1/10	38-44 42/10	6364-7415 7167/10			
4p30	Kara-Tut[16]			1-24 10/1541	4-40 22/1531	0.2-2.8 1.0/1026	32-64 43/1099	6111-7986 7179/901			
2p47	Kargasha			3-12	25-35	1.0-3.5	41-48	8368-8850	83-86	5.4-8.4	
USGS [illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[14] 14 borehole samples analyzed by Bishkek Polytechnical Inst.

[15] Run of mine samples, 1955 "possibly weathered"

[16] Borehole samples, 1982-84

Source	Site	Seam	%W,r	%Wa	%A,d	%S,d (total)	V,daf	Q,daf (kcal/kg)	%C, daf	%H, daf	N+S+ O,daf
3p137	Kok-Yangak	6		2-19 6/162	2-35 12/23 2	0-7.4 1.2/57	24-48 38/47	4109-8123 7549/56			
3p135	Kok-Yangak	5+6[17]	7-9 9/8	2-7 4/26	7-31 18/45	0.2-4 1.9/12	24-37 32/33	7162-7683 7501/12	82[17]	4.5- 5.0	12
3p138	Kok-Yangak	6	9/8		17'8	1.1/8	35/8	7573/8			
2p37	Kok-Yangak		12-21 14	1-17 12	7-20 12	0.3- 4.9 1.8	31-38 34		74-79 78	3.3- 6.0 4.9	
3p139	Kok-Yangak	5+6	10/9		16/9	1.1/9	34/9	7501/9			
2p43	Kok-Yangak			6-10 7	3-19 14	0.9- 3.6 1.3	27-42 33	7740	78	5	15
3p138	Kok-Yangak[18]	5	10/2		22/2	0.8/2	27/2	6651/2			
USGS k-11	Kum-Bel		5		9	0.8	43	8011	82	5.3	12
2p47	Kum-bel (Rn=D-G)		?	5	20	0.3- 1.0	37-40	8203	81	5.5	
3p157	Kum-Bel	K22[19]		0-19 4/69	8-34 19/42	0.4- 1.8 0.8/24	22-58 40/24	7501-8457 7931/20	81	5.5	13
2p43	Kyzyl-Kiya			20-24 23	9-14 11	1.2- 2.8 1.6	35-38 37	6650	76	4.4	20
2p39	Kyzyl-Kiya		24-28	19-24 23	10-17 16	1.2- 4.6 4.4	29-40 35	4685-5550	67-78 72	3.7- 4.9 4.5	
USGS k-13	Kyzyl-Bulak		17		4	0.4	39	7575	80	4.6	15
3p129	Kyzyl-Bulak[20]			8-20 10/54[21]	5-26 12/54	0.1- 0.3 0.2/16	42-49 45/16	4535-4989 4794/15			
2p26	Soguta.		17-18 17	8-18 10	8-22 14	0.3- 3.0 1.1	40-42 42	6960-7350 7155		6	

[17]Kok-Yangak mine: Severnaya and Markay also given; also data on Seams: I,V,VI, Moshchnyy

[18]"Active mine", 1984, Inst. KNIUGI and VUKhIN; Seams 5 & 6 &5+6 listed

[19]Prox. given separately for seams 6,8,9.12.14.16.18.20.21.22.24.25; Ult.for 9,14,20,22

[20]Sampled as Sary-Mongol; 33-44'N, 72-54'E at 3200m elev.; "discovered by herdsmen of Sary-Mongol Sovkhoz in 1993"

[21]Why so many analyses if opened just since '93?

Source	Site	Seam	%W,r	%Wa	%A,d	%S,d (total)	V,daf	Q,daf (kcal/kg)	%C, daf	%H, daf	N+S+ O,daf
2p40	Sulyukta		17-21 20	17-22 19	7-21 12	0.5- 0.8 0.6	28-39 33	5055-6000 5201	74-78 76	3.8- 5.1 4.6	
2p43	Sulyukta			8-12 10	8-18 11	0.2- 0.8 0.6	28-48 36	5040	77	4	19
USGS k-15	Tash-Kumyr Severnaya	III-low	14		15	1.8	43	7503	78	5.1	16
USGS k-14	Tash-Kumyr Severnaya	III-upper	17		8	1	42	7509	79	5.1	15
4,p17	Tash-Kumyr. Severnaya-1	III		3-15 8/11	4-24 16/14	0.4- 3.4 1.2/9	37-43 40/9	6945-7554 7360/8			
3p18	Tash-Kumyr Severnaya 2	III		4-18 10/23 2	5-32 13/95	0.4- 7.1 1.1/17 2	30-47 41/175	6859-7597 7215/175			
2p43	Tash-Kumyr			7-10 9	6-15 11	0.5- 2.2 1.3	34-41 37	7200-7400 7315	78	5	16
2p33	Tash-Kumyr		7-9 8	7-9 8	5-25 11	0.2- 2.0 0.7	27-36 33		77-80 79	4.5- 5.3 4.9	
2p32	Tash-Kumyr[22]			3-16 7	4-31 16	0.1- 7.9 1.2	26-46 37	5265-8412 7433			
2p47	Tuyuk. (Rn=PK)			1-3	12-16	0.6- 1.2	33-38	8515-8609	87-90	5.8- 8.1	
USGS K-16	Valakish		22		11	1	43	7312	77	5.2	17
3p76	Valakish (Uchkorgon) [23]			2-37 14/25 2	8- 34/19 /238	0.3- 3.6 1.4/25 2	35-82 51/252	6047-6955 6492/169	69-78 75/31	4.0- 6.2 5.5/31	14-24 19/31 [24]
3p76	Valakish. (Uchkorgon)[25]			10-17 13/20	11-33 18/20	0.7- 3.7 1.4/20	36-43 39/20	6386-7900 7120/20			
2p47	Zindan (Rn=G)		11-14	0-2	23-24	0.4	33	8230	85-86	5.0- 5.1	

[22]Picked the 6 column max-min and averaged averages.

[23]YuKGI data; HCNO data may be of mixed source

[24]Addition of separate N, O, Stot., max. & min. is approximate combined.

[25]BPI data

5. General proximate and ultimate data

Basic analytical data of the USGS samples are in table III-4 and are discussed earlier in this chapter. We gathered published and unpublished older data on Kyrgyz coals, some of which is on table III-7, in order to relate the US data to data produced under sampling and analytical practice in the former USSR. We include here mainly information for the mines and seams we sampled.

The mineral matter in coal is not usually analyzed, but ash left after burning coal at high temperature is used as an inexpensive means to estimate the mineral content of coal, and the ash in a laboratory test is also an approximation of the ash left from industrial combustion. The ash reported in table III-4 results from ASTM analysis at 750°C. ISO standard ash determination is at 815°C, and recent practice in the USSR agrees with ISO (800-830°C range). Note, however, that USSR practice uses a different slow heating sequence in analysis of brown coals and in analysis of stone coals; since produced Kyrgyz coals are about half brown coal and half stone coal, there may be some discontinuity in the Soviet data on ash. USGS analyses for this project included ashing also at 900°C in preparation for analysis of the major / minor / trace elements. All but three samples yielded equal or slightly lower ash at the higher temperature, but the difference is small (Table III-10).

6. Organic matter composition and type

a. Maceral composition (group analysis)

We petrographically analyzed the maceral group proportions in the USGS samples by visual point counting on polished sections of crushed coal. The resulting data are, therefore, volume estimates based on area -- not weight -- of each component. Table III-8 lists the results on three bases: 1) Total point count of four maceral groups plus minerals, 2) Mineral percent plus percentage of four maceral groups on a mineral-free basis, 3) Three maceral group percentages (vitrinite, inertinite, liptinite) on a mineral- and mixtinite-free basis. Mixtinite is very fine organic matter, which can not be identified reliably by optical microscopy, mixed with some fine mineral matter. Using blue-excitation fluorescence it is seen to include much liptinite, but point counting this liptinite is unreliable because fluorescent objects below the polished surface could be counted by mistake. We estimate that the mixtinite contains roughly 1/3 vitrinite, 1/3 minerals, 1/3 liptinite, and only a small amount of inertinite. If the mixtinite-free data on table III-8 had an added share of liptinite to account for the liptinite in the mixtinite, the indicated liptinite content would be increased significantly, by several percent, in the high-mixtinite samples.

Figure III-10 is a ternary diagram of the maceral group percentages which shows the great range of composition and allows comparison with other data. The great abundance and range of inertinite places many Kyrgyz coals far outside the range of most U.S. and European coals. This should be kept firmly in mind by engineers and other coal specialists. Technology of some important Jurassic coals in the former USSR and technology of "Gondwana" coals from India and Pakistan, Australia, South Africa, and Brazil may be more applicable to Kyrgyz coals than would be technology familiar in North America and Europe.

Table III-8. Maceral group percentage in coals sampled by the USGS in Kyrgyzstan. Point counting on polished sections of crushed splits of each sample was done by N. Bostick, USGS, under white light. Mineral matter and mixtinite was counted at the same time, and the calculations of mineral- or mixtinite-free basis at the right of the table used these counts. Mixtinite is very fine organic matter, which can not be identified reliably by optical microscopy, mixed with some fine mineral matter.

Sample Id #	Location Site Name	Seam and Sample Type	Sample Prep Number	Point count of macerals					
				Mnl	Vt	In	Lpt	Mxt	N
K-1	Abshir	? - grab (chunks)	2023	91	835	158	30	89	1203
K-2	AgUlak	6 - run of mine	2025	203	207	706	23	225	1364
K-3	Almalyk	? - chan : top $^1/_3$	2027	549	584	97	20	139	1389
K-4	Dzhergalan	V - chan : top $^1/_4$+bot. $^1/_2$	2029	66	423	566	18	31	1104
K-5	Dzhergalan	IV - channel	2031	111	188	876	30	95	1300
K-6	Kara-Tyube	III - channel (~$^1/_2$)	2033	66	650	143	1	279	1139
K-7	Kara-Keche	Osn. - chan : <$^1/_{10}$	2035	30	122	948	48	36	1184
K-8	Kara-Tut	? - chan : bot. $^1/_4$	2037	243	539	455	33	252	1522
K-9	Kara-Tut	? - chan : top $^3/_5$	2039	550	549	181	20	84	1384
K-10	Kok-Yangok	6 - chan : mid. $^4/_5$	2041	359	271	746	9	20	1405
K-11	Kum-Bel	22 - grab	2043	70	1118	30	19	37	1274
K-13	Kyzyl-Bulak	? - channel	2045	85	462	607	15	35	1204
K-14	Tash-Kumyr, Sevem.	3 - chan : upper	2047	122	813	444	39	64	1482
K-15	Tash-Kumyr, Sevem.	3 - chan : lower	2049	188	453	258	34	153	1086
K-16	Valakish	? - chan : mid 3.4m	2051	261	429	374	16	125	1205

Sample Id #	Location Site Name	Mineral[1] Percent	USGS Vt/In	Literature Vt/In	Mineral Free Percent[2] Vt	In	Lpt	Mxt	Mixtinite - Free Percent: Mineral Free[3] Vt	In	Lpt	Mineral[4] %
K-1	Abshir	7.6	5.28		75.1	14.2	2.7	8.0	81.6	15.4	2.9	8.2
K-2	AgUlak	14.9	0.29		17.8	60.8	2.0	19.4	22.1	75.4	2.5	17.8
K-3	Almalyk	39.5	6.02	10.00	69.5	11.5	2.4	16.5	83.3	13.8	2.9	43.9
K-4	Dzhergalan	6.0	0.75	0.50	40.8	54.5	1.7	3.0	42.0	56.2	1.8	6.2
K-5	Dzhergalan	8.5	0.21	0.20	15.8	73.7	2.5	8.0	17.2	80.1	2.7	9.2
K-6	Kara-Tyube	5.8	4.55	2.00	60.6	13.3	0.1	26.0	81.9	18.0	0.1	7.7
K-7	Kara-Keche	2.5	0.13	0.40	10.6	82.1	4.2	3.1	10.9	84.8	4.3	2.6
K-8	Kara-Tut	16.0	1.18	1.90	42.1	35.6	2.6	19.7	52.5	44.3	3.2	19.1
K-9	Kara-Tut	39.7	3.03	1.90	65.8	21.7	2.4	10.1	73.2	24.1	2.7	42.3
K-10	Kok-Yangok	25.6	0.36	2.50	25.9	71.3	0.9	1.9	26.4	72.7	0.9	25.9
K-11	Kum-Bel	5.5	37.27	31.00	92.9	2.5	1.6	3.1	95.8	2.6	1.6	5.7
K-13	Kyzyl-Bulak	7.1	0.76		41.3	54.2	1.3	3.1	42.6	56.0	1.4	7.3
K-14	Tash-Kumyr, Sevem.	8.2	1.83	14.00	59.8	32.6	2.9	4.7	62.7	34.3	3.0	8.6
K-15	Tash-Kumyr, Sevem.	17.3	1.76	14.00	50.4	28.7	3.8	17.0	60.8	34.6	4.6	20.2
K-16	Valakish	21.7	1.15		45.4	39.6	1.7	13.2	52.4	45.7	2.0	24.2

Area percents calculated form point count as estimated volume percents.

[1] = [Mnl / (Mnl+Vt+In+Lpt+Mxt)] 100 = mineral %

[2] = [maceral type / (Vt+In+Lpt+Mxt)] 100 = % maceral type Mnl free

[3] = [maceral type / (Vt+In+Lpt)] 100 = % maceral type Mxt & Mnl free

[4] = [Mnl / (Mnl+Vt+In+Lpt)] 100 = mineral % Mxt free

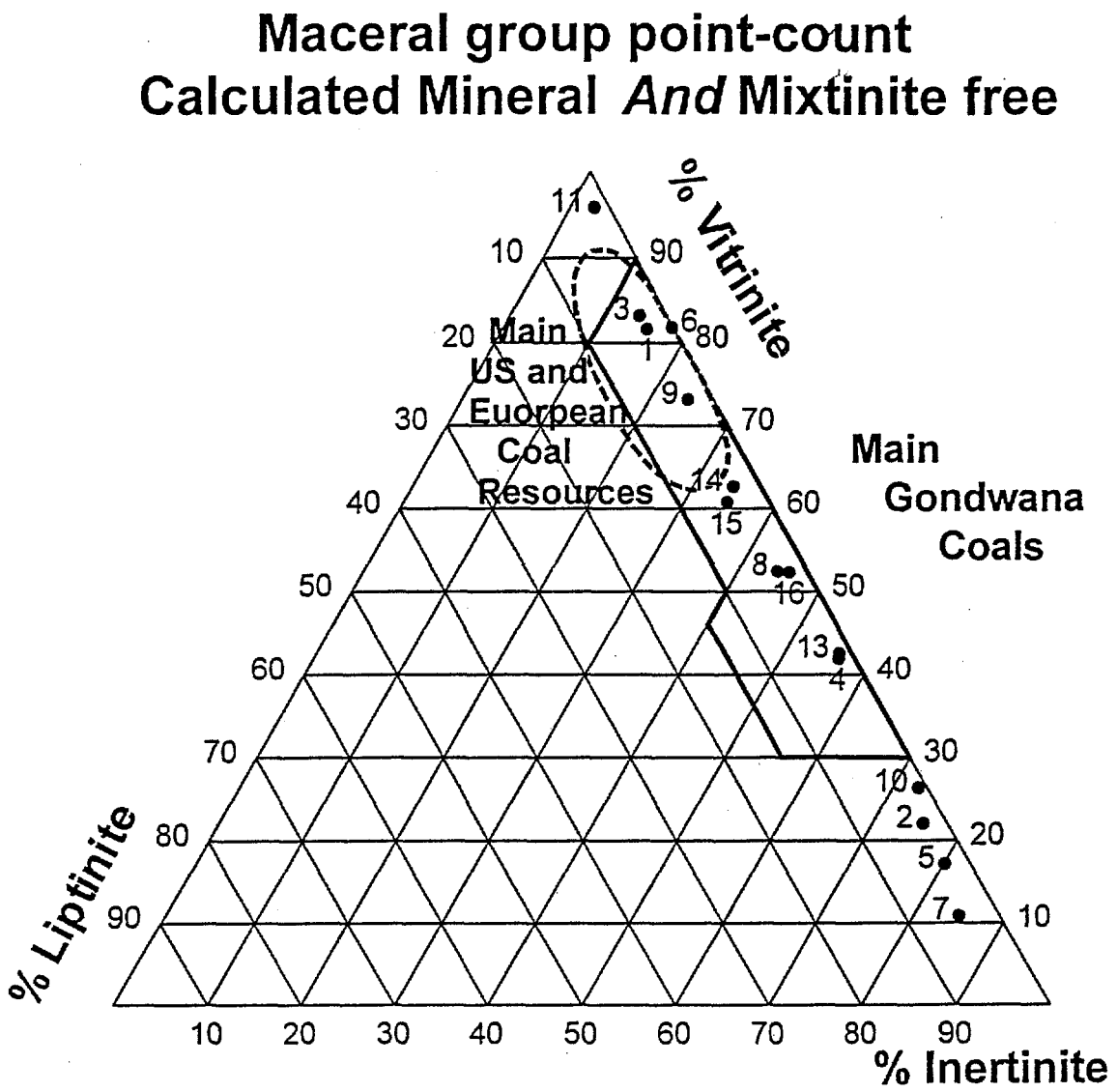

Figure III-10. Ternary diagram of maceral group composition (mineral- and mixtinite-free basis) of Kyrgyz coals sampled by the USGS. The field of "main Gondwana coals" (solid line) is from Strauss, et al. (1978) and that of "main U.S. coal resources" is from data by Waddell et al. (1978).

Petrographic analyses from older USSR literature and unpublished analyses given in Solpuyev (1994) are compared with our analyses of samples from the same mines (Fig. III-11). In about half the cases we have information that the samples reported are from the same seam we sampled. The agreement is notable -- much better than agreement of our analyses of major and minor elements, for instance, even though maceral analyses can be very subjective. One explanation for the good agreement comes to mind: Maceral analyses are rarely done on chance grab or run-of-mine samples, but usually on high quality channel samples or core.

b. Elemental H, C, N, O composition

The type of organic matter in coal is indicated chemically by the content of hydrogen, carbon, and oxygen. Normally the nitrogen and sulfur content is reported at the same time as other organic constituents, though their content is not easily connected with type of organic matter. Unlike petrographic determination of the organic type of coal, the chemical determination is complicated by large chemical changes as the coal changes from lignite to higher rank. Hence, normally only chemical ratios and cross relations between parameters can be used to determine organic type. Figure III-12, a classical *van Krevelen* diagram, shows the low H/C ratio at a given rank (measured by O/C) of many Kyrgyz coals resulting from their high inertinite content. Figure III-13 shows the same low hydrogen content, relative to rank as measured by vitrinite reflectance. Our data on hydrogen does not agree very well with data from the literature on Kyrgyz coals. Figure III-14 indicates the linear regression line of the LITERATURE / USGS plot for hydrogen, compared with a 1:1 perfect agreement line. Figure III-15 shows the same comparison for elemental carbon, with much better agreement. Note, however, the great spread of values from the literature in both cases. We believe that this spread results mainly from differences in sampling and the natural variation in the coals from a given site, not from analytical discrepancies.

7. Sulfur

Sulfur content of the 15 USGS coal samples ranges from 0.32 percent to 2.53 percent (Table III-9). There is some agreement between the sulfur in the USGS samples and sulfur reported in the literature (Figure III-16., but also a striking deviation in coals determined by the USGS to contain relatively high sulfur. It is unlikely that this deviation results from analytical discrepancies. More likely, samples reported in the literature may have been "premium" material from a given mine or seam. Sulfate sulfur ranges from 0.04 percent to 0.15 percent and probably represents the oxidation of pyritic sulfur to ferrous sulfate that took place during the interval of time between sampling of the coal and the analyses of the coal. Alternatively, in some instances there may have been some oxidation of the coal prior to our taking the sample. The sum of the sulfate sulfur and the pyritic sulfur is approximately the same as the amount of organic sulfur in most samples. This agrees with a general rule that in much coals half the sulfur is pyritic and half is organic.

There is no reason to expect the presence of any significant amount of any sulfide mineral in these coals other than pyrite or marcasite (both FeS_2). There is excess iron available in each sample to stoichiometrically combine with the sulfur to make the FeS_2.

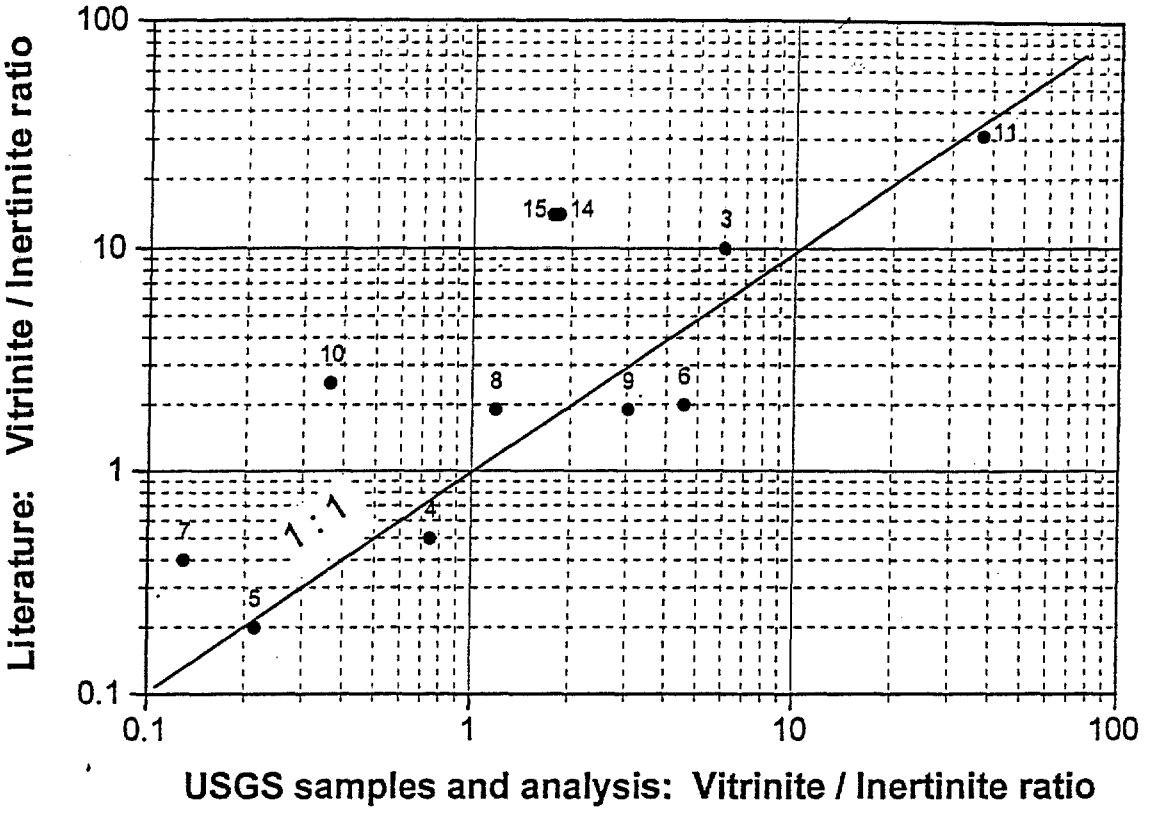

Figure III-11. Vitrinite / inertinite ratio of Kyrgyz coals sampled by the USGS in relation to the range of the same ratio reported in the literature for coals from the same mines, in some cases stated to be from the same seam.

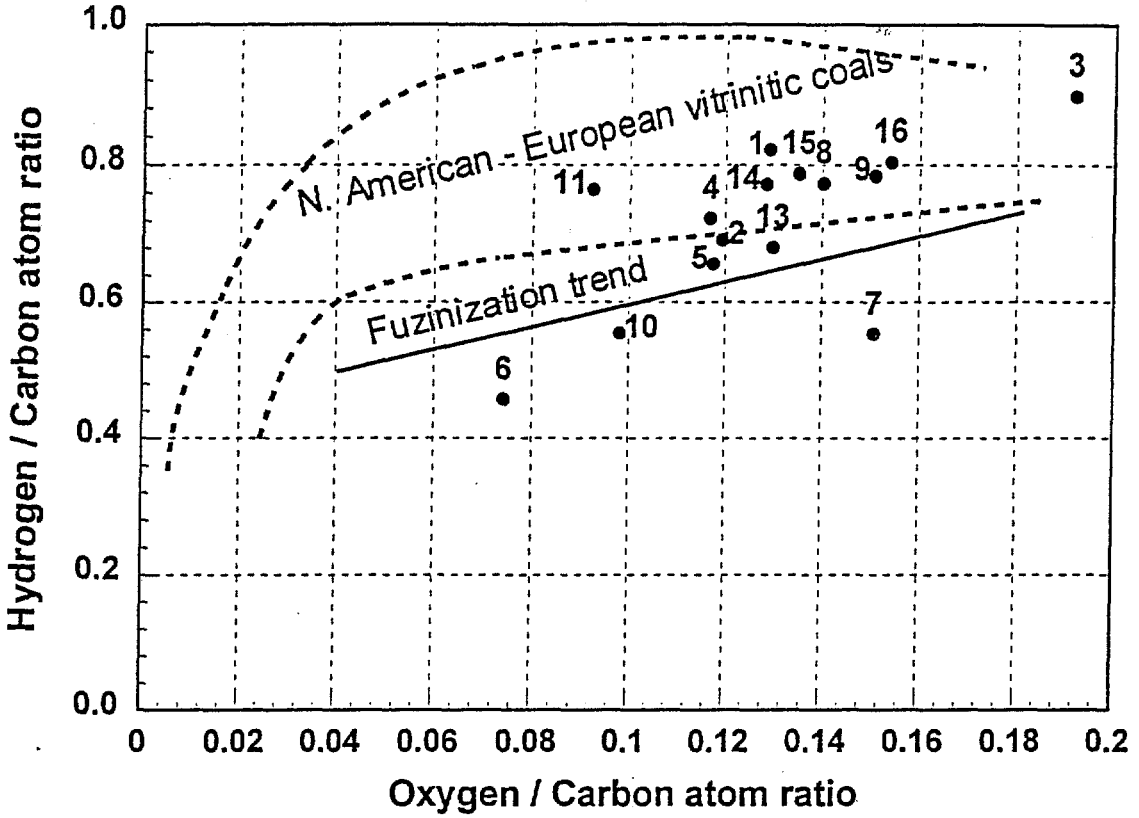

Figure III-12. Hydrogen / carbon atomic ratio in relation to oxygen / carbon atomic ratio of Kyrgyz coals sampled by the USGS.

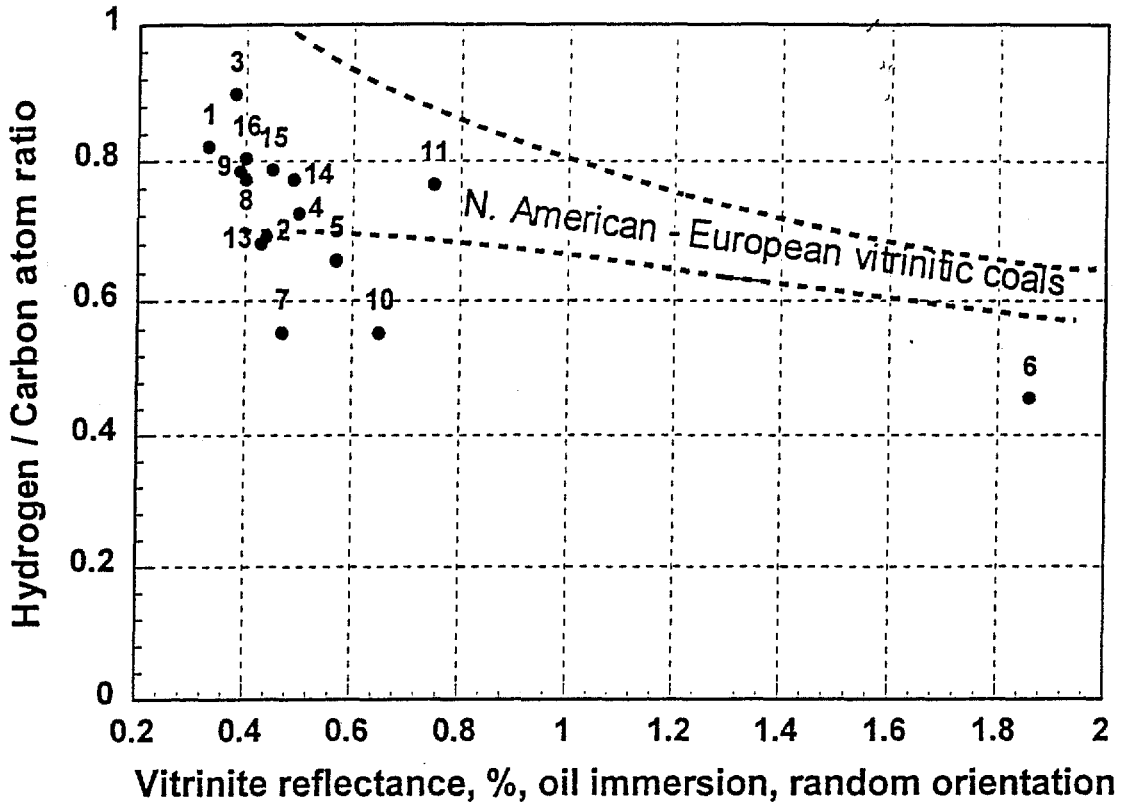

Figure III-13. Hydrogen / carbon atomic ratio in relation to vitrinite reflectance of Kyrgyz coals sampled by the USGS.

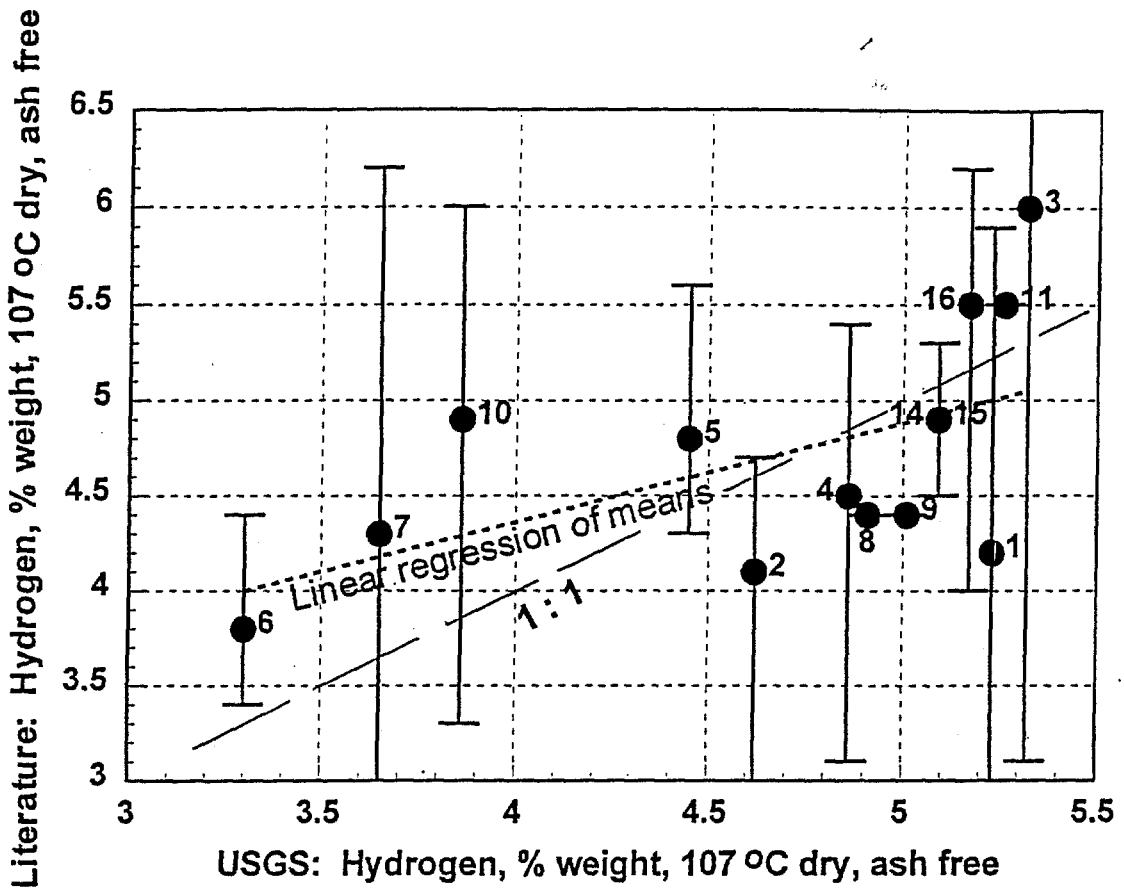

Figure III-14. Hydrogen content of Kyrgyz coals sampled by the USGS in relation to the range reported in the literature for coals from the same mines, in some cases stated to be from the same seam.

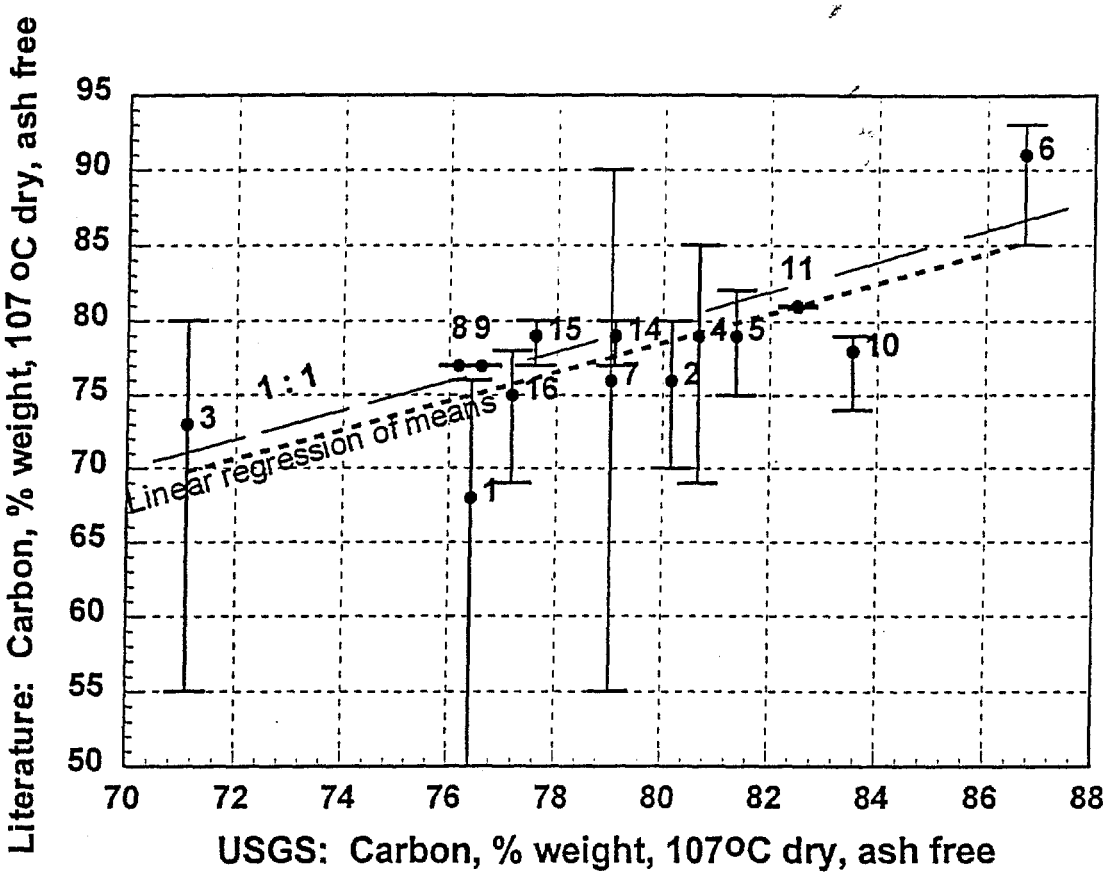

Figure III-15. Elemental carbon content of Kyrgyz coals sampled by the USGS in relation to the range reported in the literature for coals from the same mines, in some cases stated to be from the same seam.

Table III-9. Total sulfur, % weight, air-dry-coal basis of USGS samples of Kyrgyz coals compared with data from the literature on coals from the same mines, often from the same seams.

Sample Id #	Location Site Name	Seam and Sample Type	USGS S^{tot}_{dry}	Literature S^{tot}_{dry} minimum	maximum	average
K-1	Abshir	? - grab (chunks)	3.56	1.3	7.0	2.6
K-2	AgUlak	6 - run of mine	1.23	0.4	3.0	1.4
K-3	Almalyk	? - chan : top $^1/_3$	2.98	0.2	7.0	1.5
K-4	Dzhergalan	V - chan : top ¼+bot. ½	0.83	0.0	2.0	1.1
K-5	Dzhergalan	IV - channel	0.37	0.0	1.8	0.6
K-6	Kara-Tyube	III - channel (~½)	0.36	0.4	1.1	0.7
K-7	Kara-Keche	Osn. - chan : $<^1/_{10}$	0.55	0.0	2.3	1.0
K-8	Kara-Tut	? - chan : bot. ¼	2.88	0.2	2.8	1.0
K-9	Kara-Tut	? - chan : top $^3/_5$	1.47	0.2	2.8	1.0
K-10	Kok-Yangok	6 - chan : mid. $^4/_5$	0.74	0.0	7.4	1.2
K-11	Kum-Bel	22 - grab	0.84	0.4	1.8	0.8
K-13	Kyzyl-Bulak	? - channel	0.44	0.1	0.3	0.2
K-14	Tash-Kumyr, Severn.	3 - chan : upper	1.02	0.4	7.1	1.1
K-15	Tash-Kumyr, Severn.	3 - chan : lower	1.77	0.4	7.1	1.1
K-16	Valakish	? - chan : mid 3.4m	0.99	0.3	3.7	1.4

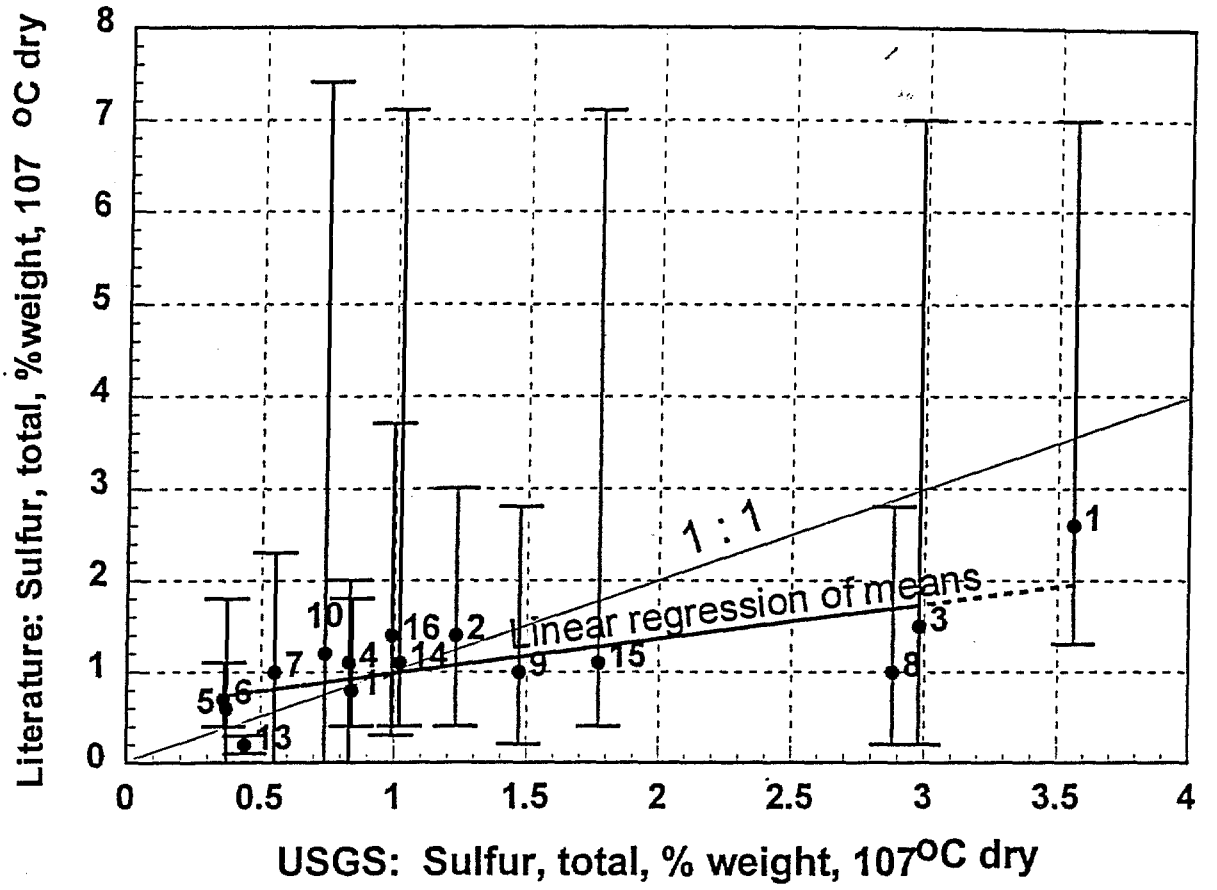

Figure III-16. Total sulfur of Kyrgyz coals sampled by the USGS in relation to the range and mean of total sulfur reported in the literature for coals from the same mines, in some cases stated to be from the same seam.

Coal utilization within the United States is greatly influenced by federal regulations based on the Clean Air Act of 1970, that set standards for emissions of sulfur dioxide (SO_2) from new steam electricity generating plants. The limit was set at 1.2 pounds of SO_2 per million Btu of heat input. Coals that meet the requirements are referred to as "compliance " coals. Four of the 15 samples collected and analyzed meet the standards for compliance (less than 1.2 pounds SO_2 per million Btu): three are close to being compliance and would produce between 1.2 and 1.3 pounds per million Btu; and the remaining eight samples are non-compliance as we sampled them.

In the United States, there are several ways in which a non-compliance coal could be utilized in a new electricity generating facility. These include blending the higher sulfur coal with a coal of lower sulfur content, cleaning the coal prior to burning to reduce the pyritic sulfur, and removal of the SO_2 from the stack gasses by scrubbing the combustion gasses. Presently there is no means of reducing SO_2 emissions in power and heat stations in Kyrgyzstan to a level comperable to U.S. standards, although the SO_2 emissions are less than in other CIS countries (Mezgin and others, 1993). In 1996 is scheduled the refurbishment of boilers in the main Bishkek thermoelectric plant -- possibly with reduced emissions as a result.

8. Major, minor and trace elements (mainly in minerals)

a. Major and minor elements

Mineral matter in coal consists primarily of the following major and minor elements: Si, Al, Fe, Mg, Ca, Na, K, Ti, P, and Mn. We have reported the concentrations of these as oxides of the elements in percentage of the ash of the coal in tables III-10 and III-11. They are also shown as elements (not oxides) in percent of the total coal sample in tables III-12 and III-13, later in this chapter.

Coals in which the mineral matter consists principally of alumino-silicate minerals, generally representing the detrital material which had washed into the peat forming environment (swamp), have relatively high SiO_2 and Al_2O_3 contents. Coals that are high in Fe_2O_3 and CaO represent either the deposition of iron and calcium carbonate minerals early in the coal formation process, or the precipitation of these minerals along fractures and bedding following coal formation.

Combustion Engineers have developed several indices with which to classify the tendency of a coal to form bonded deposits on the boiler. These are referred to as fouling indices and generally take the form:

Fouling index= (base/acid) x Na_2O, where base is the sum of CaO, Fe_2O_3, MgO, Na_2O, and K_2O. Acid is the sum of SiO_2, Al_2O_3, and TiO_2.

Using this formula, several of the coals analyzed have fouling indices in the range that might cause concern if the coals were being considered for use in a large pulverized-coal fired steam boiler. However, these measures of fouling are based on experiences with, primarily, bituminous coals of North America, are not precise, and would only indicate the need for further testing of the

Table III-10. Major and minor elements in 900°C high-temperature ash, reported as oxides and normalized so that the sum of these reported oxides is 100%. The percent total ash (105°C dry coal basis) of these analyses is listed along with two columns (as-received and air-dry) of ash values from ashing at 750°C as part of the proximate and ultimate analyses. In table III-11 these oxides and some oxide ratios are compared with values taken from the literature on Kyrgyz coals.

Sample Id #	Location Site Name	% ash reported in Prox. anal. (750°C)		% ash reported in first ashing[1]	%LOI Plus % Missing	% Relative to 100% of reported elements after 2 ashings and one fusion									
		A_{ar}	A_d			SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO
K-1	Abshir	4.7	6.6	6.2	34.44	7.90	9.00	54.30	5.86	20.90	1.24	0.26	0.20	0.11	0.24
K-2	AgUlak	11.2	14.6	13.7	16.75	49.61	24.26	10.23	2.46	10.47	< 0.18	1.61	0.91	0.18	0.07
K-3	Almalyk	27.2	35.2	31.1	10.32	49.73	30.78	8.08	1.39	5.78	0.43	0.65	2.73	0.35	0.08
K-4	Dzhergalan	6.6	7.2	8.1	28.12	28.94	14.33	14.75	1.95	37.01	1.27	0.65	0.64	< 0.07	0.40
K-5	Dzhergalan	8.9	9.8	9.6	13.89	52.96	24.04	3.58	0.98	14.52	1.32	1.49	0.92	0.08	0.13
K-6	Kara-Tyube	19.6	22.0	21.9	6.39	61.00	26.28	2.37	2.02	3.06	0.31	3.34	1.52	0.10	0.01
K-7	Kara-Keche	6.8	8.8	8.8	27.16	30.62	24.44	6.53	4.87	31.85	< 0.21	0.22	0.78	0.15	0.33
K-8	Kara-Tut	14.2	18.4	16.0	11.32	51.98	19.96	17.59	1.91	5.46	0.85	1.27	0.81	0.09	0.08
K-9	Kara-Tut	13.3	16.9	17.0	10.65	57.97	22.72	9.00	2.35	4.48	1.02	1.43	0.90	0.09	0.04
K-10	Kok-Yangok	11.6	12.8	13.4	17.38	30.02	15.25	37.04	1.89	13.19	< 0.18	0.38	0.96	0.15	0.96
K-11	Kum-Bel	8.3	8.8	7.9	4.05	54.82	34.71	3.79	1.51	0.52	0.18	3.65	0.71	0.10	0.01
K-13	Kyzyl-Bulak	3.2	3.8	3.5	13.68	50.05	31.74	10.06	0.75	4.78	0.56	0.28	1.32	0.45	< 0.01
K-14	Tash-Kumyr, Severn.	6.8	8.1	8.2	17.66	45.54	21.86	15.42	1.81	9.64	3.32	1.42	0.89	0.07	0.02
K-15	Tash-Kumyr, Severn.	13.1	15.4	14.4	10.47	59.76	20.10	10.24	0.95	4.85	1.47	0.84	1.69	0.09	0.01
K-16	Valakish	8.9	11.5	11.9	28.76	33.27	18.81	7.97	2.30	33.41	0.45	0.63	1.11	1.80	0.25

[1] - For element analysis in Denver, USGS, ashed at 900°C - relative to samples dried at 105°C.

Table III-11. Six of the major and minor elements in 900°C high-temperature ash, reported as oxides and normalized so that the sum of the ten reported oxides is 100%. Values from the literature on Kyrgyz coal from the same mines, where possible from the same seam, are listed. Two ratios of oxides are listed in order to compare them with values from the literature. In table III-10 the full suite of ten oxides and the percent total ash from the coals is listed.

Sample Id #	Location Site Name	Chemical analysis in % USGS						
		SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O+K_2O	$\frac{Al_2O_3}{SiO_2}$	$\frac{FeO}{Al_2O_3+SiO_2}$
K-1	Abshir	7.90	9.00	54.30	20.90	1.49	1.14	13.94
K-2	AgUlak	49.61	24.26	10.23	10.47	1.79	0.49	50.03
K-3	Almalyk	49.73	30.78	8.08	5.78	1.08	0.62	50.00
K-4	Dzhergalan	28.94	14.33	14.75	37.01	1.92	0.50	29.97
K-5	Dzhergalan	52.96	24.04	3.58	14.52	2.81	0.45	53.10
K-6	Kara-Tyube	61.00	26.28	2.37	3.06	3.65	0.43	61.09
K-7	Kara-Keche	30.62	24.44	6.53	31.85	0.43	0.80	30.88
K-8	Kara-Tut	51.98	19.96	17.59	5.46	2.12	0.38	52.87
K-9	Kara-Tut	57.97	22.72	9.00	4.48	2.45	0.39	58.37
K-10	Kok-Yangok	30.02	15.25	37.04	13.19	0.56	0.51	32.45
K-11	Kum-Bel	54.82	34.71	3.79	0.52	3.82	0.63	54.93
K-13	Kyzyl-Bulak	50.05	31.74	10.06	4.78	0.83	0.63	50.36
K-14	Tash-Kumyr, Severn.	45.54	21.86	15.42	9.64	4.74	0.48	46.25
K-15	Tash-Kumyr, Severn.	59.76	20.10	10.24	4.85	2.31	0.34	60.27
K-16	Valakish	33.27	18.81	7.97	33.41	1.08	0.57	33.69

Sample Id #	Location Site Name	Chemical analysis in % Literature						
		SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O+K_2O	$\frac{Al_2O_3}{SiO_2}$	$\frac{FeO}{Al_2O_3+SiO_2}$
K-1	Abshir							
K-2	AgUlak	48.00	32.00	6.30	7.90	0.00	0.67	48.20
K-3	Almalyk	47.00	29.00	4.90	6.80	1.20	0.62	47.17
K-4	Dzhergalan	46.00	22.00	8.80	13.00	1.90	0.48	46.40
K-5	Dzhergalan	32.00	18.00	22.50	19.00	2.00	0.56	33.25
K-6	Kara-Tyube							
K-7	Kara-Keche	25.00	16.00	8.70	24.80	1.10	0.64	25.54
K-8	Kara-Tut	60.00	20.00	8.10	6.30	1.80	0.33	60.41
K-9	Kara-Tut	60.00	20.00	8.10	6.30	1.80	0.33	60.41
K-10	Kok-Yangok	56.00	22.00	8.90	4.00	0.00	0.39	56.40
K-11	Kum-Bel	58.00	28.00	7.80	1.30	1.30	0.48	58.28
K-13	Kyzyl-Bulak							
K-14	Tash-Kumyr, Severn.	56.00	26.00	6.00	4.00	0.00	0.46	56.23
K-15	Tash-Kumyr, Severn.	56.00	26.00	6.00	4.00	0.00	0.46	56.23
K-16	Valakish	44.00	19.00	9.20	17.00	2.00	0.43	44.48

coals with the higher fouling index values; something that would be done in case of any further major development of coals in the Kyrgyz Republic. In lower rank coals (lignite) the Na_2O content is more heavily weighted when fouling is predicted and only coals with less than 2% Na_2O are considered to be "low fouling".

The limited number of samples reported upon here makes it difficult to generalize concerning the major elements in coals of the Kyrgyz Republic. We do recognize significant variability within a very small area. For example, samples taken only a few tens of meters apart, from two different coal beds at Dzhergalan (samples K4 and K5) exhibit very different ash chemistry. In sample K4 the "base elements" of Fe_2O_3 and CaO are dominant, whereas in K5 the "acid elements" of SiO_2 and Al_2O_3 are dominant.

b. Trace elements

Trace elements determined on the 15 coal samples are shown in tables III-12 and III-13 and include nearly all elements of environmental and industrial concern. The values were compared with average values for coals of the world, or of the United States for those elements for which world-wide data were not available, and anomalous values were noted. For this purpose, "anomalous" was defined as one tenth or less than the mean or ten times greater than the world-wide mean of the element.

The most significant observation concerning the trace element data is that there is very little that is worth noting about it. There were very few values that were high relative to the world-wide means. They are limited to a single manganese value in a sample from Kok Yangak (K10) and three elevated zinc values (K3, K13, and K14). The mode of occurrence of the Mn is not known and the single high value requires validation. The Mn may be associated with carbonate mineral, but this is only conjecture at this time.

Zinc values are significantly higher than the world coal average in three of the samples. Elevated zinc values generally indicate the presence of sphalerite (ZnS) in coals, and the sphalerite generally occurs along fractures in the coal. Zinc is not considered a problem element in coal inasmuch as it is refractory and remains in the ash when the coal is burned.

Zinc is the only one of the heavy metals to be found in elevated concentrations in the coals sampled for this report. Other elements, which are of interest because of their potential environmental impacts, such as As, Be, Cd, Co, Cr, Ni, P, Pb, and U are all present in amounts similar to or less than the world-wide averages. The relatively low concentrations of Se, Hg, And Cl, which are also potentially deleterious elements, were mentioned previously. The number of samples collected was certainly limited and, although they came from many different coal regions, they can not be considered to represent all of the coals of the Kyrgyz Republic. However the uniformly low trace element concentrations and the very small number of elevated values suggests that trace and minor element concentrations in Kyrgyz coals should not, generally, pose a problem for the continued mining and utilization of the coals.

Table III-12. Major, minor and trace elements of high-temperature ash (900C) from USGS samples of Kyrgyz coals. This table lists the data as percent or parts per million of the ash. Whole-coal (dry) values for four volatile elements (Cl, F, Se, Hg) are listed at the bottom. See table III-13 for the same data calculated on a whole-coal basis.

Element Name	Units Of Analysis	Sample Id. Number and Location Site Name														
		K-1 Abshir	K-2 AgUlak	K-3 Almalyk	K-4 Dzherg.	K-5 Dzherg.	K-6 Kara Tyube	K-7 Kara Keche	K-8 Kara Tut	K-9 Kara Tut	K-10 Kok Yangok	K-11 Kum Bel	K-13 Kyzyl Bulak	K-14 Tash Kumyr, Severn.	K-15 Tash Kumyr, Severn.	K-16 Valakish
		Major Elements, Analyzed in 900C ash made into 1100C Fusion Pellets (X-Ray Fluorescence)														
Si	%	2.42	19.31	20.85	9.72	21.32	26.69	10.42	21.55	24.21	11.59	24.59	20.19	17.53	25.01	11.08
Al	%	3.12	10.69	14.61	5.45	10.96	13.02	9.42	9.37	10.74	6.67	17.62	14.50	9.53	9.53	7.09
Fe	%	24.90	5.96	5.07	7.41	2.15	1.55	3.33	10.91	5.62	21.40	2.55	6.07	8.88	6.41	3.97
Mg	%	2.32	1.24	0.75	0.84	0.51	1.14	2.14	1.02	1.27	0.94	0.87	0.39	0.90	0.51	0.99
Ca	%	9.79	6.23	3.70	19.01	8.93	2.04	16.58	3.46	2.86	7.79	0.36	2.95	5.67	3.10	17.01
Na	%	0.60	< 0.11	0.29	0.68	0.85	0.22	< 0.11	0.56	0.68	< 0.11	0.13	0.36	2.03	0.98	0.24
K	%	0.14	1.11	0.48	0.39	1.06	2.60	0.13	0.94	1.06	0.26	2.91	0.20	0.97	0.62	0.37
Ti	%	0.08	0.46	1.47	0.28	0.47	0.85	0.34	0.43	0.48	0.47	0.41	0.68	0.44	0.91	0.47
P	%	0.03	0.07	0.14	< 0.02	0.03	0.04	0.05	0.03	0.03	0.05	0.04	0.17	0.03	0.03	0.56
Mn	%	0.12	0.05	0.05	0.22	0.09	0.01	0.19	0.05	0.03	0.61	0.01	< 0.01	0.02	0.01	0.14
		Major Elements, Analyzed in 900C Ash (Atomic Absorption)														
Al	%	3.10	10.00	14.00	5.70	11.00	13.00	9.70	9.10	10.00	6.70	17.00	14.00	9.20	9.30	7.50
Ca	%	9.60	6.10	3.70	19.00	9.10	2.30	17.00	3.50	2.90	7.90	0.41	3.10	5.90	3.20	17.00
Fe	%	26.00	5.90	4.80	7.60	2.10	1.50	3.20	11.00	5.60	23.00	2.70	6.10	8.30	6.10	4.00
K	%	0.15	1.10	0.46	0.42	1.00	2.50	0.13	0.89	0.99	0.26	2.80	0.18	0.90	0.59	0.39
Mg	%	2.30	1.20	0.74	0.95	0.51	1.20	2.20	1.00	1.20	0.98	0.85	0.39	0.89	0.50	1.10
Na	%	0.61	0.10	0.30	0.82	0.95	0.21	0.14	0.55	0.69	0.07	0.16	0.07	2.10	0.94	0.30
P	%	0.02	0.05	0.13	0.01	0.02	0.03	0.04	0.02	0.02	0.04	0.04	0.18	0.02	0.02	0.62
Ti	%	0.08	0.40	1.60	0.28	0.40	0.66	0.30	0.36	0.40	0.32	0.44	0.71	0.41	0.86	0.39
		Trace Elements, Analyzed in 900C Ash (Atomic Absorption)														
Mn	ppm	1200	450	570	2300	870	89	1900	490	330	6300	110	140	110	87	1400
Ag	ppm	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
As	ppm	140	< 20	36	< 20	< 20	27	120	130	53	< 20	100	100	110	270	270
Au	ppm	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20
B	ppm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ba	ppm	130	130	490	250	280	590	260	460	490	270	1500	220	110	510	250
Be	ppm	11	3	4	16	8	4	2	6	7	6	10	5	27	16	3
Bi	ppm	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20
Cd	ppm	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	26	< 4
Ce	ppm	38	100	150	120	120	130	57	88	130	76	110	180	86	100	85
Co	ppm	28	14	51	190	72	24	12	29	44	72	100	93	83	48	37
Cr	ppm	120	78	380	97	64	150	46	210	200	110	270	150	250	240	160
Cu	ppm	240	78	260	130	140	170	86	160	200	67	450	160	170	170	190
Eu	ppm	4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	4	< 4	< 4
Ga	ppm	26	25	53	12	23	38	16	34	45	28	56	18	140	51	21
Ge	ppm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ho	ppm	< 8	< 8	< 8	< 8	< 8	< 8	< 8	< 8	< 8	< 8	< 8	< 8	< 8	< 8	< 8
La	ppm	11	63	80	73	79	76	26	50	72	45	57	94	43	59	52
Li	ppm	9	84	98	22	52	120	210	54	75	57	130	94	60	33	37
Mo	ppm	89	< 4	12	< 4	< 4	< 4	27	45	14	< 4	18	9	15	16	8
Nb	ppm	< 8	24	45	14	24	34	18	22	24	11	38	35	24	30	15
Nd	ppm	48	45	70	62	49	57	35	48	76	35	66	94	54	49	35
Ni	ppm	580	41	180	160	130	55	7	100	140	110	240	240	300	220	150
Pb	ppm	24	58	51	96	53	82	47	73	70	27	98	84	84	250	34
Sc	ppm	32	18	59	20	23	32	18	32	43	17	55	36	70	40	27
Sn	ppm	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Sr	ppm	1600	1400	710	360	260	550	4100	820	530	340	65	1300	1600	920	1700
Ta	ppm	< 80	< 80	< 80	< 80	< 80	< 80	< 80	< 80	< 80	< 80	< 80	< 80	< 80	< 80	< 80
Th	ppm	< 8	21	17	20	21	34	23	17	20	18	38	42	21	43	20
U	ppm	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200
V	ppm	160	100	500	81	81	200	41	220	240	120	460	170	390	190	190
W	ppm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Y	ppm	130	38	61	130	63	39	38	81	120	17	100	70	150	110	37
Yb	ppm	10	2	6	16	5	4	3	6	12	< 2	9	5	13	9	4
Zn	ppm	190	130	1100	110	170	250	27	320	120	150	310	11000	430	3100	44
Zr	ppm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Whole Coal Analyses (Various Methods)														
Cl	ppm	< 150	< 150	200	< 150	< 150	890	< 150	< 150	< 150	< 150	410	< 150	360	< 150	< 150
F	ppm	44	85	92	49	59	160	90	88	62	28	100	32	48	50	78
Se	ppm	1.4	0.3	1.2	0.3	0.2	0.4	0.1	0.8	0.6	0.2	0.1	0.4	0.3	0.4	1.0
Hg	ppm	0.26	0.02	0.33	0.02	< 0.02	0.20	< 0.02	0.30	0.23	0.08	0.04	< 0.02	0.14	0.28	0.17
Ash 900C	%	6.2	13.7	31.1	8.1	9.6	21.9	8.8	16.0	17.0	13.4	7.9	3.5	8.2	14.4	11.9

Table III-13. Major, minor and trace elements of high-temperature ash (900C) from USGS samples of Kyrgyz coals, calculated as percent or parts per million of the whole coal, air dry (105C) basis. Whole-coal (dry) values for four volatile elements (Cl, F, Se, Hg) are listed at the bottom. See table III-12 for the same data raw for the ash as analyzed.

Element Name	Units Of Analysis	Sample Id. Number and Location Site Name														
		K-1 Abshir	K-2 AgUlak	K-3 Almalyk	K-4 Dzherg.	K-5 Dzherg.	K-6 Kara Tyube	K-7 Kara Keche	K-8 Kara Tut	K-9 Kara Tut	K-10 Kok Yangok	K-11 Kum Bel	K-13 Kyzyl Bulak	K-14 Tash Kumyr, Sevem.	K-15 Tash Kumyr, Sevem.	K-16 Valakish
		Major Elements, Analyzed in 900C ash made into 1100C Fusion Pellets (X-Ray Fluorescence)														
Si	%	0.15	2.64	6.48	0.79	2.05	5.85	0.92	3.45	4.12	1.55	1.94	0.71	1.44	3.60	1.32
Al	%	0.19	1.46	4.54	0.44	1.05	2.85	0.83	1.50	1.83	0.89	1.39	0.51	0.78	1.37	0.84
Fe	%	1.54	0.82	1.58	0.60	0.21	0.34	0.29	1.75	0.96	2.87	0.20	0.21	0.73	0.92	0.47
Mg	%	0.14	0.17	0.23	0.07	0.05	0.25	0.19	0.16	0.22	0.13	0.07	0.01	0.07	0.07	0.12
Ca	%	0.61	0.85	1.15	1.54	0.86	0.45	1.46	0.55	0.49	1.04	0.03	0.10	0.47	0.45	2.02
Na	%	0.04	< 0.02	0.09	0.05	0.08	0.05	< 0.01	0.09	0.11	< 0.01	0.01	0.01	0.17	0.14	0.03
K	%	0.01	0.15	0.15	0.03	0.10	0.57	0.01	0.15	0.18	0.03	0.23	0.01	0.08	0.09	0.04
Ti	%	0.00	0.06	0.46	0.02	0.05	0.19	0.03	0.07	0.08	0.06	0.03	0.02	0.04	0.13	0.06
P	%	0.00	0.01	0.04	< 0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.02	0.01	0.00	0.01	0.07
Mn	%	0.01	0.01	0.02	0.02	0.01	0.00	0.02	0.01	0.01	0.08	0.00	< 0.00	0.00	0.00	0.02
		Major Elements, Analyzed in 900C Ash (Atomic Absorption)														
Al	%	0.19	1.37	4.35	0.46	1.06	2.85	0.85	1.46	1.70	0.90	1.34	0.49	0.75	1.34	0.89
Ca	%	0.60	0.84	1.15	1.54	0.87	0.50	1.50	0.56	0.49	1.06	0.03	0.11	0.48	0.46	2.02
Fe	%	1.61	0.81	1.49	0.62	0.20	0.33	0.28	1.76	0.95	3.08	0.21	0.21	0.68	0.88	0.48
K	%	0.01	0.15	0.14	0.03	0.10	0.55	0.01	0.14	0.17	0.03	0.22	0.01	0.07	0.08	0.05
Mg	%	0.14	0.16	0.23	0.08	0.05	0.26	0.19	0.16	0.20	0.13	0.07	0.01	0.07	0.07	0.13
Na	%	0.04	0.01	0.09	0.07	0.09	0.05	0.01	0.09	0.12	0.01	0.01	0.00	0.17	0.14	0.04
P	%	0.00	0.01	0.04	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.07
Ti	%	0.00	0.05	0.50	0.02	0.04	0.14	0.03	0.06	0.07	0.04	0.03	0.02	0.03	0.12	0.05
		Trace Elements, Analyzed in 900C Ash (Atomic Absorption)														
Mn	ppm	74.4	61.7	177.3	186.3	83.5	19.5	167.2	78.4	56.1	844.2	8.7	4.9	9.0	12.5	166.6
Ag	ppm	< 0.2	< 0.5	< 1.2	< 0.3	< 0.4	< 0.9	< 0.4	< 0.6	< 0.7	< 0.5	< 0.3	< 0.1	< 0.3	< 0.6	< 0.5
As	ppm	8.7	< 2.7	11.2	< 1.6	< 1.9	5.9	10.6	20.8	9.0	< 2.7	7.9	3.5	9.0	38.9	32.1
Au	ppm	< 1.2	< 2.7	< 6.2	< 1.6	< 1.9	< 4.4	< 1.8	< 3.2	< 3.4	< 2.7	< 1.6	< 0.7	< 1.6	< 2.9	< 2.4
B	ppm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ba	ppm	8.1	17.8	152.4	20.3	26.9	129.2	22.9	73.6	83.3	36.2	118.5	7.7	9.0	73.4	29.8
Be	ppm	0.7	0.4	1.2	1.3	0.8	0.9	0.2	1.0	1.2	0.8	0.8	0.2	2.2	2.3	0.4
Bi	ppm	< 1.2	< 2.7	< 6.2	< 1.6	< 1.9	< 4.4	< 1.8	< 3.2	< 3.4	< 2.7	< 1.6	< 0.7	< 1.6	< 2.9	< 2.4
Cd	ppm	< 0.2	< 0.5	< 1.2	< 0.3	< 0.4	< 0.9	< 0.4	< 0.6	< 0.7	< 0.5	< 0.3	< 0.1	< 0.3	3.7	< 0.5
Ce	ppm	2.4	13.7	46.7	9.7	11.5	28.5	5.0	14.1	22.1	10.2	8.7	6.3	7.1	14.4	10.1
Co	ppm	1.7	1.9	15.9	15.4	6.9	5.3	1.1	4.6	7.5	9.6	7.9	3.3	6.8	6.9	4.4
Cr	ppm	7.4	10.7	118.2	7.9	6.1	32.9	4.0	33.6	34.0	14.7	21.3	5.3	20.5	34.6	19.0
Cu	ppm	14.9	10.7	80.9	10.5	13.4	37.2	7.6	25.6	34.0	9.0	35.6	5.6	13.9	24.5	22.6
Eu	ppm	0.2	< 0.5	< 1.2	< 0.3	< 0.4	< 0.9	< 0.4	< 0.6	< 0.7	< 0.5	< 0.3	< 0.1	0.3	< 0.6	< 0.5
Ga	ppm	1.6	3.4	16.5	1.0	2.2	8.3	1.4	5.4	7.7	3.8	4.4	0.6	11.5	7.3	2.5
Ge	ppm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ho	ppm	< 0.5	< 1.1	< 2.5	< 0.6	< 0.8	< 1.8	< 0.7	< 1.3	< 1.4	< 1.1	< 0.6	< 0.3	< 0.7	< 1.2	< 1.0
La	ppm	0.7	8.6	24.9	5.9	7.6	16.6	2.3	8.0	12.2	6.0	4.5	3.3	3.5	8.5	6.2
Li	ppm	0.6	11.5	30.5	1.8	5.0	26.3	18.5	8.6	12.8	7.6	10.3	3.3	4.9	4.8	4.4
Mo	ppm	5.5	< 0.5	3.7	< 0.3	< 0.4	< 0.9	2.4	7.2	2.4	< 0.5	1.4	0.3	1.2	2.3	1.0
Nb	ppm	< 0.5	3.3	14.0	1.1	2.3	7.4	1.6	3.5	4.1	1.5	3.0	1.2	2.0	4.3	1.8
Nd	ppm	3.0	6.2	21.8	5.0	4.7	12.5	3.1	7.7	12.9	4.7	5.2	3.3	4.4	7.1	4.2
Ni	ppm	36.0	5.6	56.0	13.0	12.5	12.0	0.6	16.0	23.8	14.7	19.0	8.4	24.6	31.7	17.9
Pb	ppm	1.5	7.9	15.9	7.8	5.1	18.0	4.1	11.7	11.9	3.6	7.7	2.9	6.9	36.0	4.0
Sc	ppm	2.0	2.5	18.3	1.6	2.2	7.0	1.6	5.1	7.3	2.3	4.3	1.3	5.7	5.8	3.2
Sn	ppm	< 0.6	< 1.4	< 3.1	< 0.8	< 1.0	< 2.2	< 0.9	< 1.6	< 1.7	< 1.3	< 0.8	< 0.4	< 0.8	< 1.4	< 1.2
Sr	ppm	99.2	191.8	220.8	29.2	25.0	120.5	360.8	131.2	90.1	45.6	5.1	45.5	131.2	132.5	202.3
Ta	ppm	< 5.0	< 11.0	< 24.9	< 6.5	< 7.7	< 17.5	< 7.0	< 12.8	< 13.6	< 10.7	< 6.3	< 2.8	< 6.6	< 11.5	< 9.5
Th	ppm	< 0.5	2.9	5.3	1.6	2.0	7.4	2.0	2.7	3.4	2.4	3.0	1.5	1.7	6.2	2.4
U	ppm	< 12.4	< 27.4	< 62.2	< 16.2	< 19.2	< 43.8	< 17.6	< 32.0	< 34.0	< 26.8	< 15.8	< 7.0	< 16.4	< 28.8	< 23.8
V	ppm	9.9	13.7	155.5	6.6	7.8	43.8	3.6	35.2	40.8	16.1	36.3	6.0	32.0	27.4	22.6
W	ppm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Y	ppm	8.1	5.2	19.0	10.5	6.0	8.5	3.3	13.0	20.4	2.3	7.9	2.5	12.3	15.8	4.4
Yb	ppm	0.6	0.3	1.9	1.3	0.5	0.9	0.3	1.0	2.0	< 0.3	0.7	0.2	1.1	1.3	0.5
Zn	ppm	11.8	17.8	342.1	8.9	16.3	54.8	2.4	51.2	20.4	20.1	24.5	385.0	35.3	446.4	5.2
Zr	ppm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Whole Coal Analyses (Various Methods)														
Cl	ppm	< 150	< 150	200	< 150	< 150	890	< 150	< 150	< 150	< 150	410	< 150	360	< 150	< 150
F	ppm	44	85	92	49	59	160	90	88	62	28	100	32	48	50	78
Se	ppm	1.4	0.3	1.2	0.3	0.2	0.4	0.1	0.8	0.6	0.2	0.1	0.4	0.3	0.4	1.0
Hg	ppm	0.26	0.02	0.33	0.02	< 0.02	0.20	< 0.02	0.30	0.23	0.08	0.04	< 0.02	0.14	0.28	0.17
Ash 900C	%	6.2	13.7	31.1	8.1	9.6	21.9	8.8	16.0	17.0	13.4	7.9	3.5	8.2	14.4	11.9

c. Environmentally significant or volatile elements analyzed in whole coal

In addition to determining the organic elements C, H., O, and N, 45 additional major, minor and trace elements were also determined (Tables III-12 , III-13). Several of those were selected because of their potential deleterious effects on coal utilization or on the environment. These include Cl, Se, and Hg.

The amount of chlorine reported was generally below the lower limit of detection of 0.015% and the highest value reported was 0.089%. Boiler operators are generally not concerned about chlorine in coal unless the value exceeds 0.20%. All of the coals sampled were well below the level at which one would be concerned.

Mercury and selenium are of potential concern in coal combustion because the elements are volatile and, when in significant concentration, are deleterious to animals, including humans. Concentrations of these two elements in the 15 coal samples from the Kyrgyz Republic that we have analyzed are approximately an order of magnitude less than (one-tenth the value) the average concentration of these elements in other coals of the world.

9. Technical character of coals

a. Heating value

The heating value of coals is determined in the laboratory in a bomb calorimeter, but there are many different ways to report the results -- most only roughly indicaate the natural coal with moisture and mineral matter as it is actually used . In some countries, such as the US, the results are commonly reported on a moist basis, but with mineral matter calculated to zero. This requires that the samples actually are of a quality to represent the bed moisture. Figure III-17 shows the moist, mineral-free heat value of the bed-moist USGS samples from Kyrgyzstan, in MJ/kg. Most of the data available in the literature on Kyrgyz coals are dry basis, ash free; such values for the USGS samples are shown in figures III-18 and III-19. Heating value reported previously for Kyrgyz coals ranges widely among samples from a given mine (Figure III-20), probably because the character of samples was not well defined when collected or when the results were reported. The results from the USGS samples agree roughly in most cases with the mean of values reported from earlier analyses (Figure III-20).

b. Ash fusion temperature (reducing / oxidizing)

Ash fusion temperatures are used to predict the slagging and fouling character of coals during combustion. Table III-14 shows our analyses for coals from Kyrgyzstan, both in reducing and oxidizing conditions of analysis. The four temperatures reported are initial deformation, softening, hemisphere and fluid (flow) temperature. Our data show temperatures in reducing atmosphere slightly lower than in oxidizing atmosphere, which is characteristic of iron-bearing coals. Ash fusion temperature may be useful mainly where coals are stoker fired, not fed pulverized, but we consider they should be available for our suite of samples because our data are probably the only

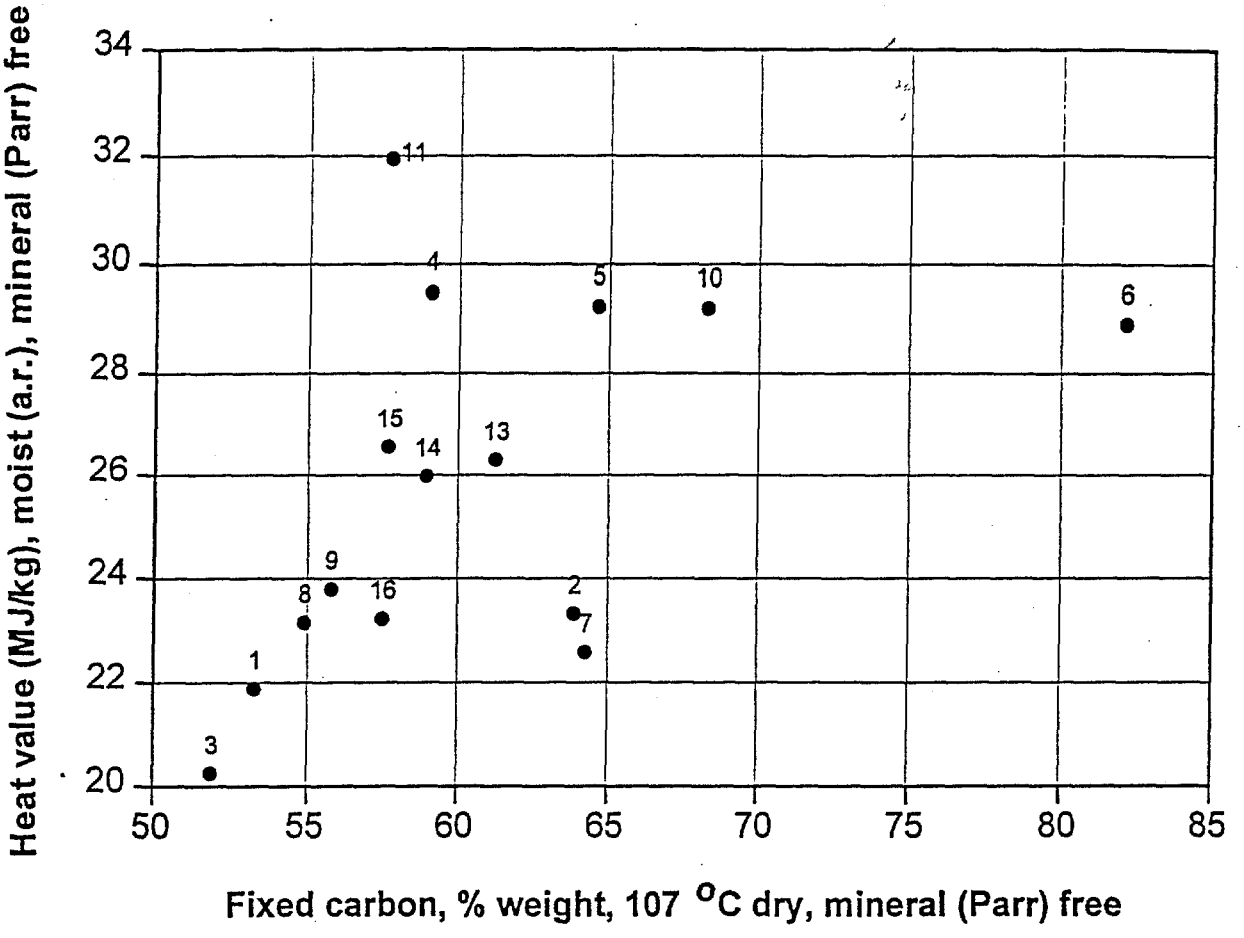

Figure III-17. Heat value in relation to fixed carbon of Kyrgyz coals sampled by the USGS.

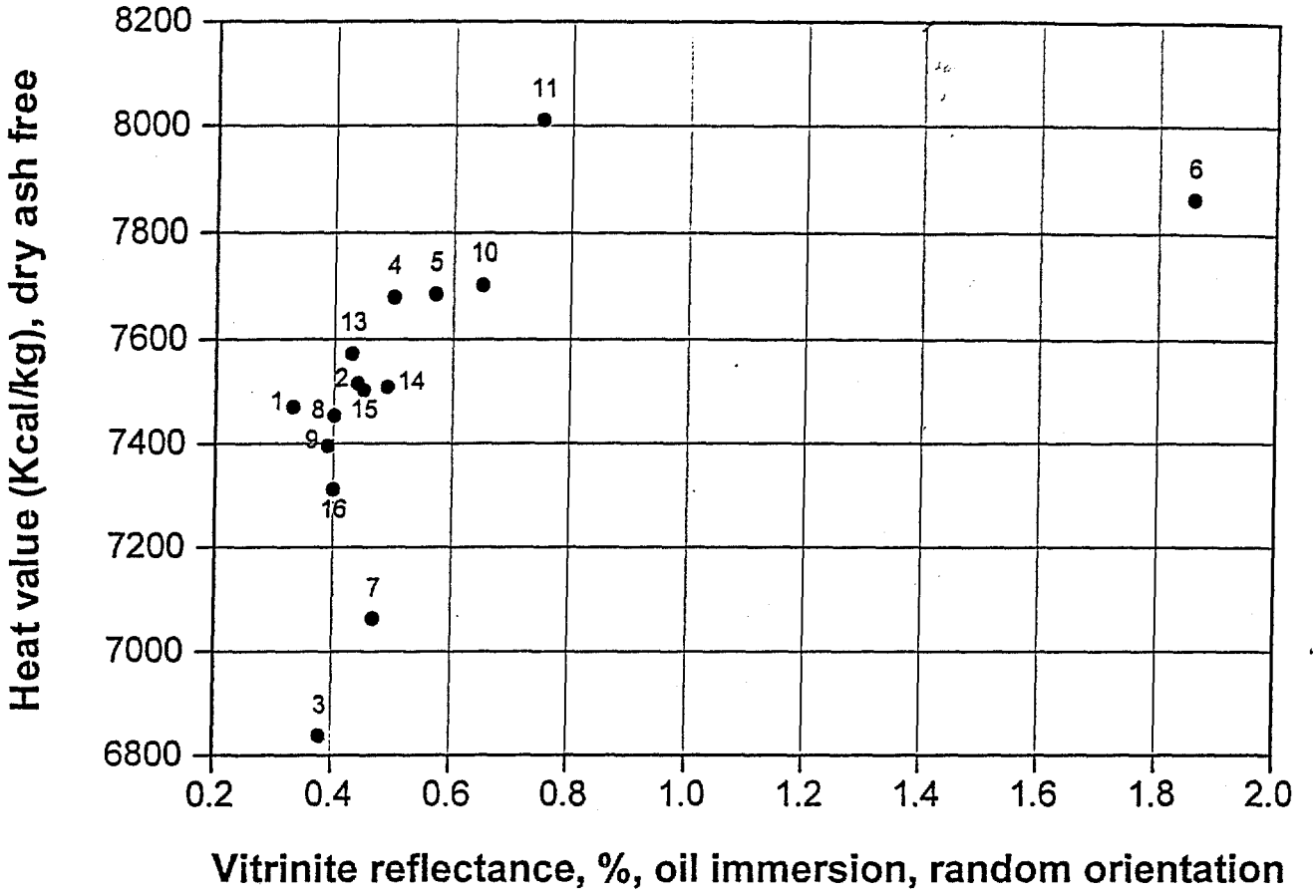

Figure III-18. Heat value in relation to vitrinite reflectance of Kyrgyz coals sampled by the USGS.

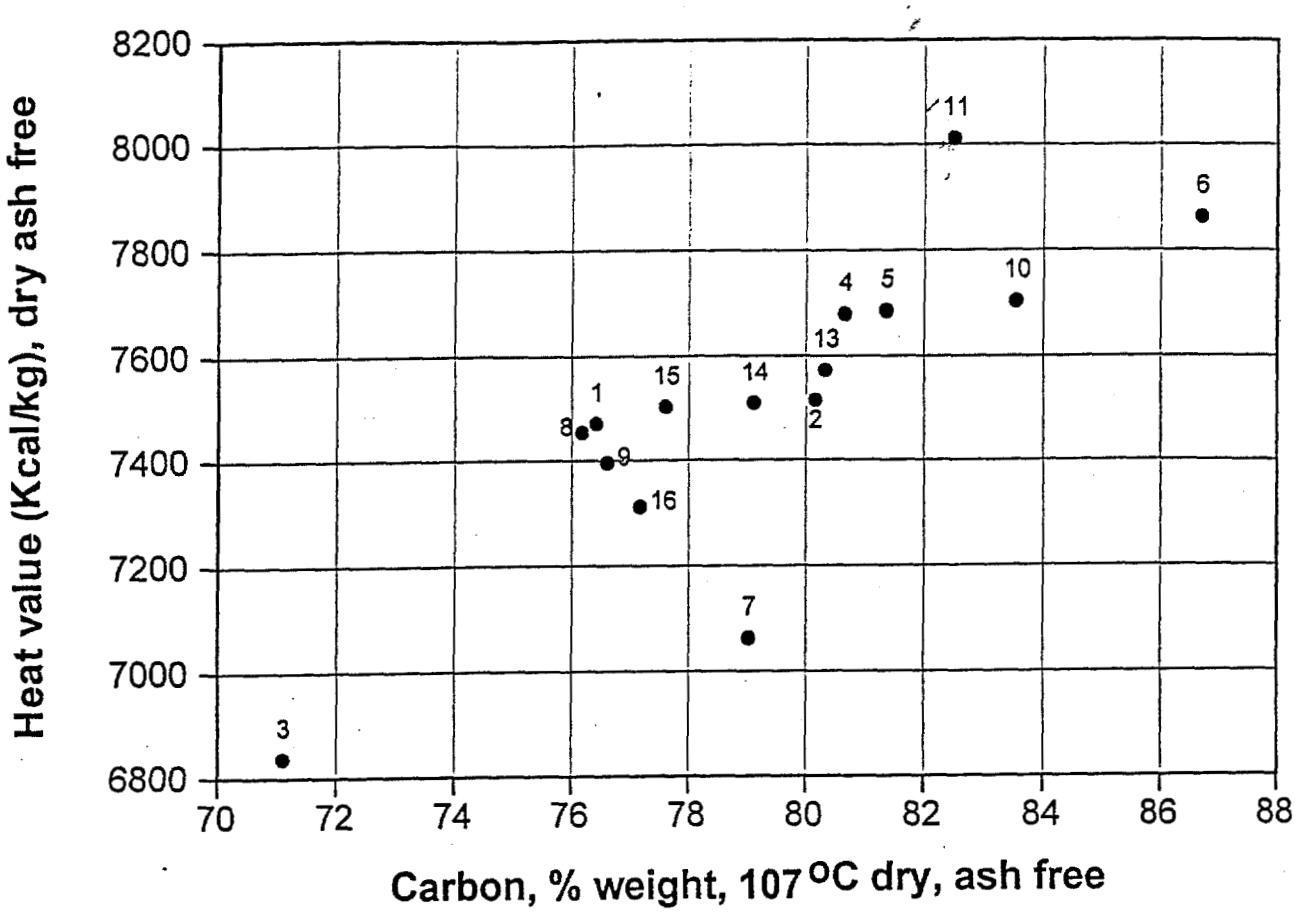

Figure III-19. Heat value in relation to elemental carbon of Kyrgyz coals sampled by the USGS.

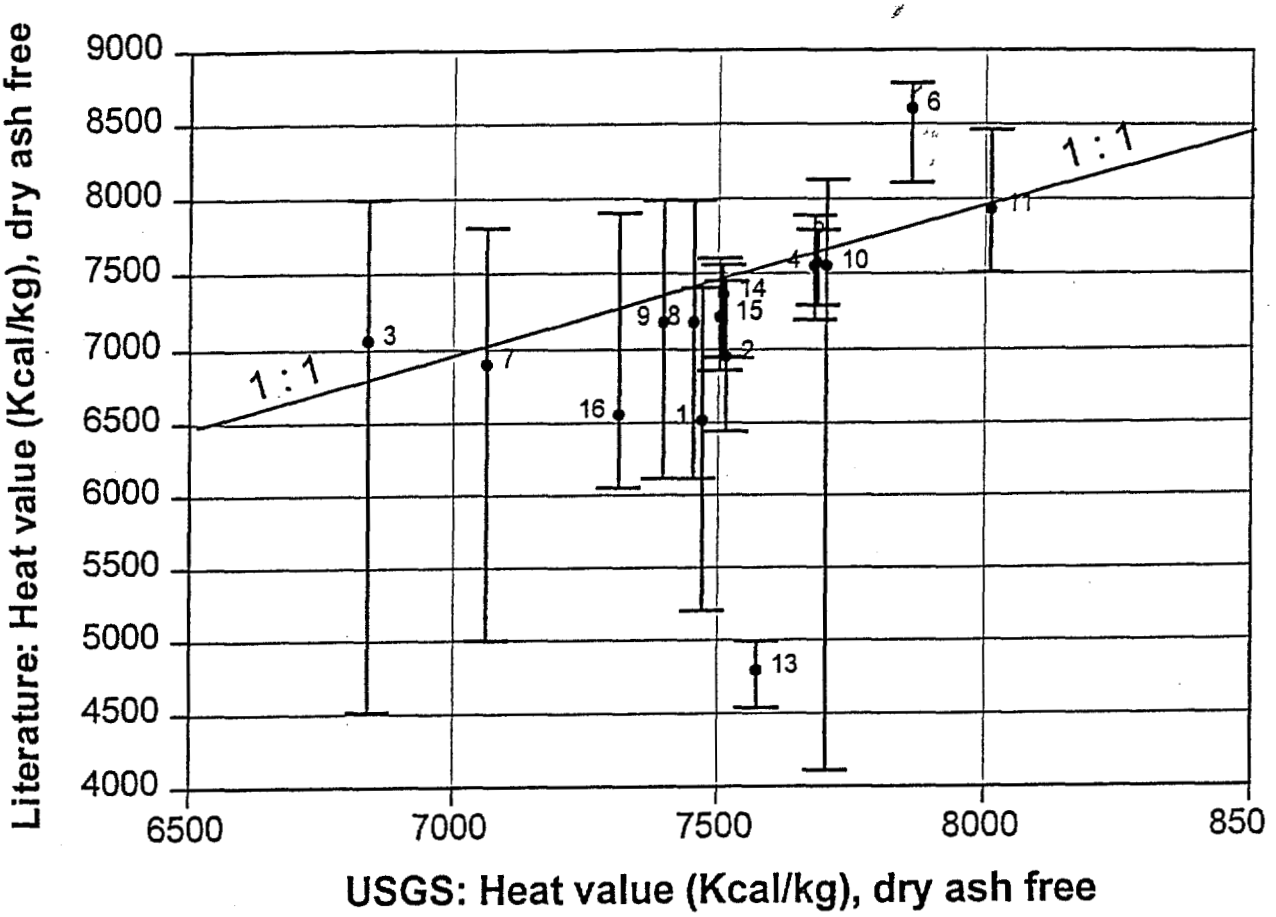

Figure III-20. Heat value of Kyrgyz coals sampled by the USGS in relation to the range and mean of heat value reported in the literature for coals from the same mines, in some cases stated to be from the same seam.

Table III-14. Ash fusion temperatures in both oxidizing and reducing atmosphere of coal samples collected by the USGS in Kyrgyzstan. Free swelling index, Hardgrove grindability, apparent specific gravity, and ash content (750°C) are listed for the same samples.

K-#	Site	HGI	FSI	S.G.	%Ad	Ash fusion temp. (reducing), °C				Ash fusion temp. (oxidizing), °C			
						Init.Def[1]	Soften.[2]	Hemi[3]	Fluid[4]	Init.Def.	Soften.	Hemi	Fluid
1	Abshir	63	0	1.29	6.6	1232	1249	1254	1260	1293	1310	1343	1421
2	AgUlak	78	0	1.31	15	1227	1266	1282	1310	1282	1310	1332	1360
3	Almalyk	61	0	1.52	35	1343	1416	1438	1482	1427	1449	1477	1504
4	Dzhergalan	48	1	1.35	7.2	1204	1254	1260	1271	1210	1260	1271	1321
5	Dzhergalan	51	0	1.41	9.8	1277	1304	1316	1388	1299	1321	1366	1404
6	Kara-Tyube	93	0	1.53	22	1360	1427	1454	1521	1371	1466	1493	1527
7	Kara-Keche	71	0	1.3	8.8	1321	1343	1354	1360	1332	1349	1360	1377
8	Kara-Tut	73	0	1.35	18	1099	1127	1138	1210	1266	1304	1343	1388
9	Kara-Tut	62	0	1.37	17	1177	1199	1216	1427	1266	1310	1349	1443
10	Kok-Yangak	68	0	1.34	13	1138	1166	1193	1216	1304	1321	1349	1366
11	Kum-Bel	47	4	1.31	8.8	1538	1538	1538	1538	1538	1538	1538	1538
13	Kyzyl-Bulak	73	0	1.29	3.8	1377	1421	1427	1443	1432	1466	1477	1493
14	Tash-Kumyr,S	69	0	1.37	8.1	1093	1121	1132	1199	1238	1254	1271	1293
15	Tash-Kumyr,S	61	0	1.4	15	1154	1177	1193	1210	1282	1338	1366	1399
16	Valakish	73	0	1.33	12	1160	1182	1204	1216	1193	1210	1232	1266

K-#	Site	HGI	FSI	S.G.	%Ad	Ash fusion temp. (reducing), °F				Ash fusion temp. (oxidizing), °F			
						Init.Def.	Soften.	Hemi	Fluid	Init.Def.	Soften.	Hemi	Fluid
1	Abshir	63	0	1.29	6.6	2250	2280	2290	2300	2360	2390	2450	2590
2	AgUlak	78	0	1.31	15	2240	2310	2340	2390	2340	2390	2430	2480
3	Almalyk	61	0	1.52	35	2450	2580	2620	2700	2600	2640	2690	2740
4	Dzhergalan	48	1	1.35	7.2	2200	2290	2300	2320	2210	2300	2320	2410
5	Dzhergalan	51	0	1.41	9.8	2330	2380	2400	2530	2370	2410	2490	2560
6	Kara-Tyube	93	0	1.53	22	2480	2600	2650	2770	2500	2670	2720	2780
7	Kara-Keche	71	0	1.3	8.8	2410	2450	2470	2480	2430	2460	2480	2510
8	Kara-Tut	73	0	1.35	18	2010	2060	2080	2210	2310	2380	2450	2530
9	Kara-Tut	62	0	1.37	17	2150	2190	2220	2600	2310	2390	2460	2630
10	Kok-Yangak	68	0	1.34	13	2080	2130	2180	2220	2380	2410	2460	2490
11	Kum-Bel	47	4	1.31	8.8	2800+	2800+	2800+	2800+	2800+	2800+	2800+	2800+
13	Kyzyl-Bulak	73	0	1.29	3.8	2510	2590	2600	2630	2610	2670	2690	2720
14	Tash-Kumyr,S	69	0	1.37	8.1	2000	2050	2070	2190	2260	2290	2320	2360
15	Tash-Kumyr,S	61	0	1.4	15	2110	2150	2180	2210	2340	2440	2490	2550
16	Valakish	73	0	1.33	12	2120	2160	2200	2220	2180	2210	2250	2310

[1] Initial deformation temperature: The temperature at which the first rounding of the apex of the cone occurs.

[2] Softening temperature: The temperature at which the cone has fused down to a spherical lump in which the height is equal to the width at the base.

[3] Hemispherical temperature: The temperature at which the cone hs fused down to a hemispherical lump at which point the height is one half of the width of the base.

[4] Fluid temperature: The temperature at which the fused mass has spread out in a nearly flat layer with a maximum height of 1.6mm.

information of familiar type that combustion engineers outside the former USSR would have on Kyrgyz coals.

c. Hardgrove Grindability index

The Hardgrove Grindability index (HGI) is widely used in engineering of coal combustion. The HGI for the USGS samples of Kyrgyz coals are in table III-14. A higher HGI generally predicts coals that are more easily pulverized with lower energy cost, of importance in designing coal-fired generators. Perhaps more important, however, in the present Kyrgyz coal industry is the problem of excess fines produced in mining and handling coal. The HGI may be a good predictor of which coals should be mined to maximize chunk products and which to maximize fine products for particular markets. However, to realize that use of the HGI test, one would need maceral analysis, for Unsworth and others (1991) indicate strong influence of maceral composition on coal breakage and on the HGI.

d. Free swelling index

The free swelling index (FSI) is an inexpensive test to predict the swelling and caking properties of coal. In addition, where coals are known to swell or cake normally, low FSI values can indicate weathering *in situ* or in storage, which lowers the value of coal. The use in this present study is very limited, for the coals presently produced in Kyrgyzstan are mostly not caking. Two of the coals sampled could have been expected to cake or agglomerate -- the low-volatile bituminous coal from Kara-Tyube (K-6) and the high-volatile B bituminous coal from Kum-Bel (K-11) (table III-5). The latter does have FSI of 4.0 as expected, but the former shows FSI of 0 (tables III-4, III-14), probably because the rank is too high to maintain caking properties, but possibly because the sample was weathered.

10. Sources of additional similar data on Kyrgyz coals

At the present time the data resulting from this project may be the only information on Kyrgyz coals in forms familiar to engineers and geologists who work in the US and elsewhere outside the former USSR. However, there is much scattered information on Kyrgyz coals in the Russian-language technical literature, though more on geology than technology. Two recent publications on properties and technology of Kyrgyz coals are Barsanayev, S.B., editor, 1991, Improving methods of exploiting coal deposits of Central Asia (mainly physical properties of coal and rock in mining) and Dzhamanbayev, A.S., 1983, Coals of Kyrgyzstan and rational ways of using them (mainly chemical and industrial and briquetting properties).

Additionally there is a very large body of "fond" information and raw data on file at the Ministry of Geology and Mineral Resources in Bishkek. Probably much of that same information is preserved in Tashkent, Uzbekistan (from which much coal work in all of Central Asia was organized) and in Russia -- but access to information on particular coals or sites is likely to be difficult. Both "fond" and published information on properties, geology and resources of Kyrgyz coals have been compiled recently by T.S. Solpuyev, head of the Coal Division of the Ministry of

Geology and Mineral Resources of the Republic of Kyrgyzstan (Solpuyev, T.S., 1994). Solpuyev's monumental 420 page compilation is particularly valuable because of his great practical field experience in Kyrgyz coal regions and because it serves to identify many unpublished works on coals of Kyrgyzstan.

E. PAST AND PRESENT PRODUCTION, PRICING LEVEL

1. Past and present production

In 1979, about 4.5 million tonnes of coal were produced in Kyrgyzstan. From 1980 to 1990 the production ranged between 3.5 and 4.0 million tonnes. Since then production has decreased drastically and the production for 1995 was about 455 thousand tonnes. Coal production from 1961 to 1994 is shown on figure III-21. The sixty-five year production history of the Kok-Yangak mining area in the East Fergana Coal Region, shown in figure III-22, exemplifies the production history of much of the coal industry of Kyrgyzstan.

Many reasons have been offered to explain the precipitous decline in production, and it seems clear that a combination of many factors is responsible. Cited reasons are depletion of reserves, antiquated, worn-out machinery, fuel shortages, reluctance of miners to work unpaid, loss of experienced personnel, loss of markets by extra-national decisions, poor transportation infrastructure, and problems in transition from a centrally-planned union economy to a market-based national economy.

Table III-15 shows the actual production, imports and exports of coal for Kyrgyzstan in the years 1990-1992, and the same data as planned for the period 1993-2010. Obviously, the plan is badly askew with present reality of less than one million tonnes of coal produced in 1994. No data was available regarding imports and exports in 1994.

In the first four months of 1996 34,400 tonnes of coal were exported to Uzbekistan, 1,800 tonnes to Tadjikistan, and 2,800 tonnes to Kazakstan. Of this 39,000 tonnes all but 600 tonnes were fine coal that presumably was used in district heating plants. Because currencies are not convertible, the coal was bartered largely for foodstuffs which then are distributed to the coalmine workers in lieu of wages.

2. Present and potential utilization

The bulk of the coal resources of Kyrgyzstan are suited for use as a source of thermal energy. A small part of the resources in the Eastern Fergana Coal Region may possess characteristics allowing use as metallurgical coke for smelting iron and other ores, foundry coke, and as smokeless household fuel. The coals are friable and the product of the operating mines includes a large percentage of fine fragments. The fine fragments are not a major problem if the coal is used in powder-coal fired installations such as large thermal electricity and heat stations. The coarser-grained portion of the mines production is usable in a wider range of applications, from stoker-fed boilers to domestic heating and cooking in a variety of stoves.

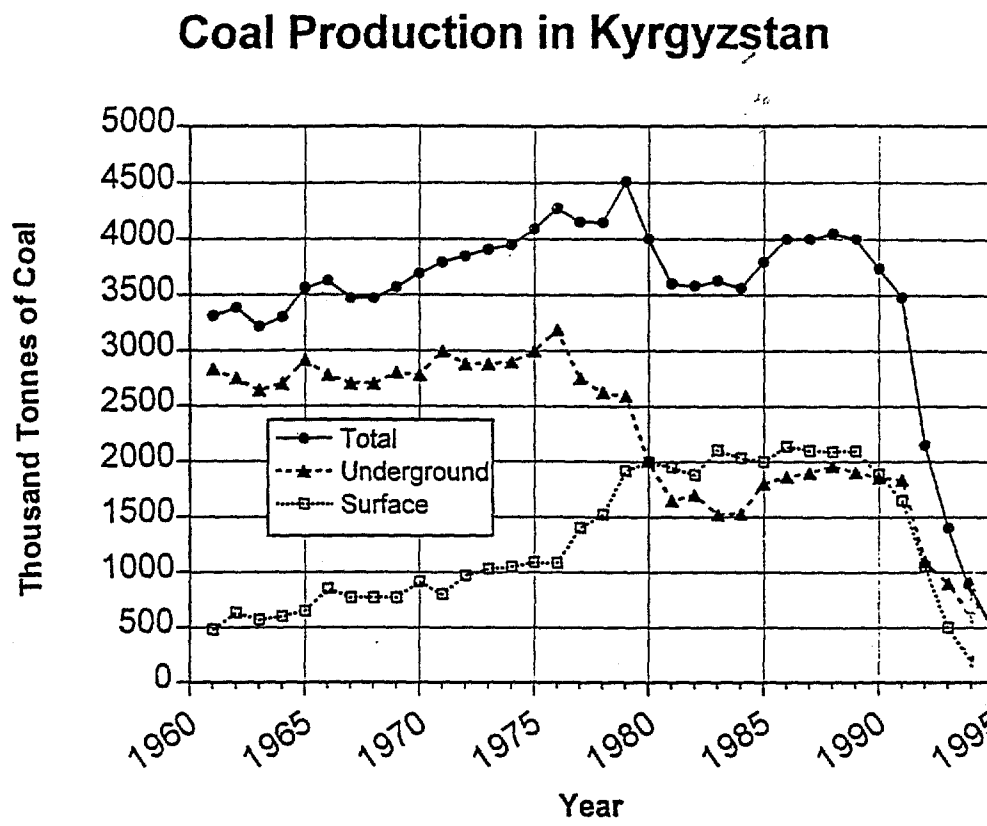

Figure III-21. Thirty five year production history of coal in Kyrgyzstan based KYRGYZKOMUR records, with 1994 production estimated in October 1994 from variou sources in the production branch of the coal industry of the country.

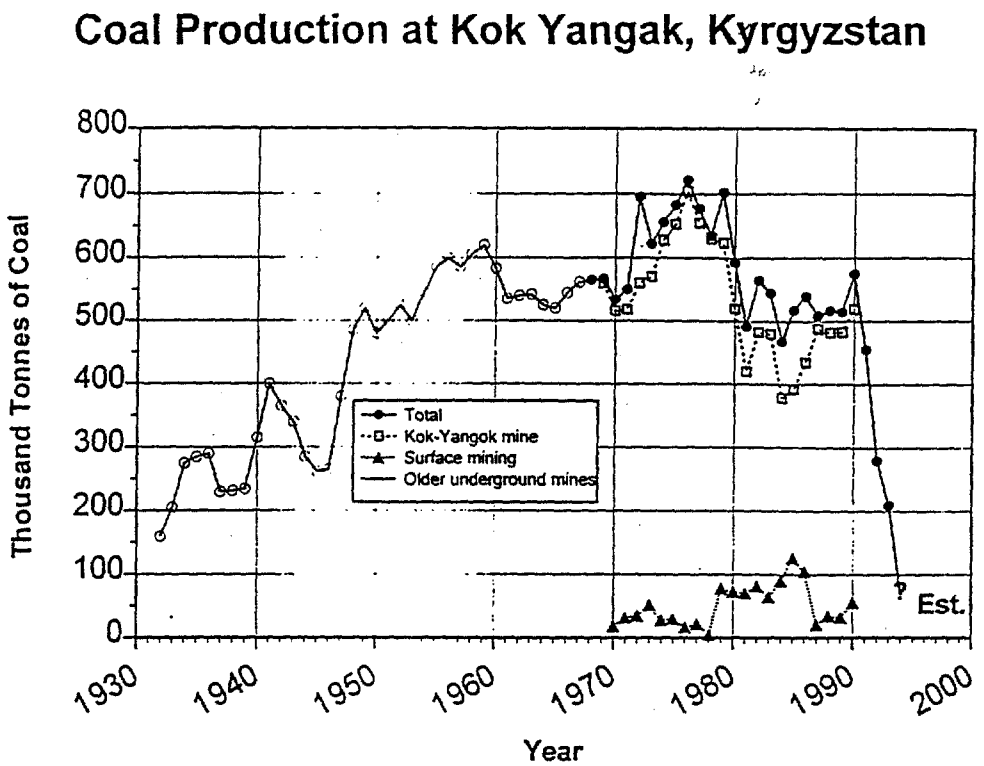

Figure III-22. Sixty year production history at Kok-Yangak, Kyrgyzstan. Several entries to undergound operations in early decades were replaced by the present horizontal entries in the late '60s. Minor "small enterprise" surface mining presently near Kok-Yangak would not change these production figures noticably. Based on a plot in Kyrgyzkomur (1994), pg. 54, and a chart at the mine offices, with 1994 estimated by mine management in October, 1994.

Table III-15. Kyrgyzstan coal production, import and export in recent years and plans to 2021.

Parameter			Amount per year, in Thousand Tonnes								
			Actual			Planned					
			1990	1991	1992	1993	1994	1995	2000	2005	2010
1.	Coal production	Total	3742.0	3483.0	2150.5	3300	3600	4200	5300	6300	7000
		Lump quality	1197.4	1105.0	623.6	1045	1060	1196	1834	2268	2514
		Fines and unsorted	2544.6	2396.0	1527.0	2255	2534	3004	3466	4032	4486
2.	Coal import	Total	2900.0	2655.0	1262.9	2000	1900	1500	1000	400	0
		Lump quality	1484.6	1300.0	394.6	1055	1084	1004	666	232	0
		Fines and unsorted	1415.4	1355.0	868.3	945	816	496	334	168	0
3.	Combined resource	Total	6642.0	6156.0	3413.4	5300	5500	5700	6300	6700	7000
		Lump quality	2682.0	2405.0	1018.2	2100	2150	2200	2800	3100	3314
		Fines and unsorted	3960.0	3751.0	2395.2	3200	3350	3400	3500	3600	3686
4.	Use in Kyrgyzstan	Total	4687.4	4418.0	2392.0	4300	4500	4700	5300	5700	6000
		Lump quality	2250.4	2155.0	890.2	2100	2150	2200	2700	3000	3200
		Fines and unsorted	2437.0	2281.0	1501.0	2200	2350	2500	2600	2700	2800
5.	Export	Total	1954.6	1720.0	1024.4	1000	1000	1000	1000	1000	1000
		Lump quality	431.6	250.0	128.0	0	0	0	0	0	0
		Fines and unsorted	1523.0	1470.0	896.4	1000	1000	1000	1000	1000	1000

Unfortunately, there is little market for the fine-grained coal from the Kyrgyz mines. The coarser coal is in demand for heating installations and domestic use. The mining systems in use in Kyrgyzstan inevitably produce a large amount of fine coal for which there is no demand, along with the coarse coal which is in demand.

Though changes in mining methods may reduce the amount (percentage) of fine coal produced, the friability of the coal dictates that there will always be a considerable amount of fines produced along with coarser-sized coal. Development of a use for the fine coal is necessary. Of potential uses for fine coal, the application of briquetting technology to produce cohesive aggregations of the fine coal for use in coarse-coal applications appears most practical and possible.

The coarse coal produced in mining will almost certainly be in demand for the foreseeable future as long as it can be supplied for an affordable price. Small cogeneration facilities using coarse coal to produce heat and electricity in remote areas of the republic could abate present and future energy shortages in those areas if suitable nearby coal deposits are available.

3. Coal pricing structure

a. General

Kyrgyzstan's change to a free market economy during the past four years has disrupted many aspects of business activity. The condition of the general economy of the country can be characterized as distressed and the pricing of commodities is unstable. The information obtained in regard to coal pricing for the purposes of this report reflects these uncertainties. The price is certainly being affected by supply (with factors of quality and location) and by regional demand. However, the overall market can be categorized as being in turmoil due to the following series of factors.

The primary problem is the decline in sale (and hence, mining) of fine size coal with attendant reduction in the availability of coarse sizes. Next, the lack of hard currency payments by heating, electricity generating, and industrial plants to the mines, which could be used to import equipment and supplies, has forced reduction in tonnage mined. In some cases, the market for fine coal was lost when the national government obtained barter agreements across borders, primarily with Kazakstan. In these cases, transportation costs were certainly a factor. Also basic to the problem is the instability of the new currencies of the newly established central Asian countries and hence, the lack of established exchange rates.

As a result, the nation's coal production has declined over a six year period from about 4 million tonnes to 455 thousand tonnes in 1995. The steady loss of market for the fine sizes and non-payment in cash for coal delivered to bulk consumers has forced mines to reduce or cease fine coal shipments and, therefore, maximum production. The resulting decline in availability of funds caused mines to reduce maintenance of equipment, number of miners, support personnel, and staff.

In Kyrgyzstan, the price of coal is affected by the above problems. The price of coal to a

consumer anywhere is made up of two main parts: (1) its price at the mine and (2) the price of transportation to its point of use. While a complete coal price analysis is beyond the scope of this study, inquiries made which centered on the coal price at the mine did result in the following information.

b. Price of coal

Kyrgyzstan's historic coal market price is based on the size of coal particles available for sale. The major portion of the market was formerly coal fines defined as 13 mm (1/2") or less. Coal particle sizes over 13 mm are generally considered to be coarse coal which is used primarily for home heating/cooking in less urban areas and is currently in short supply. There are indications that sizes greater than 20 mm (3/4 inch) brings a premium price and is also in short supply nationwide.

COAL PRICES PER METRIC TON FOB MINES/CLEANING-SIZING PLANTS
[in US$ at 10 Som to 1 US$]

FINE COAL (Generally, particle size 13 mm or less):
6 Responses in the $8 - $10 range, average $8.70/ton.
2 Responses: $4/ton and $12/ton.

Note: Price range is due to quality (all are high ash: 20-35%). Fines are being stockpiled at several mines.

COARSE COAL (Generally, particle size more than 13 mm to 20 mm):
6 Responses in the $9 - $13 range, average $9.70/ton.

Note: Quality is about the same as fine coal.

COARSE COAL (Generally, particle size greater than 20 mm, called Lump Coal):
3 Responses at $18.00, $20.00 and $22.50/ton.

Notes: We were told, in the town of Kyzyl Kiya, that premium lump coal sells for $40 - $50/ton delivered. The supply of this coal is very limited and some of the price paid by the consumer will be in the form of bartered vegetables, wood fuel or traded labor.

The BBC television news, aired in Bishkek, interviewed people in the street willing to pay $48/ton (in Kyrgyz Soms) for lump coal delivered for winter heating, if it was available.

The above prices were stated to include cost of production only (direct costs). No indirect costs such as amortization charges for development, equipment and facility depreciation, interest, and other fixed costs are included. The mine that stated a $20/ton price claimed that 18% is profit (the only mine to declare that their price included a profit) and the rest is direct cost of production. This means that coal prices are understated.

In May, 1996, further discussions of prices and taxes elicited the following: the small mines operating under the Private Enterprises Mine Program reach an agreement quarterly with the local government tax office on the value per ton of the coal that they have mined or will mine. This is called the Tax Price. They pay a five percent tax on the coal produced, whether they sell it or not. They then can sell the coal for more or less than the Tax Price. The 5% tax is distributed 20% to local government, 30% to the Oblast, and 50% to the central Government. In addition to the 5% tax on production, they pay 25% tax on sales to the Central Government, 5% insurance (social liability?), 1.5% for road maintenance, and 1.5% to a Water and Air Quality Protection Fund. These taxes must be paid on barter transactions also and the same tax structure applies to all coal mines of the private enterprise program. We do not yet have information about the former state mines, now being converted to state stockholding companies.

In the fourth quarter of 1995, the value of coal produced - the Tax Price - by the Private Enterprises mines ranged from 90 to 120 soms ($9-12) per ton with an average of about 100 soms ($10) per ton. The average for the state-owned mines was about 185 soms ($18.5) per ton and the range was as follows: Kyzyl-Kiya-182 soms per ton, Solyukta-195, Almalyk-142, Agulak (and Kara-Keche?)-96, Tash-Kumyr-173, Kok-Yangak-175, Dzhergalan-242, and Soguty-322. These prices probably are direct cost of production, only. No market (sale) prices were available.

c. Coal Transportation Prices

The price for transportation is as important as the mine price of the coal itself. It is not uncommon for transportation charges to exceed the mine price of coal. In Kyrgyzstan, we were quoted prices of $8 and $10/ton for transporting coal in 7 to 20 ton truckloads. The distances are too vague to consider these prices to be anything but general indicators. We estimate that coal transportation by truck demands a price in the $0.40 to $1.00/ton-mile range. (These prices currently include all, or partly, bartered food stuffs and other agricultural products.) Government subsidy in the form of improved road networks, upgrading and maintenance of existing roads, and an extended internal railroad system will lower the stated high ton per mile transportation costs.

IV. INFORMATION AVAILABILITY

One of the tasks undertaken by the resource assessment team was the gathering of available data pertinent to the coal resource situation in Kyrgyzstan from sources in Kyrgyzstan and the United States. The volume of information that was found is large. The scientific and engineering organizations and agencies of the former Soviet Union produced large quantities of data in a variety of formats and much of that information may still exist. Reportedly, a standardized distribution system was followed for practically all forms of data and information that was recorded on paper. Ordinarily, five copies were prepared of each report, letter, memorandum, etc. One copy went to a central records repository (fond), one to a central ministry or equivalent agency, one to the appropriate agency in the particular Soviet republic, one retained in the originating office or unit, and one kept by the author(s).

Much of the recorded material is fragmentary, such as progress reports, or separated data, such as analyses without sample information. In many cases, perhaps most, comprehensive reports- commonly final- were prepared for particular activities and many of these reports exist as "fond" (repository) literature. The problem is to locate the repository and gain access. Many reports were eventually made available in a published form as summary presentations at domestic and international meetings and much research information is formally preserved in the scientific series and reports of the former Soviet Union. Specialized libraries world-wide contain large quantities of this Russian-language scientific and technical literature. Unfortunately for westerners, much of this literature has not been translated to any other language. Consequently, the data resulting from this study may be the only information on Kyrgyz coals in forms familiar to European and North American geologists and engineers.

The team found that there are large quantities of unpublished information and raw data relevant to the coal resources of Kyrgyzstan in the files of such organizations as the Ministry of Geology and Mineral Resources in Bishkek. Recently, the available information on the geology, resources and characteristics of the coals of Kyrgyzstan have been compiled by T.S. Solpuyev, Head of the Coal Division of the Ministry of Geology and Mineral Resources. His compilation is particularly valuable because it identifies many unpublished works on the coals of Kyrgyzstan. He is presently engaged in preparing much of the data in a form for publication. Published reports that have been particularly helpful are those of Barsanayev (1991) and Dzhamanbayev (1983).

There is a significant amount of available information on the coals of Kyrgyzstan that is beyond the scope of this study; such as tests of pyrolysis behavior and products, mineral transformations at high temperatures, semicoke and coke formation, sorptive properties, tar production and type, briquetting and pelleting tests, extractions with organic solvents, humic acid fractionation, and others. The potential value of such information is difficult to judge, for in the most accessible sources the data are commonly presented isolated from the basic information about the samples. The systematic field and laboratory records from the Soviet Union era do appear to be preserved in large measure - though the loss of institutional memory and access because of retirements, job-switching, emigration, and even the unintentional physical loss or disorganization of records, may be happening at an accelerating rate.

In May, 1996, Bostick visited Tashkent, Uzbekistan, and conferred with S.M. Tomalak, First Deputy Director, and G.M. Ibragimov, Coal Utilization Engineer, of Kumir AB. Kumir AB is the present designation of the organization known as Sredazugul in Soviet Union times, which was responsible for coal exploration and development in the Central Asian Region. Bostick was told that Kumir AB has "vast" quantities of inherited information about coals throughout the region. There was no opportunity for verification.

The teams efforts in gathering and organizing the available information is largely displayed in the Selected Bibliography to this report, which lists reports both cited and uncited. The bibliography does not attempt to list most fond material or the place of deposit. In the interests of preventing duplication, providing time-related comparative data, and avoiding unnecessary expense and delays, a centralized listing of available information according to type and depository should be created to avoid loss and expedite use in the future.

V. ISSUES AND SUGGESTIONS

The coal resource situation in Kyrgyzstan is affected by the interrelated factors: geologic, extraction, utilization, transportation, economic and institutional/political. The assessment addressed facets of the first four; economics and institutional/political factors are not in the scope of the assessment study except as observations. Environmental factors are commented upon as appropriate.

That the interrelated factors are not merging to satisfy the social and economic needs of the Republic are shown by the demonstrated inability of the existing indigenous coal mining industry to satisfy the anticipated need for coal in the short-term (through 1995) and probably for the long-term (through 2010) also. Efforts to restructure the existing coal industry to retain its viability were obvious by May, 1996.

It was anticipated in 1992 that the energy budget of the Republic in 1994 would require 3.6 million tonnes of domestically-produced coal. Actual production in 1995 was only 455 thousand tonnes.

Long-term energy plans derived in 1992 anticipate that the Republic will need 7.0 million tonnes of domestically-produced coal in 2010.

A. GEOLOGIC FACTORS

Coal is known to be present in more than 60 different named deposits in Kyrgyzstan and the generally-accepted estimate of 31,000 million tonnes of original geologic coal resources in the country may be conservative. The estimate has not changed recently because exploration peaked several decades ago and is almost non-existent now.

1. Issue 1.-Exploration and development

There have been only limited exploration and development efforts in Kyrgyzstan during the past decade or two. Past exploration and development activities have apparently been concentrated in the areas selected decades ago because of location, perceived resource potential, ease of minability, and their place in the long-range energy plans of the former Soviet Union. As a consequence, a large part of the coal resources classed as potentially recoverable are also concentrated in past and present mining areas. The portion of the presently estimated potentially recoverable reserves that has been mined, lost-in-mining or is otherwise unrecoverable, is unknown to the assessment team.

In many of these mining areas the reserves within the technical and economic boundaries of the original mine layout have been depleted without investing in the exploration needed for development of new mines or extensions of the existing mines. In other known coal areas of the country, mining has never been considered, presumably because of remoteness from major utilization sites in the former Soviet Union, difficult or non-existent transportation facilities, and a presumed lack of major resources in easily-minable settings. As previously-remote regions of the

nation develop economically and socially, an increase in available energy will be required. An increased understanding of the resources and the potentially recoverable reserves of most of the known coal areas of the nation is required before policy decisions about future energy budgets and plans for capital expenditures for new mines or extensions can be made and justified.

Very limited exploration activities were underway in May, 1996. In the Abshir coal area of the South Fergana region one drill rig was testing expansion of the mining area at the request of the Kyzyl-Kiya mining company. Another drill rig was searching for coal in several areas in the Alay coal region at the behest of residents of the region. In the Uzgen Basin of the East Fergana coal region trenching and other surface exploration activities was being done at the request of small private mine operators. The exploration is being done by the Southern Expedition of the Ministry of Geology and Mineral Resources.

Suggestions are: 1) Increase exploration and development of the nation's coal resources with initial emphasis on present mining areas with recognized resource(reserve) potential, and on areas inadequately explored previously; and 2) Initiate exploration and development activities in parts of the country where coal is known to be present but has never been mined.

2. Issue 2.-Economically recoverable reserves

The coal resources of Kyrgyzstan have traditionally been classified according to reliability (based on the amount and distribution of data) and various technical and engineering factors (such as thickness, depth, rank and others) in a system similar to others used worldwide. It has now been recognized that availability and recoverability evaluations are also required for informed planning of recovery and utilization. Studies of this type meld a great range of geologic, engineering, and technologic factors with economic factors such as mining costs, market demand and product values, to provide the basic information and resulting options needed for planning the extraction and support facilities required for elements of a mining industry, and for overall policy planning.

Suggestion: Evaluate the amount of coal available and economically recoverable in the mining areas of the country. The studies would provide basic data about the coal resources that are recoverable at a cost that the economy of Kyrgyzstan can accept. Studies of this type are required before investment of time, energy and capital in elements of a mining industry can be further justified.

3. Issue 3.-Available information

During the course of past exploration, development, mining, and utilization, large amounts of information were gathered and generated regarding the coal resources of Kyrgyzstan. The information exists in a range of forms and is stored in a variety of settings. Unpublished information in files, such as laboratory analytical reports in laboratories; reports prepared for obscure meetings, published reports in agency or local series, unpublished reports of completed research, and other forms of potentially important data are presently still available in appropriate places. However, reorganizations, retirements, emigration and other causes for loss of institutional

memory endanger these types of information that could be of significant future value.

Suggestion: Gather and organize the presently available information that can affect the future coal industry of Kyrgyzstan. As a minimum, the location of such information should be recorded to provide starting points for future recovery attempts. Ideally, the information should be gathered and organized so it could be integrated and intepreted as needs arise. Much duplication might be avoided with considerable future savings in time and money.

B. EXTRACTION FACTORS

1. Issue 4.-Depleted or otherwise unviable mines

Some of the present mining areas of the country have been in operation for long periods, one for at least 100 years. Some of the mines that were developed as large-scale, mechanized, long-wall underground operations several decades ago have depleted their reserves and worn out their machinery, and apparently have no identified adjoining or adjacent potentially recoverable reserves. Some of the older surface mines have reached the limit of safe and technically-feasible mining because of high overburden ratios. Examples of such mines are the Severnay underground mine at Tash-Kumyr in the Northern Fergana Region and the Abshir and Almalyk surface mines in the South Fergana Region.

Suggestions are 1) Encourage mines such as these to produce as much coal as possible for as long as possible with a minimum of capital investment until safety and efficiency require closure; 2) Consider changes in mining methods where this is may be a viable option, for example, from surface to underground as at Almalyk, or developing a surface mine adjacent to an underground mine as at Severnay and Kara-Soo mines in Tash-Kumyr.

2. Issue 5.-Mines suitable for rapid increase in production

Some of the mining areas of the country have mines in operation, development and planning that reportedly have access to large quantities of potentially recoverable reserves. Committal of funds and other resources is required before coal production can begin or increase. The quantity and quality of the available and economically recoverable reserves should be established along with the economic and engineering parameters for successful operations. Examples of such mines and areas are; the Tegenek underground mine presently under development at Tash-Kumyr, and the underground extension of the existing surface mine at Almalyk. Reportedly, the surface operations at Kara-Keche in the Kavak Coal Region could increase production with more, better or different equipment. In addition, underground mining in several areas of the Kavak Region might be feasible if increased production is desired in the future.

Suggestions are 1) Initiate availability and recoverability studies of the mines and mining areas that could contribute to an increase in the country's coal production in a relatively short time-frame; 2) establish the engineering and economic parameters for successful operation of such elements of the

future coal mining industry; 3) if production for the benefit of Kyrgyzstan is desirable and feasible, provide the capital investment that will be needed.

3. Issue 6.-Private (formerly Small) Enterprises Mining Program

The modern coal mining industry of Kyrgyzstan was created with the intent of producing large quantities of coal efficiently and safely from large, highly mechanized, underground mines operating with longwall mining methods in areas with access to the transportation network of the former Soviet Union or in areas with nearby utilization sites. The mining areas operated as responsible social entities as well as productive enterprises. All exploration, development, mining, transportation, distribution and marketing were performed at the direction of government agencies. With independence, the loss of traditional markets, and the desire for creation of a nationally-responsive market economy with the energy budget to make it possible, structural changes in the coal industry are occurring.

One of the changes was initiation a few years ago of the Small Enterprises Mining Program, which was designed to satisfy local demand for coal by encouraging mining by local individuals or groups by surface -mining methods at outcrop areas. The mines were restricted to 10,000 or less tonnes of production per year and were required to provide free coal to "Budget Institutes" (schools, hospitals, etc.) who could not pay for the coal. (However, this "free" coal was credited against the taxes they would have to pay on their production.)

In 1995 the Small Enterprises Mining Program was reconstituted as the Private Enterprise Mining Program, restrictions on production and other requirements (such as "free" coal) were removed, and private investment is encouraged. The Small Enterprises received some direction and assistance from Kyrgyzkomur but the Private Enterprises apparently do not. The Ministry of Geology and Mineral Resources is responsible for resource and reserve information prior to mining, for licensing the private mines, assisting operators with required documentation, providing technical expertise, and monitoring the conduct of mining activities.

At present all of the fifteen licensed private mines (and the dozen or more very small unlicensed mines) are surface operations essentially restricted to outcrop areas and production of coal with available earth-moving equipment. Increased production from the private mines will require more specialized equipment and technical knowledge. One of the possible changes is initiation of small-scale underground mining by conventional or continuous mining methods. Usual advantages of the continuous and conventional mining systems are much less capital expense and production of coal of coarser character. In addition, because they are usually more labor intensive than longwall, continuous and conventional mining might supply employment to considerable numbers of displaced miners. Generally, productivity is not as high; for example, longwall productivity in the USA in 1993 was 3.30 short tonnes per worker-hour, with continuous mining it was 2.84, and with conventional mining it was 2.56. Also, recovery is not as great--in the USA in 1993 it was estimated that 56 percent of the coal in longwall mines will ultimately be recovered, compared with 53 percent of the coal in continuous or conventional mines (Energy Information Administration, 1995).

Suggestion: Increase production to satisfy demand for coal energy, local and otherwise, by assisting the Private (formerly Small) Enterprises Mining Program. The private enterprises mines need training, assistance and support in all aspects of coal exploration, development, mining and marketing so they can be viable members of the developing free-enterprise system in Kyrgyzstan. In addition to up-grading surface mining capabilities, small-scale underground mining with conventional or continuous mining methods should be encouraged. Assistance, direction and overview from the Ministry of Geology and Mineral Resources (and perhaps from Kyrgyzkomur) within the available experience, responsibilities, and specialities is required. Training and assistance is needed particularly to produce optimum quantities of coarse coal product. The technologic training must be coupled with training and assistance in free-enterprise mining economics, and in the conduct of small market-economy business operations.

C. UTILIZATION FACTORS

1. ISSUE 7.-Briquetting

The coals of Kyrgyzstan are inherently friable. The percentage of the coal produced by the operating mines that is classed as fines varies from about 35 to 70 percent. The longwall underground mines produce the largest percentage of fines and the surface mines produce the smallest percentage. Introduction of other mining methods such as continuous or conventional underground methods might reduce the percentage of fines in the coal produced. However, the friable nature of the coals dictates that, regardless of mining methods employed, the coals produced will include a variable but large portion of fine-sized material. The fine coal is usable in installations burning powdered coal but is poorly suited for use in furnaces with grates that are fed by stokers, or in domestic stoves. At present, the coarse coal portion of the mine production seems to have a ready market but the fine coal does not and must be stockpiled or discarded. Some studies of the possibilities of briquetting the coals of Kyrgyzstan have been conducted. Briquetting programs developed elsewhere to produce briquettes that might be usable in Kyrgyzstan await comparative examination.

Suggestion: Research and test the feasibility of briquetting as a solution to the problem of coal fines. Cooperative consultancy with experts from other countries might accelerate selection of appropriate processes for testing at laboratory and pilot scale.

2. ISSUE 8.-Domestic (non-imported) coal for northern Kyrgyzstan

The heavily populated northern part of Kyrgyzstan in the Chu Valley region depends largely on coal imported from Kazakstan. The quality of the imported coal is mostly poorly- suited for the installations that use it. Reportedly, the mine at Dzhergalan east of Issyk Kul in the northeastern part of Kyrgyzstan could increase production to supply coal for transport by truck or barge to the railroad at Balykchy at the western end of Issyk Kul for transport westward. If this possibility is feasible, the amount of imported coal might be reduced and better quality coal supplied to users in the area. Better quality coal might be blended with imported coal to produce boiler feed of greater efficiency.

Suggestion: Investigate the possibility of increasing coal production at the Dzhergalan mine in the Issyk Kul coal region to supply coal to the Chu Valley Region. The dependency of northern Kyrgyzstan on imported coal might be at least partially alleviated by supplying better-quality domestic coal to the district heating and electricity-generating plants at Bishkek and Kara Balta.

D. TRANSPORTATION FACTORS

1. Issue 9.-Inadequate infrastructure

The pre-independence transportation infrastructure of Kyrgyzstan was never intended to support the internal activities of an independent nation. As a consequence, the Kyrgyz Republic is poorly served by its present roads and railroads. The mountainous character of the country presents serious but not unsurmountable obstacles to building of roads. Maintenance of the existing, heavily-used roads, which total about 30,000 km, is poor, perhaps because of a shortage of operable equipment. [The assessment team saw one operable road grader during their journeys.] Only the northern part of Kyrgyzstan has a railroad system. The areas peripheral to the Fergana Valley in the southwestern part of the country have access to the railroads that serve Uzbekistan, Tadjikistan and Kazakstan. The central, eastern and southern parts of the country have no railroads. A large part of the 370 km of railroads in the nation are in the northern part. For comparison, the farming-ranching State of South Dakota in the USA is about the size of Kyrgyzstan but with far less population, and has 3,100 km of railroads and about 134,000 km of paved and unpaved roads.

Coal mined in the coal regions in southwestern Kyrgyzstan formerly could travel about 1,000 km through Uzbekistan and Kazakstan to reach utilization sites in northern Kyrgyzstan, but presently is restricted to nearby markets. The coal mined in the Kavak coal region in central Kyrgyzstan must be hauled by truck to market areas in southern and northern parts of the country. The coal mined in the northeastern part of the country moves by truck only 65 km to the utilization site.

Suggestions are: 1) Increase routine maintenance of existing roads to improve efficiency and decrease costs of truck transport of bulk commodities such as coal. 2) Develop an expanded railroad transportation system to help solve the problem of transporting domestically-produced coal for use internally, and perhaps for export. The proposed railroad connecting southwestern and northern Kyrgyzstan would allow coal from the southwestern part of the nation to be used in the northern part of the country. In addition, the railroad would traverse the coal-rich Kavak coal region allowing cheaper transportation of the Kavak coals to northern markets.

E. COMBINED FACTORS

1. Issue 10-Periodic Review

The expected improvement in the economy of the Republic will create an increased demand for energy. Demand for coal will increase in correlation with increase in Gross Domestic and National Products. A periodic, preferably annual, review of all aspects of the coal industry of Kyrgyzstan

would provide an update and continuing analysis of the progress of exploration, development, mining, marketing and utilization. An annual review by an expert group of country-knowledgeable specialists would be a source of unbiased reliable information for policy-makers, planners and investors. Timely technical and economic information is necessary to support the coal industry in its transition from a part of a centrally-planned monolith to an important and necessary part of a sound market-oriented economy.

Suggestion: Plan an annual review by country-knowledgeable western specialists with appropriate Kyrgyz counterparts and cooperators. The catylytic combination of basic and time-dependent information with the varieties of experience, knowledge and viewpoints represented by the review team and their coworkers would supply the integrated and summarized data needed by a very broad range of governmental and private agencies and organizations. A periodic up-date would be the most cost-effective way to maintain understanding of the swiftly-changing coal energy situation in the Kyrgyz Republic.

VI. SELECTED BIBLIOGRAPHY

The following bibliographic list includes reports that are not specifically cited in the body of this report. The uncited reports are included herein for possible use by other researchers on aspects of the coal resources of Kyrgyzstan. Language of non-English works is abbreviated after the English translation of the title, eg., =Rus.

Adyshev, M. M., Kashirin, F. T., Umurzakov, S. U., and others (eds.), 1987, Atlas of the Kyrgyz Soviet Sociealist Republic =Rus. [Atlas Kirgizskoy Sovetskoy Sotsialisticheskoy Respubliki], Tom 1: Moscow, 157 p.

Amanaliyev, N. A., Muraliev, A. M., Tuleberdiyv, Zh. T. (eds.), 1993, The Energy Programme of Kyrgyzstan =Rus. [Energeticheskaya programma kyrgyzstana]: KyrgNIINTI (Bishkek), 96pg.

anonymous, 1968, Coal basins and deposits of Central Asia. =Rus [Ugol'nyye basseyny i mestorozhdeniya Srednyey Azii], V.6 of Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR: Moscow, Nedra, v. 6.

ASTM (American Society for Testing and Materials), 1994, Annual book of ASTM standards, Volume 05.05-Gaseous Fuels; Coal and Coke. American Society for Testing and Materials, Philadelphia, PA. [Revision issued annually].

Ayruni, A.T., Galazov, R.A., Sergeyev, I.V., Kaledin, N.V., and Zenkovich, L.M., 1990, Gas abundance in the USSR coal mines; complex development of gas-bearing coal deposits =Rus. [Gazoobil'nost' kamennougol'nykh shakht SSSR; kompleksnoye osvoyeniye gazonosnykh ugol'nykh mestorozhdeniy.]: Moscow, Nauka, 216 p.

Babadagly, V. A., and Usuvaliyev, M. U. (eds), 1990, Geology and oil and gas in Kyrgyzstan =Rus. [Geologiya i neftegazonosnost' kirgiziy]: Frunze, 136 p.

Babushkin, L. N. (ed.), 1963, Atlas of the Uzbek SSR =Rus. [Atlas uzbekskoy Sovetskoy Sotsialisticheskoy Respubliki]: Akad. nauk UzSSR; Tashkent, 53 p.

Bakirov, A.B., and Burtman, V.S. (Compilers), 1984, Guidebook for Excursion 032, Kirghiz Soviet Socialist Republic; International Geological Congress 27th Session, Kyrgyzstan Publishing House, Frunze.

Barsanayev, S.B., 1991, Improving methods of exploiting coal deposits of Central Asia =Rus [Sovershenstvovaniye razrabotki ugol'nykh mestorozhdeniy Sredney Asii]: Bishkek, Ilim, 152 p.

Bazarbaev, E. G., and others, 1993, Development of the oil and gas industry =Rus. [Razvitiye neftegazovoy promyshlennosti]: Ch. 7, in Amanaliyev, N. A., Muraliev, A. M., Tuleberdiyv, Zh. T. (eds.), The Energy Programme of Kyrgyzstan =Rus. [Energeticheskaya programma kyrgyzstana]: KyrgNIINTI (Bishkek), 96pg.

Belskaya, M.A., and e., 1987, Increasing the effectiveness of capital investments in the coal industry. =Rus. [Povysheniye effektivnosti kapitalnykh vlozhenii v ugol'noy promyshlennosti]: Moscow, Nedra, 106 p.

Buchnev, V.F., 1991, Stability of roof and the effectiveness of technology in cleanup mining =Rus [Ustoychivost' krovli i effektivnost' primenyaemykh tekhniki i technologii vedeniya ochistnykh rabot], in Barsanayev, S.B., ed., Sovershenstvovaniye razrabotki ugol'nykh mestorozhdeniy sredney azii [Improvement in exploitation of coal deposits in central Asia]: Bishkek, Ilim, p. 28-42.

Buchnev, V.F., and Matykeyev, K.K., 1991, The nature of rock pressure and the interaction between mechanized supports and country rocks in the Kok-Yangak mine of "Sredazugol'" =Rus [Issledovaniye proyavleniy gornogo davleniya i kharaktera vzaimodeystviya mekhanizirovannykh krepey s bokovymi porodami na shakhte "Kok-Yangak" P/O "Sredazugol'"], in Barsanayev, S.B., ed., Sovershenstvovaniye razrabotki ugol'nykh mestorozhdeniy sredney azii [Improvement in exploitation of coal deposits in central Asia]: Bishkek, Ilim, p. 9-27.

Budnikov, A. I., Sadabayev, T. D., Bogombzev, S. S., Kamchybekov, D. K., Adzhikeyev, Z, Amanaliyev, N. A., Grishin, V. Kh., Minakov, V. V., Il'in, V. I., Peretyat'ko, A. D., Kovalenko, A. A., and Doolotaliyev, S. D., 1993, Development of the coal industry =Rus. [Razvitiye ugol'noy promyshlennosti]: Ch. 6, in Amanaliyev, N. A., Muraliev, A. M., Tuleberdiyv, Zh. T. (eds.), The Energy Programme of Kyrgyzstan =Rus. [Energeticheskaya programma kyrgyzstana]: KyrgNIINTI (Bishkek), 96pg.

Bybochkin, A.M., 1983, Instructions on application of reserve classification to deposits of coal and oil shale =Rus. [Instruktsiya po primeneniyu klassifikakatsii zapasov k mestorozhdeniyam ugley i goryuchikh slantsev]: Moscow, Gosukarstvenniya komissiya po zapasam polezn. isk. pri Sov. Minist.SSSR (GKZ SSSR), 47 p.

Carter, M.D., and Gardner, N.K., 1989, An assessment of coal resources available for development; U.S. Geological Survey Open-File Report 89-363,52 p.

Dzhamanbayev, A.S., 1983, Coals of Kyrgyzstan and methods of using them effectively =Rus. [Ugli Kirgizey i puti ikh ratsional'nogo ispol'zovaniya: Frunze, Ilim, 234 p.

Eggleston, J.R., Carter, M.D., and Cobb, J.C., 1990, Coal resources available for development-a methodology and pilot study; U.S. Geological Sirvey Circular 1055,15 p.

Energy Information Administration, 1995, Oil and gas resources of the Fergana basin (Uzbekistan, Tajikistan, and Kyrgyzstan): U.S Dept. of Energy, Office of Oil and Gas, DOE/EIA-TR/0575, 147p.

Fedyanin, A.A., and Tamalak, S.M., 1991, Determining the hydro-physical properties of roof rocks in mining thick coal seams in the central asian coal region =Rus [Uchyot vodno-fizicheskikh svoystv krovel'nykh porod pri otrabotke moshchnykh ugol'nykh plastov sredneaziatskogo uglenosnogo

regiona], in Barsanayev, S.B., ed., Sovershenstvovaniye razrabotki ugol'nykh mestorozhdeniy sredney azii [Improvement in exploitation of coal deposits in central Asia]: Bishkek, Ilim, p. 67-73.

Gavrilin, A.A., 1968a, Geological conditions of mining =Rus. [Gorno-geologicheskiye usloviya], in Gavrilin, A.A., and Kuznetsov, I.A., eds., Ugol'nyye basseyny i messtorozhdeniya sredney asii, Tom 6 of Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR: Moscow, Nedra, p. 156-164.

---, 1968b, Characteristics of coal quality =Rus. [Kharakteristika kaachestva ugley], in Gavrilin, A.A., and Kuznetsov, I.A., eds., Ugol'nyye basseyny i messtorozhdeniya sredney asii, Tom 6 of Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR: Moscow, Nedra, p. 136-155.

Gavrilin, A.A., and Kuznetsov, I.A., 1968, Coal basins and deposits of Central Asia =Rus. [Ugol'nyye basseyny i mestorozhdeniya sredney asii]: Moscow, Nedra, v. 6, of Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR: Moscow, Nedra, 600 p.

Gavrilin, A.A., and Mikhaylov, V.V., 1968, Predicting coal occurrence according to the regions of accumulation =Rus. [Prognoz uglenosnosti po oblastyam uglenakopleniya], in Gavrilin, A.A., and Kuznetsov, I.A., eds., Ugol'nyye basseyny i messtorozhdeniya sredney asii, Tom 6 of Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR: Moscow, Nedra, p. 102-110.

Gavrilin, A.A., and Morozova, T.P., 1968, Coal reserves of Central Asia =Rus. [Zapasy ugley sredney asii], in Gavrilin, A.A., and Kuznetsov, I.A., eds., Ugol'nyye basseyny i messtorozhdeniya sredney asii, Tom 6 of Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR: Moscow, Nedra, p. 177-186.

Ginsburg, A.I., 1968, Petrographic and genetic character of the coals =Rus. [Petrograficheskaya i geneticheskaya kharakteristika ugley], in Gavrilin, A.A., and Kuznetsov, I.A., eds., Ugol'nyye basseyny i messtorozhdeniya sredney asii, Tom 6 of Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR: Moscow, Nedra, p. 111-135.

Grenon, M., 1979, IIASA conference on energy resources, 3rd, Moscow, 1977 Future coal supply for the world energy balance [1st ed.]: Oxford, Pergamon, v. IIASA proceedings series v.6, 720 p.

Kamenov, B., and Zheleznova, N., 1984, Coal basins and deposits of SMEA member countries and Yugoslavia =Rus. [Ugol'nyye basseyny i mestorozhdeniya stran-chlenov SEV i SFRYu]: Moscow, Soviet ekonomicheskoy vzaimopomoshchi, 505 p.

Karenov, R.S., 1987, Effectiveness of renewal and use of basic funds in the coal industry =Rus. [Effektivnost' obnovleniya i ispolzovaniya osnovnykh fondov v ugol'noy promyshlennosti]: Alma-Ata, Izd-vo Akad. nauka Kazakhskoy SSR, 238 p.

Kashin, N.A., 1968, Construction materials at coal deposits of Central Asia =Rus. [Stroitel'nyye materialy ugol'nykh mestorozhdeniy Sredney Asii], in Gavrilin, A.A., and Kuznetsov, I.A., eds.,

Ugol'nyye basseyny i messtorozhdeniya sredney asii, Tom 6 of Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR: Moscow, Nedra, p. 165-176.

Kashirin, F.T., 1957, A new coal-bearing region in the Kirgiz SSR =Rus.[Novyi uglenosnyi raion v Kirgizskoi SSR]: Akad. Nauk sssr, Lab. Geol. lUglya, Trudy, v. vyp.7, p. 47-52.

---, 1966, The level of geological study of the USSR; vol. 46, Kirgiz SSR, from 1946-1950: Published works. =Rus. [Geologicheskaya izuchennost' SSSR; Vol. 46, Kirgizskaya SSR, period 1946-1950, vypusk I, Opublikovannyye raboty]: Frunze, Akad. Nauk Kirg. SSR, Inst. Geol., Upr. Geoll, v. 46, 159 p.

---, 1968, The Alabuga-Naryn and Chatyrkul' coal regions =Rus. [Alabua-Narynskiy i chatyrkul'skiy uglenosnyye rayony], in Gavrilin, A.A., and Kuznetsov, I.A., eds., Ugol'nyye basseyny i messtorozhdeniya sredney asii, Tom 6 of Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR: Moscow, Nedra, p. 433-438.

---, 1974, Prospectives for developing new coal deposits in the Kirgiz SSR =Rus. [O perspektivakh osvoyeniya novykh ugol'nykh mestorozhdeniy kergizkoy SSR]: Akademii nauk Kirgizskoy SSR, v. 1974, p. 53-60.

---, 1988, Coal geology in Kirghiziya for the past 70 years of Soviet power =Rus. [Ubol'naya geologiya v Kirgizii za 70 let Sovetskoy vlasti]: Izvestiya Akad. nauk Kirg. SSR, 1988 (1) 72-79. [English translation included as appendix to this report.]

---, 1990, The Kavak coal basin -- structure, coal content, possible exploitation =Rus [Kavakskiy ugol'nyy basseyn]: Frunze, Ilim, 172 p.

Kashirin, F.T., and Gilmetdinova, N.K., 1968, The north Tyan'-Shan' region of coal accumulation =Rus. [Severo-Tyan'-Shan'skaya obsast' uglenakopleniya], in Gavrilin, A.A., and Kuznetsov, I.A., eds., Ugol'nyye basseyny i messtorozhdeniya sredney asii, Tom 6 of Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR: Moscow, Nedra, p. 209-267.

Kashirin, F.T., Krivolutskaya, V.N., and Korolev, V.G., 1966, The level of geological study of the USSR; vol. 46, Kirgiz SSR, from 1946-1950: Published works. =Rus. [Geologicheskaya izuchennost' SSSR; Vol. 46, Kirgizskaya SSR, period 1946-1950, vypusk I, Opublikovannyye raboty]: Frunze, Akad. Nauk Kirg. SSR, Inst. Geol., Upr. Geoll, v. 46, 159 p.

Kashirin, F.T., Ibragimov, I.M., and Karabalayev, K.K., 1975, The Uzgen coal basin; geologic structure, coal content, prospects for development =Rus. [Uzgenskiy kamennougol'nyy basseyn; geologicheskoye stroyeniye, uglenosnost, perspektivy osvoyeniya]: Frunze, Ilim, 165 p.

Khafizov, YuS., 1991, Improvement of technology in cleanup mining and increasing the production at the Dzhergalan mine =Rus [Puti sovershenstvovaniya tekhnologii ochistnykh rabot na shakhte "Dzhergalan" i uvelicheniya eyo proizvodstennoy moshchnosti], in Barsanayev, S.B.,

ed., Sovershenstvovaniye razrabotki ugol'nykh mestorozhdeniy sredney azii [Improvement in exploitation of coal deposits in central Asia]: Bishkek, Ilim, p. 89-94.

Kochnev, YeA., Ivanova, A.I., and Ginsburg, A.I., 1968, The east Fergana coal region =Rus. [Vostochno-Ferganskiy uglenosnyy rayon], in Gavrilin, A.A., and Kuznetsov, I.A., eds., Ugol'nyye basseyny i messtorozhdeniya sredney asii, Tom 6 of Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR: Moscow, Nedra, p. 362-433.

Kopylov, B.V., 1977, Coal [Ugol'], in Pomazkov, K.D., ed., Geology of the USSR. Kirgiz SSR. Natural resources: Moscow, Nedra, v. 25 (Book 2), p. 10-37.

Kravtsov, A.I., 1979, Gas content of coal basins of the USSR =Rus.[Gazonosnost' ugol'nykh basseynov SSSR]: Moscow, v. 1-3.

Kravtsov, A.I., and etc, 1978, Gas-bearing coal deposits of the USSR =Rus. [Gazonosnost' uglenosnykh otlozheniy SSSR], in Obschchiye dannyye po ugol'nym basseynam i mestorozhdeniym SSSR: Moscow, Nedra, p. 202-229.

Kuznetsov, I.A., and Gavrilin, A.A., 1968, Geologic-economic evaluation of the coal resources of Central Asia =Rus. [Geologo-ekonomicheskaya otsenka ugol'nykh resursov sredney asii], in Gavrilin, A.A., and Kuznetsov, I.A., eds., Ugol'nyye basseyny i messtorozhdeniya sredney asii, Tom 6 of Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR: Moscow, Nedra, p. 187-206.

Kyrgyzkomur, 1993, A program of development of the coal industry of the Republic of Kyrgzystan for 1993-2010 =Rus. [Programma razvitiya ugol'noy promyshlennosti Respublika Kyrgyzstana na 1993-2010] [Internal Document ed.]: Osh, Ministerstvo Energitiki, Respublika Kyrgyzstana, Gos.Kontsern "kyrgyzkomur", 56 p.

Loba, M., 1986, Developments in Soviet coking technology: Delphic Associates, 155 p.

Mezgin, V. A., Mamatkanov, D. M., Sysenko, V. I., Shapar, A. K., Komarov, M. I., Minakov, V. V. and Mambetzhanova, S. A., 1993, Ecological problems of energy supply =Rus. [Ekologicheskiye problemy energetiki]: Ch. 12, in Amanaliyev, N. A., Muraliev, A. M., Tuleberdiyv, Zh. T. (eds.), The Energy Programme of Kyrgyzstan =Rus. [Energeticheskaya programma kyrgyzstana]: KyrgNIINTI (Bishkek), 96pg.

Mikhaylov, V.V., and Gavrilin, A.A., 1968, Main regions of coal accumulation in Central Asia =Rus. [Osnovnyye oblasti uglenakopleniya Sredney Asii, in Gavrilin, A.A., and Kuznetsov, I.A., eds., Ugol'nyye basseyny i messtorozhdeniya sredney asii, Tom 6 of Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR: Moscow, Nedra, p. 68-84.

Molchanov, I.I., and Tyzhnov, A.V., 1978, Coal and oil shale reserves of the USSR =Rus. [Zapasy uglya i goryuchikh slantsev SSSR], in Ammosov, I.I., ed., Obshchiye dannyye po ugol'nym basseynam i mestorozhdeniym sSSR: Moscow, Nedra, v. 12, p. 27-55.

Ognev, V.K., 1946, Structural-facies feaatures of coal-bearing strata of the East-Fergana coal basin =Rus: Frunze, Izd. Kirgiz. filiala, Akad. nauk SSSR.

Poliansky, B.V., 1980, The evolution of triassic-jurassic sedimentation in the Caucasus-Pamirs zone of the Tethys in Aubouin, Jean, Debelmas, Jacque, and Latreille, Michel, (Coordinators), Geology of the Alpine chains born of the Tethys, Conference C5, Inernational Geological Congress 26th Session [Bureau de Recherches Geologiques et Minieres, Memoire 115, p. 138.

Pomazkov, K.D., and Kopylov, B.V., 1977, Geology of the USSR. Kirgiz SSR. Natural resources. [Geologiya SSSR. Kirgizskaya SSR. Poleznyye iskopayemyye]: Moscow, Nedra, v. 25 (Book 2 of 2 + map folder), 152 + maps p.

Rohrbacher, T.J.; Teeters, D. D.; Osmonson, L. M.; Plis, M. N., 1994, Coal recoverability and the definition of coal reserves, Central Appalachian Region: U.S. Bureau of Mines, Open-file Report 10-94, 36 p.

Rusanova, O.D., 1969a, Methods of analysis and sources, in Rusanova, O.D., ed., Petrologiya ugley sredneaziatskikh mestorozhdeniy: Tashkent, "Fan" Press, Uzbek SSR, p. 42-43.

---, 1969b, Petrology of coals of Central Asian deposits =Rus. [Petrologiya ugley sredneaziatskikh mestorozhdeniy]: Tashkent, "Fan" Press, Uzbek SSR, 186 p.

Ryabinin, V.I., 1917, Bituminous coal in Kok-Maynak urochishche on Dongurme River: Surface & Subsurface, v. 2.

Sagers, M.J., 1993, The energy industries of the former USSR: Post Soviet Geography, v..34, p. 341-418.

Schnitzel, W., 1981, Briquetting, in Elliott, M.A., ed., Chemistry of coal utilization, 2nd suppl.vol [Chapter 11 ed.]: J.Wiley, p. 609-664.

Scott, D. C., 1995, Coal recoverability and coal reserve analyswis, Appilachian Basin, 1995: U.S. Bureau of Mines, Open-file Report 75-95, 21 p.

Sekisov, G.V., Grishin, V.K., and Yerneyev, R.Y., 1991, The basic ways to provide efficient development of the coal industry in Kyrgyzstan =Rus [Osnovnyye puti obespecheniya effektivnogo razvitiya ugol'noy promyshlennosti kirgizii], in Barsanayev, S.B., ed., Sovershenstvovaniye razrabotki ugol'nykh mestorozhdeniy sredney azii [Improvement in exploitation of coal deposits in central Asia]: Bishkek, Ilim, p. 3-9.

Shabarov, N.V., 1939, A new (East Fergana) coal basin in the Kirgiz SSR and its analogs in the Uzbek and Tajik SSR =Rus: Sovyetskaya geologiya, v. 1939.

Shabarova, N.V., 1958, Reserves of coal and bituminous shale of the USSR =Rus. [Zapasy ugley

i goryuchikh slantsev SSSR]: Moscow, Gostechizdat, 179 p.

Sikora, F.F., 1991, V3c: The influence of moisture on the process of spontaneous combusion of coal in pillars =Rus [Vliyaniye vlagi na protsess samonagrevaniya uglya v tselikakh], in Barsanayev, S.B., ed., Sovershenstvovaniye razrabotki ugol'nykh mestorozhdeniy sredney azii [Improvement in exploitation of coal deposits in central Asia]: Bishkek, Ilim, p. 73-82.

Solpuyev, T.S., 1994, Coal quality and reserve calculations for the Republic of Kyrgyzstan, including type and rank classification according to GOST 25543-88 -- Report of work by the Coal Group, Committe on Geology, in 1992-1994 =Rus.: Bishkek, "Fond" report, unpublished archives., Vol. 1, 165 pg.; Vol. 2, 262 pg. [plus separate folios of maps, sections, columns] p.

Stankevich, YuV., 1968, The Alay prospecitve area =Rus. [Alayskaya perspektivnaya ploshchad'], in Gavrilin, A.A., and Kuznetsov, I.A., eds., Ugol'nyye basseyny i messtorozhdeniya sredney asii, Tom 6 of Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR: Moscow, Nedra, p. 333-335.

Stankevich, YuV., Kopylov, B.V., Kopayev, V.A., Gavrilin, A.A., Zakharevich, V.A., and Utkin, V.I., 1968, The south Tyan'-Shan' region of coal accumulation =Rus. [Yuzhno-Tyan'Shan'skaya oblast' Uglenakopleniya], in Gavrilin, A.A., and Kuznetsov, I.A., eds., Ugol'nyye basseyny i messtorozhdeniya sredney asii, Tom 6 of Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR: Moscow, Nedra, p. 268-333.

Timoveev, P. P. and Bogolyubova, L. I., 1964, Die stoffliche Zusammensetzung der kohlen der Jura-Kohlenbildung auf dem Gebiet der UdSSR =Ger. [The constitution of Jurassic coals in the area of the USSR]: Fortsschr. Geol. Rheinld. u. Westfl. 12: 357-376.

Ulmishek, G.F., and Masters, C.D., 1993, Estimated petroleum resources in the former Soviet Union: United States Geological Survey Open-File Report 93-316, 12p., 1 map, 1 table.

Umyrzakov, A.K., 1987, Atlas of the Kirgiz Soviet Socialist Republic. Vol.1. Natural conditions and resources. [Atlas kirgizskoy sovetskoy sotsialisticheskoy respubliki. Tom 1. Prirodnyye usloviya i resursy]: Moscow, Glavloye upravleniye geodezii i kartografii, v. 1, 157 p.

Volkova, I.B., and Ginzburg, A.I., 1974, Atlases of Mesozoic coals of the USSR =Rus. [Atlasy mezozoiskikh ugley SSSR]: Moscow, Medra, 175 p.

Wood, G.H., Jr., Kehn, T.M., Carter, M.D., and Culbertson, W.C., 1983, Coal resource classification system of the U.S. Geological Survey; U.S. Geological Survey Circular 891, 65 p.

World Bank, 1995, Kyrgyz Republic energy sector review: World Bank, Infrastructure, Energy & Environment Division, Country Department III, Report No. 14036-KG.

Yerneyev, R.Y., 1991, Analysis of coal reserve loss during mining at the Dzhergalan deposit =Rus

[Analiz poter' zapasov uglya pri eksplyatatsii Dzhergalanskogo mestorozhdeniya], in Barsanayev, S.B., ed., Sovershenstvovaniye razrabotki ugol'nykh mestorozhdeniy sredney azii [Improvement in exploitation of coal deposits in central Asia]: Bishkek, Ilim, p. 82-89.

Zheleznova, N.G., 1983, Coal reserves of the countries of the world =Rus.[Zapasy ugley stran mira]: Moscow.

VII. APPENDIXES

APPENDIX I. PRIVATE (SMALL) ENTERPRISE MINING PROGRAM

SUMMARY

The Private Enterprises Mining Program allows private investors access to the coal resources of the Republic for the purposes of mining and marketing coal to satisfy local and regional energy requirements of the nation. The private operators engaged in the program receive technical assistance from agencies of the State, primarily from the Ministry of Geology and Mineral Resources, but need additional training and assistance in resource and mining technology, market development, and economics of small, free-enterprise, market-economy mining companies.

BACKGROUND

The Small Enterprises Mining Program was initiated by government decree circa 1993 in an attempt to help satisfy the energy requirements of local areas of the Republic. The program envisioned recovery of coal from accessible outcrops by operators with little or no mining experience equipped with whatever earth-moving machinery was available. Operators were required to supply coal to "Budgetary Institutions" (schools, hospitals, etc.) at no cost, and were not allowed to produce more than 10,000 tonnes of coal annually. The Committee of Geology (now the Ministry of Geology and Mineral Resources) provided resource guidance and was responsible for licensing and general overview of operations. The Ministry of Industry, Material Resources and Trade was authorized in September, 1994, and April, 1995, to issue loan guarantees in the amount of 1.5 million soms and 910 thousand soms, respectively, to catalyze the program. Seven enterprises and four enterprises received the loan guarantees, respectively. [*We were told that only two of the eleven firms are repaying the banks that provided the money, the Ministry never had any money for the program, and does not expect to be involved in repayment of the loans to banks.*] Technical advice to the small enterprises was provided upon request by KYRGYZKOMUR, the government coal mining company operating under the Ministry of Industry, Material Resources and Trade.

PRESENT STATUS OF THE PROGRAM

Within the past year, the program has been renamed the Private Enterprises Mining Program. The mines now have no production restrictions and are not required to provide unpaid-for coal to the Budget Institutes. KYRGYZKOMUR may still provide advice and assistance, and the ability of the Ministry of Geology to assist the program may have been increased. Table 1 is a list of the licensed Private Enterprises Mines in the program. In addition, there may be as many as eleven unlicensed mines operating in local areas.

Licensed enterprises receive resource and reserve information from the Ministry of Geology and Mineral Resources, and can contract with the Ministry for exploration assistance such as trenching or drilling. The enterprises must pay taxes on production and sales, must submit regular reports on activity, and may receive technical advice and guidance in mining.

TABLE 1.--LIST OF LICENSED PRIVATE ENTERPRISES

ENTERPRISE NAME AND TYPE[1]	LOCATION	Production-1995-tonnes
	Alay Coal Region	
Ken (PF)	Kyzyl-Bulak Area	12,600
Oshpirim (SF)	Kyzyl-Bulak Area	5,000
Kenchi (SE)	Noruskul Area	4,500
	South Fergana Coal Region	
Zhatan (SF)	Yatan-Almalyk Area	300
Gavus (PF)	Chukur Area	?
	East Fergana Coal Region	
Dzhalal-Abad (SE)	Western Kumbel Area	3,900
Soyuz-Ken (PF)	Aldyzhar Area	?
Altybay (VE)	Kumbel Area	5,200
Nichke-Say (SE)	Kumbel Area	1,000
Zhibek (SE)	Ming-Teke Area	200
Tashim (SE?)[2]	Kumbel Area	1,900
	South Central Coal Region	
Sardar (PF) with	Turuk Area	5,900?
Aksay (SE)	Aksay Area	500
	Kayak Coal Region	
Besh-Sary (SE)	Kara-Keche Area	0?
	North Fergana Coal Region	
Seytek (VE)	Kok-Yangak Area	700
	Unknown Region	
Tuyuk (SF)		

[1] PF--Private Firm, SF--Stock Firm, SE--Small Enterprise, VE--Village Enterprise
[2] Not in supplied table of licensed enterprises, but was visited in 1994--see Appendix III.2, Site Visits.

Enterprises are listed in four organizational forms in table 1. It is probable that those listed as Small Enterprises are similar to Private Firms but may still have a more cooperative or communal aspect. Private Firms and Stock Firms are probably similar to western understanding of those terms. Village Enterprises are almost certainly responses to local needs and are cooperative in nature.

Table 1 shows that the bulk of coal produced by the small mines came from the Alay coal region. Reportedly, more coal has been produced than sold in the Alay Region. In other areas sales may have matched production. In addition to the production listed in table 1, about 14,000 tonnes were reportedly produced by about eleven other small mines, perhaps all unlicensed as yet.

At most (all?) of the small mines, coal is 1) mined when someone desiring coal arrives with a truck, or 2) mined and stockpiled awaiting the arrival of someone with a truck. The coal is not segregated by size in most (all?) cases and the percentage of coarse versus fine coal can range widely. Cash is the desired form of payment, barter may be accepted, and humanitarian supply with little or no prospect of recovery of mining costs almost certainly takes place.

The former chief geologist of KYRGYZKOMUR, T. Kydyrbaev, is now an Inspector, headquarted in Osh, who reports directly to the Chief of the Department on Geological Control, Utilization and Conservation of Natural Resources in the Ministry of Geology and Mineral Resources in Bishkek. He has oversight and information responsibility for eleven of the licensed private coal enterprises plus all other mineral extraction operations in Dzhalal-Abad and Osh Oblasts. Private Enterprise activities in other oblasts are the responsibility of the headquarters office in Bishkek.

Each private enterprise must reach an agreement quarterly with the local tax office on the value per ton of the coal mined in that quarter. This value is called the Tax Price and the miner must pay a 5% tax per ton of coal produced based upon the Tax Price. This production tax is distributed 20% to local settlements, 30% to the Oblast, and 50% to the central government. When the coal is sold the actual sale price may be more or less than the Tax Price. On the actual sales price the enterprise operator pays a 25% sales tax, a 5% insurance (social liability?) tax, a 1.5% tax intended for road maintenance, and a 1.5% tax for a Water and Air Quality Protection Fund. [*If coal is traded for other commodities, the same taxes apply to the barter transaction.*]

In the fourth quarter of 1995 the Tax Price established for private enterprises coal mines ranged between 90 and 120 soms per ton and averaged about 100 soms per tonne. In contrast the average Tax Price for state-owned mines was about 185 soms per tonne with a range from 96 to 322 soms per tonne.

In 1995, the private coal mining enterprises reportedly produced about one-ninth of the coal mined in the Republic. They constitute an important part of the system that supplies energy for the people of Kyrgyzstan. With assistance the private mining companies could supply more of the fuel needs of the Republic, employing citizens to develop and produce indigenous resources.

NEEDS FOR PROGRAM DEVELOPMENT

The Small Enterprises Mining Program began as a very legitimate humanitarian response to needs for energy in many local areas of the Republic. In those areas coal was unavailable to, or unaffordable by, some or all of the population. The program still is aimed at satisfying the local and regional energy needs of the people of Kyrgyzstan. However, in common with many other parts of the emerging market-oriented economy of the independent countries that were formerly parts of the Soviet Union, the program is now attempting to emphasize private enterprise as a solution to continuing domestic requirements.

The program was initiated under nearly crisis conditions with essentially no requirements for specialized mining knowledge, experience and equipment. The program assumed that market values and other economic factors were of little importance compared to the fuel needs of the population, and loans (perhaps a form of subsidy) were supplied to start the program.

In its present form the program seems to be in transition from its original strongly communal form to that of privately-funded, small, market-responsive, private enterprises that are intended to support the operators and recompense investment. Some of the enterprises listed in table 1. will never be "privatized". Some of them are attempting to function as "profit-making organizations" or "investment opportunities". Many of them need help of various kinds in their attempt to supply the coal needs of the Republic. Those attempting to become viable economic entities require assistance to increase technological and engineering sophistication, to recognize and satisfy marketing factors, and to understand and apply the complex system of economic and legal factors that affect small-scale, market-oriented, coal-mining enterprises.

Assistance ranging from on-site advice to training could be supplied in response to individual enterprise needs to be identified through the Ministry of Geology and Mineral Resources, other governmental agencies, the Association of Small Enterprises (the members are small mining enterprises operators), or through individual contacts and site visits. In addition, general applicable training courses over an identified range of needs could be offered to groups interested in privatization of small coal mines. One suggestion that emerged during discussions was the desirability of a "planned" or "model" small coal-mining enterprise that could be used as a successfull "pilot" analog to instruct, guide and promote private enterprise.

A program to assist and train elements of KYRGYZKUMURHOLDING in mine management, mineplanning and design techniques, financial systems, and marketing may be initiated soon. It is appropriate that a similar program designed specifically for private entrepreneurs and investors be available through the Private Enterprise Mining Program.

APPENDIX II

PRODUCTION OF SMOKELESS, WHOLE-COAL BRIQUETS IN THE KYRGYZ REPUBLIC

A. PRELIMINARY ASSESSMENT

B. AN ILLUSTRATIVE CONCEPT FOR AN ENTERPRISE

by

Charles Bliss, Ch.E.

The work reported here is an update of work completed in June 1995 by the author under funding provided by the U.S. Agency for International Development through International Development and Energy Associates, Inc. (IDEA, Inc.) of Washington, DC. Much significant information upon which this report is based results from the work in Kyrgyzstan undertaken by a team from the United States Geological Survey (USGS), plus a coal mining consultant and a coal utilization consultant. This team is referred to in this report as the *Assessment Team*. Nevertheless, the contents of this report are solely the responsibility of the author.

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A -- PRELIMINARY ASSESMENT

INTRODUCTION

Coal mining operations in the Kyrgyz Republic result in large accumulations of fine coal. From information the Assessment Team obtained in the field, this is coal of particle size less than 13 mm (0.51 inches) and perhaps, at times, less than 5 mm (0.20 inches) in size. The data indicate that the coal mine production can contain up to 70% of such unmarketable fines.

Markets in the Kyrgyz Republic for such a product are currently disappearing for various reasons, which are discussed elsewhere in the main USGS report. For example, users of coal, who depend on stoker-fired combustion, find that the fine coals either blow out through the chimney or fall through the grate into the bottom ash before they are adequately burned. Other problems with the use of fine coal occur during transport and storage. Losses of coal occur with accompanying environmental degradation. During the winter the coal fines can freeze on the conveyor belts in storage bunkers. The need for some kind of satisfactory agglomeration (lumping) technology has been recognized by researchers in the country, and their attention has been focused on conventional briquetting technology.

Compressing finely-divided coal into various shapes, suited to their ultimate uses, is a well-known technology (i.e., briquetting) with a long history. Pressure is applied to coal in a mold so that the particles adhere to each other in stable manner for subsequent handling. Some coals can adhere without the addition of a binder material, others cannot. Many different binders have been used or tested: mineral oils and tars, vegetable oils and starches, and absorbent clays such as fuller's earth and bentonite.

Any briquetting on a commercial scale must control environmental pollution and, therefore, must control obnoxious and undesirable emissions during use. Briquetting technology has advanced to the stage where acceptable control of emissions is practical, regardless of the type of use for the briquettes. In other words, the control of emissions can lie in the nature and properties of the product itself, rather than in the manner of use. Moreover, the indications are that such briquettes can be produced at a suitably low cost.

It is the purpose of this report, as an appendix to the report of the Assessment Team, to review and to bring modern developments in environmentally-acceptable, whole-coal-based briquettes to the attention of both the researchers in this field and the concerned government authorities in the Kyrgyz Republic. The briquette manufacturing technology, illustrated in part B of this appemdix, and the estimates of costs are guidance for work which must be done under the technical, economic, and commercial conditions which prevail in the Kyrgyz Republic.

PREVIOUS WORK IN THE KYRGYZ REPUBLIC

The Assessment Team, during its field work in October-November 1994, identified and reported

on experimental work done by researchers in the Kyrgyz Republic in recent years. The following summarizes the findings.

In November 1994, a briquetting laboratory existed in Osh in apparently new quarters of the Institute for Integrated Use of Natural Resources (KIPR) of the Academy of Sciences of the Kyrgyz Republic. A brief visit to this facility showed that it is operational with two piston presses and mold heating capability. No information was readily available to assess the capability of this laboratory, or to know the history of its operations. In May 1996, the laboratory had just moved again, and there was no indication what space or facilities would be available for briquetting research. The new (May 1996) address of the laboratory is unknown, and telephones had not been installed. Briquetting research is headed by T. D. Dzholdosheva, but there is some indication that Sh. Kurmankulov will return to the laboratory from a teaching position, if research is resumed.

In 1995, a modified brick press (box chamber, not extrusion) was used to produce about 700 briquettes to test various binders and additives such as clays, lime powders, and cotton processing residue.

In May 1996, in Tashkent (Uzbekistan), the Assessment Team learned that I. G. Baymirov had moved from Osh to do briquetting work at the briquette factory of the Shargun mine in Uzbekistan. Present production there is with petroleum bitumen binder at a cost of about $92 per tonne, but research showed that cheaper (about U.S.$ 78 per tonne) and environmentally better briquettes could be made using cotton processing oil residues.

Published papers in Russian indicate that the goal of the earlier work had been to investigate, under laboratory conditions, the possibility of making briquettes from Kyrgyz brown coal and Kyrgyz bituminous coals with and without binders. These papers also indicate that briquettes with adequate thermal and water stability could be made using residual oils from cotton and animal fat processing in the Fergana Valley.

It has also been indicated that household briquettes could be made from brown-coal fines using bentonite clays or lime if the briquettes were treated with a waterproof coating to provide storage stability.

The Assessment Team identified four papers (in Russian), which report older work on briquetting of Kyrgyz coals. These papers are the following:

Berezkina, Z. H., 1971, *Experiments on processes of making consumer fuel from Kyrgyz coals*, Dissertation in Technological Science, Frunze.

Dzhamanbayev, A. S. and Krichko, A. A., editors, 1978, *Coals of Kyrgyzia and perspectives of increasing their effective use in the economy*, Scientific report IGI, FPI, ICTT, Moscow, 260 p.

Dzhamanbayev, A. S., 1983, *Coals of Kyrgyzia and the means for their rational use*, Frunze.

Kyrmankylov, Sh. Zh., 1990, *Development of briquetting technology for use of Kyrgyz brown coals as domestic fuel*, Dissertation, Technological Science, Dnepropetrovsk.

In addition, the Assessment Team reviewed an unpublished 1993 report by Zh. T. Tekenov of KIPR, Osh. This paper contains a summary of experiments, apparently mostly dealing with organic binders. References to strength, water resistance, and thermal stability probably indicate the ability of the experimental briquettes to maintain their form during handling and shipping, during storage, and during the heating process (in order to maintain the porosity of the bed). A full translation is needed, but some indication of content is the following.

- Petroleum bitumen as the binder gave strong and water stable briquettes with poor thermal stability. Additions of about 20% coking coal from Karaganda (Kazakhstan) increased thermal stability. (Coals similar to Karaganda may be available in the East Fergana coal region of Kyrgyzstan.) Some briquettes were made with Kyzyl-Kiya and Sulyukta coals using a "sodic humate" as binder, but water and thermal stability were low. The stability was increased by thermal treatment (air excluded), but the strength decreased by half.

- Two-stage technology was developed for making briquettes from brown coals. A stage of semi-coking (presumably low-temperature carbonization) is followed by briquetting with a binder using petroleum bitumen or tar from the coking. Other complicated procedures are mentioned, but the complexity increases costs drastically and the procedures use binders that are in net deficit in Kyrgyzstan.

- Trials using regional by-products were made with heavy oil from cottonseed and animal fat processing. "Gudron", a term used locally for seed oil, not petroleum residue, from cottonseed appears to have given good results in terms of briquette quality and binder consumption, after treatment of the gudron with an undefined waste from the Osh textile factory. The research reported included experiments with the parameters surrounding the use of this binder in terms of briquette quality, and a flow chart of a process. The interest seems to have been based on the prospective use of a locally-produced binder.

In Tekenov's 1993 report, a section deals with briquetting using inorganic binders, and refers to the use of bentonitic clays and forms of lime. Bentonite clays occur in the Kyrgyz Republic in association with coal deposits. Almalyk and Sulyukta coals are associated with bentonitic clays and Kara-Kiche and Ak-Ulak coals are associated with both lime (presumably limestone) and local clays.

Comprehension of the significance of the results requires a translation of Tekenov's 1993 report and access to the reports cited above. Nonetheless, the Assessment Team concluded as follows:

- A promising process for the production of briquettes for commercial use in the country appears to be the use of treated extracts from cottonseed oil as the binder. Attractiveness lies partly in the fact that the binder would be a local product from the Kyrgyz Republic or adjacent parts of Uzbekistan.

- The use of bentonitic clays as the binder with or without lime appears to be another promising basis for a commercial process.

- Excessive cost eliminates any consideration of processing to produce briquettes which involves the carbonization (semi-coking) of coal as the first step.

- In all the work reported, nothing is apparent in the discussions concerning the emissions character of the combustion products from the use of the briquettes produced.

CURRENT WORK ON BENTONITE-CLAY BINDER TECHNOLOGY

The potential of an absorbent clay as a binder for the manufacture of a briquette from whole (uncarbonized) coal, which would be smokeless during combustion, appears to have been first recognized in researches at Chulalongkorn University in Bangkok, Thailand, during the 1980s. The findings from this work seem to have been utilized in China. The experiences gained there have been considered by the U.S. Department of Energy in a program funded by USAID for possible application in City of Krakow, Poland, in order to mitigate the environmentally-degrading effects of the use of untreated whole coal for domestic and commercial purposes.

The Bangkok findings were also applied in Pakistan at the Fuels Research Centre (FRC) in Karachi, a unit of the Pakistan Council for Scientific and Industrial Research (PCSIR). The work began about 1987 and is continuing to the present day. The original clay used for the work was fullers earth, but later work focused on the use of bentonite because of superior results in suppressing the emissions of unburned volatile materials from the combustion of the coal. Hydrated lime was incorporated in the recipe for purposes of suppressing the emission of sulfur oxides.
Since most of the Kyrgyz coals do not have as much sulfur as the coals used in the Pakistani briquetting work, the amount of lime to be incorporated in the recipe for a Kyrgyz briquetting industry could be significantly less. However, lime could have a beneficial effect on the ultimate strength of the briquette to withstand handling and shipping. Some potassium nitrate was also incorporated in the recipe in order to promote ease in initial ignition.

The environmental performance of the Pakistani briquettes as a domestic cooking fuel to replace local fuel wood has been measured by the Oak Ridge National Laboratory of the United States Department of Energy. The basis was a comparison in a controlled environment of the emissions of the briquettes with the original coal itself, with fuel wood, with kerosene, and with dung. A perceived major market for the briquettes in Pakistan is as a substitute for scarce fuel wood. Industrial markets are also evident. The experimental work simulated the burning of the fuel under the conditions which exist in rural Pakistan. The conclusion reached was that the bentonite-based briquette would perform environmentally no worse than fuel wood under the conditions of use for cooking in rural housing.

The measurements were made by simulating the conditions during utilization in Pakistan for cooking purposes. The quantitative details and results have been reported in several instances in the literature, namely: Environment International, Vol. 19, pp 133-145, 1993, "*Impact on Indoor Air Quality During Burning of Pakistani Coal Briquettes*"; and a paper presented at the 6th International Conference on Indoor Air Quality, Helsinki, Finland, July 2-4, 1993, "*Comparative Emissions from Pakistani Coals and Traditional Coals*".

The FRC in Pakistan is equipped with a Belgian-wheel briquetting press and the ancillary facilities, which can produce briquettes round the clock at a rate of about eight tonnes per day. Currently the FRC is producing briquettes to serve a local market at a price of Rs. 1400 per tonne, which at the current exchange rate is equivalent to about U.S. $ 45 per tonne. Some interest has existed in Pakistan for the construction of a commercial plant on the scale of 50,000 tonnes per year, but such construction has not materialized as of this date for unknown reasons.

It is possible that briquettes can be produced through extrusion methods, but work on this aspect has not yet been done in Pakistan. The FRC product therefore is pillow-shaped having dimensions of about 5 cm by 5 cm by 2.5 cm thick (2-inches by 2-inches by 1-inch). These dimensions can be varied, depending on the design of the mould machined into the rotating wheels of the briquetting press.

Variations in this technology, which may have occurred in China, is a subject that needs investigation.

The basic principle of the process is the mixing of finely-pulverized whole coal with an absorbent clay such as bentonite. The mechanism which produces the smokeless properties may be theorized as follows.

If the clay during mixing coats each coal particle completely, then, as the coal particle is heated during combustion, the volatile material in the coal is emitted and absorbed by the clay which coats the particle, and retained. As the temperature in the briquette increases, the absorbed materials (primarily carbon and hydrogen compounds of high molecular weight and complex molecular structures) eventually crack, i.e., these absorbed materials break down to carbon and hydrogen compounds of low molecular weight, primarily gaseous in nature, and residual carbon. These cracked products then burn readily and smokelessly. This theory can be supported by the fact that clays are catalysts in petroleum heavy-oil cracking plants, where complex hydrocarbon molecules are broken down into simpler ones.

Sulfur dioxide emissions are controlled through incorporating hydrated lime in the recipe. Sulfur capture by the calcium-hydroxide molecules in the briquette can then reach as high as 65% overall. The bulk of the residual sulfur-dioxide emissions tends to occur at the beginning of combustion, when burning occurs at the surface and there is insufficient contact with the calcium-hydroxide molecules.

The expectation is that each coal candidate for commercial briquetting plant will have to be empirically tested in order to determine the recipe which produces the desired degree of smokelessness during use. The parameters which have to be evaluated during the formulation of such a recipe appear to be the following.

- ***the particle-size distribution in the pulverized coal.***

  If the theory described above is valid, it would appear that the surface to volume relationship of each coal particle will be a critical factor. The reason is that the volume of volatile material that would have to be absorbed by the clay coating the surface will depend on the volume of the coal particle. But the absorbing capability of the clay will depend on two

factors, one of which is the amount of surface of the coal particle, the other being the thickness of the clay coating (about which see below).

As coal particles in the mix become smaller, the volume of the particle decreases as the cube of the diameter while the surface area decreases only as the square of the diameter. The surface to volume ratios are more favorable the smaller the diameter of the particle. It would seem that the smaller the coal particle, the less excess clay may be required in the recipe.

- ***the weight ratio of clay to coal in the mix.***

Again, based on the theory above, the amount of clay in proportion to the coal will determine the thickness of the clay coating on the coal particle, and hence the clay volume available for the absorption of the volatile material. It would appear, as already noted above, that the finer the coal particle (the greater the surface/volume ratio of the coal particle), the thinner the clay coating and the lower the clay/coal weight ratio. Thus, from a cost point of view, there appears to be a balance to be made in order to minimize the cost of the ingredients in the recipe, between the cost of the clay used in the recipe and the cost of grinding the coal.

- ***the intensity (or thoroughness) of mixing the clay and the coal.***

It should be obvious that the intensity, or thoroughness, of mixing will determine the extent to which each coal particle is completely covered by clay. This extent is not as important in the center of the briquette, because there will be enough opportunity for absorption as the volatile material travels toward the surface. The extent will, of course, be important for the particles near the surface. In practicality, there is no practical way to control this apparent phenomenon.

- ***the amount of water addition.***

Water is needed in order to plasticize the mix in preparation for feeding the briquetting press. This water will have to be evaporated later on, after briquetting. The evaporation of the water after briquetting should introduce porosity in the briquette, which should in turn facilitate access for the oxygen in the combustion air into the interior of the briquette. Any excess water causes heat loss; an optimum water content is indicated and this needs to be determined by trial and error.

- ***the amount of lime addition.***

The primary function of the lime is as a sulfur dioxide absorbent. The amount of lime should be related to the amount of sulfur in the coal, and to the Ca/S molecular ratio for the desired capture. The addition of lime, however, may also have an undetermined effect on increasing the strength of the briquette in terms of downstream handling and transport. Therefore, for a low sulfur coal, the lime content may be determined more by strength considerations than by sulfur suppression needs.

- ***the amount of an oxidant.***

  An oxidant may or may not be needed, probably depending on the volatile material content in the coal. The function of the oxidant is to facilitate the initial ignition of the briquette. A commercial consideration could be the supply of two products, a starting briquette with an oxidant and a standard briquette without an oxidant. The oxidant is usually a small amount of potassium nitrate dissolved in the water used in the recipe.

The Fuels Research Centre in Karachi has accumulated considerable experience in recipe-formulation for a variety of Pakistani coals.

COAL AND BRIQUETTE QUALITY

The Assessment Team collected sixteen samples of Kyrgyz coals for laboratory analysis, one which was lost in shipment. The results of the analyses are reported in the United States Geological Survey Open-File Report titled *Assessment of the Coal Resources of the Kyrgyz Republic.* For convenience, the analytical results of relevance to briquette manufacture and combustion performance are reproduced here.

The samples were analyzed for their proximate analyses, their ultimate analyses, the forms in which sulfur occurs in the coals, and their heating values. The results are reported in the tables listed below. The following box explains the headings in the tables.

		Subscripts	**Superscripts**
A = Ash	C = Carbon	ar = As received	s = sulfate
W = Moisture	H = Hydrogen	d = Dry	p = pyritic
VM = Volatile Matter	N = Nitrogen	daf= Dry, Ash-free	o = organic
FC = Fixed Carbon	O = Oxygen	eq = Equilibrium Moisture	org = organic
Q = Heating Value	S = Sulfur		t = total
FSI= Free Swelling Index	ID= Sample Number		

Table a-1 identifies the samples by number and the locations where they were obtained. **Table a-2** reports the proximate analyses of the coal samples. **Table a-3** reports the ultimate analyses of the samples and also the forms in which sulfur occurs in the samples. **Table a-4** reports the heating values and the free swelling indices for the samples. Finally, **Table a-5** reports the chemical composition of the ash. Table a-6 contains calculations for the expected heating values for two product briquettes, one from a lignitic (brown coal) and the other from a bituminous coal. These coals may not be necessarily identical with the coals found in the Kyrgyz Republic but which are probably sufficiently close for illustrative purposes. Thus, none of the samples identified in Table a-1 appear to be a brown coal with a moisture content of about 48%. However, sample K-10 appears to approximate closely the bituminous coal in Table a-6.

The significance of Table a-6 is that it points out the reduction in the heating value between the initial coal and the finished briquette because of the addition of inert ingredients, the clay and the lime. Thus, it becomes important in selecting a coal for briquetting to insure that the initial ash content is low. In some cases, it may become attractive to beneficiate the coal beforehand in order to reduce ash content (and most likely sulfur content at the same time, especially the pyritic sulfur, S^p_d in Table a-5).

Another observation is the high lime (CaO) content reported for samples K-1, K-4, K-7, and K-16 in Table a-5. Depending on the original chemical form of the lime in the coal mineral matter and how this content metamorphoses during combustion, the high lime content may serve as a sulfur dioxide absorber and reduce the lime requirement in the formulation of the recipe. The significance of this observation would have to be determined by experimentation.

Finally, it should be noted that the chemical composition of the ash largely determines the ash fusion temperature. Ash fusion temperature could be important in the performance of briquettes in high combustion temperature applications, such as on the grates of stoker-fired furnaces. The criteria for predicting ash fusion and consequent slagging are complex and empirical. A discussion is, therefore, beyond the scope of this Annex.

TABLE a-1
IDENTIFICATION OF COAL SAMPLES TAKEN FOR ANALYSIS

SAMPLE ID NUMBER	LOCATION		
	SITE NAME	LATITUDE (North)	LONGI-TUDE (East)
K-1	Abshir No. 1	40.2	72.4
K-2	Agulak No. 1A+1B	41.7	74.3
K-3	Almalyk	40.3	72.7
K-4	Dhzergalan No. 1	42.5	78.8
K-5	Dhzergalan No. 2	42.5	78.8
K-6	Kara-Dobo	40.8	73.9
K-7	Kara-Keche No. 1A+1B	41.7	74.8
K-8	Kara-Tut No. 2	41.4	72.2
K-9	Kara-Tut No. 1	41.4	72.2
K-10	Kok-Yangok	41.0	73.2
K-11	Kum-Bel	41.0	73.5
K-12	**Lost in Shipment**		
K-13	Sary-Mongol	37.9	72.0
K-14	Tash-Kumyr No. 1	41.3	72.2
K-15	Tash-Kumyr No. 2	41.3	72.2
K-16	Valakish		

TABLE a-2
RESULTS OF PROXIMATE ANALYSES OF COAL SAMPLES

ID	W_{ar}	A_{ar}	VM_{ar}	FC_{ar}	A_d	VM_d	FC_d	VM_{daf}	FC_{daf}	W_{eq}
K-1	28.92	4.69	31.58	34.81	6.61	44.42	48.98	47.56	52.44	27.47
K-2	23.68	11.18	24.28	40.86	14.64	31.81	53.55	27.27	62.73	17.64
K-3	22.83	27.17	25.50	24.50	35.21	33.05	31.74	51.00	49.00	22.54
K-4	8.33	6.61	35.27	49.79	7.21	38.47	54.32	41.46	58.54	7.81
K-5	9.02	8.92	29.58	52.48	9.80	32.51	57.69	36.04	63.96	7.89
K-6	11.19	19.56	13.74	55.51	22.03	15.47	62.50	19.84	80.16	4.85
K-7	22.45	6.83	25.71	45.01	8.81	33.15	58.04	36.36	63.64	18.47
K-8	23.07	14.17	29.27	33.49	18.42	38.05	43.53	46.64	53.36	19.56
K-9	20.96	13.34	29.83	35.87	16.88	37.74	45.38	45.40	54.60	20.14
K-10	9.27	11.64	25.87	53.22	12.83	28.51	58.66	32.71	67.29	7.37
K-11	5.13	8.31	37.13	49.43	8.78	39.14	52.10	42.89	57.11	4.60
K-13	16.76	3.18	31.26	48.80	3.82	37.55	58.63	39.04	60.96	12.81
K-14	16.69	6.81	31.88	44.62	8.18	38.26	53.56	41.67	58.33	16.09
K-15	14.46	13.13	31.52	40.89	15.36	36.85	47.79	43.54	56.46	14.75
K-16	22.54	8.88	29.69	38.89	11.47	38.34	50.19	43.30	56.70	20.24

TABLE a-3
RESULTS OF ULTIMATE ANALYSES OF COAL SAMPLES
(Including Chemical Forms of Sulfur)

ID	ULTIMATE ANALYSIS					FORMS OF SULFUR			
	H_{daf}	C_{daf}	N_{daf}	S^{org}_{daf}	O_{daf}	S^{t}_{d}	S^{p}_{d}	S^{s}_{d}	S^{o}_{d}
K-1	5.23	76.42	1.39	2.27	13.15	3.56	1.34	0.10	2.12
K-2	4.82	80.16	1.02	0.74	12.76	1.23	0.55	0.04	0.64
K-3	5.32	71.00	0.78	2.16	18.20	2.98	1.49	0.10	1.39
K-4	4.86	80.67	1.01	0.26	12.56	0.83	0.56	0.02	0.23
K-5	4.45	81.37	1.02	0.17	12.75	0.37	0.11	0.11	0.15
K-6	3.30	86.71	0.94	0.39	8.59	0.36	0.03	0.02	0.31
K-7	3.65	79.03	0.84	0.34	15.88	0.55	0.19	0.04	0.32
K-8	4.91	76.18	1.15	1.20	14.23	2.88	1.84	0.06	0.98
K-9	5.01	76.61	1.20	1.00	15.41	1.47	0.55	0.09	0.83
K-10	3.86	83.54	0.83	0.21	10.92	0.74	0.49	0.06	0.19
K-11	5.26	82.51	1.17	0.77	10.14	0.84	0.08	0.05	0.71
K-13	4.56	80.33	0.74	0.23	13.91	0.44	0.17	0.05	0.22
K-14	5.09	79.11	1.14	0.51	13.54	1.02	0.54	0.02	0.46
K-15	5.09	77.60	1.24	0.73	13.98	1.77	1.12	0.03	0.62
K-16	5.17	77.17	0.69	0.48	15.85	0.99	0.53	0.03	0.43

TABLE a-4
HEATING VALUE DETERMINATIONS FOR COAL SAMPLES
(Including Free Swelling Index)

ID	HEATING VALUE DETERMINATIONS						FSI
	BTU/lb		Kcal/kg		MJ/kg		
	Q_{ar}	Q_{daf}	Q_{ar}	Q_{daf}	Q_{ar}	Q_{daf}	
K-1	8,927	13,447	4,959	7,471	20.76	31.27	0.0
K-2	8,812	13,527	4,896	7,515	20.49	31.46	0.0
K-3	6,154	12,308	3,419	6,838	14.31	28.62	0.0
K-4	11,759	13,824	6,533	7,680	27.35	32.15	0.5
K-5	11,353	13,834	6,307	7,686	26.40	32.17	0.0
K-6	9,799	14,151	5,444	7,862	22.79	32.91	0.0
K-7	8,991	12,714	4,995	7,063	20.91	29.57	0.0
K-8	8,420	13,417	4,678	7,454	19.58	31.20	0.0
K-9	8,747	13,313	4,859	7,396	20.34	30.96	0.0
K-10	10,966	13,866	6,092	7,703	25.50	32.25	0.0
K-11	12,482	14,420	6,934	8,011	29.03	33.53	4.0
K-13	10,914	13,632	6,063	7,573	25.38	31.70	0.5
K-14	10,340	13,516	5,744	7,509	24.05	31.43	0.0
K-15	9,779	13,506	5,433	7,503	22.74	31.41	0.0
K-16	9,025	13,161	5,014	7,312	20.99	30.61	0.0

TABLE a-5
COMPOSITION OF ASH OF KYRGYZ COALS
(Reported as Metal Oxides relative to 100%)

ID	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO
K-1	7.90	9.00	54.30	5.80	20.90	1.24	0.26	0.20	0.11	0.24
K-2	49.61	24.26	10.23	2.46	10.47	0.16	1.61	0.91	0.18	0.07
K-3	49.73	30.78	8.08	1.39	5.78	0.43	0.65	2.73	0.35	0.08
K-4	28.94	14.33	14.75	1.95	37.01	1.27	0.65	0.64	0.07	0.40
K-5	52.96	24.04	3.58	0.98	14.52	1.32	1.49	0.92	0.08	0.13
K-6	61.00	26.28	2.37	2.02	3.06	0.31	3.34	1.52	0.10	0.01
K-7	30.62	24.44	6.53	4.87	31.85	0.21	0.22	0.78	0.15	0.33
K-8	51.98	19.96	17.59	1.91	5.46	0.85	1.27	0.81	0.09	0.08
K-9	57.97	22.72	9.00	2.35	4.48	1.02	1.43	0.90	0.09	0.04
K-10	30.02	15.25	37.04	1.89	13.19	0.18	0.38	0.96	0.15	0.96
K-11	54.82	34.71	3.79	1.51	0.52	0.18	3.65	0.71	0.10	0.01
K-13	50.05	31.74	10.06	0.75	4.78	0.56	0.28	1.32	0.45	0.01
K-14	45.54	21.86	15.42	1.81	9.64	3.32	1.42	0.89	0.07	0.02
K-15	59.76	20.10	10.24	0.95	4.85	1.47	0.84	1.69	0.09	0.01
K-16	33.27	18.81	7.97	2.30	33.41	0.45	0.63	1.11	1.80	0.25

MARKETING CONSIDERATIONS

The purpose of this section is to provide comments and suggestions that should be helpful in the performance of a briquette marketing assessment. This activity should be the next step after assurance exists that a recipe for briquetting exists and sample product could be made available.

The first consideration should be the environmental acceptance of the briquettes to be offered to the market. The technical discussion above with respect to achieving a smokeless performance during combustion should make it reasonable to assume that briquettes ultimately produced from excess coal fines will have such an acceptance.

The environmental work performed under conditions simulating domestic cooking practices in the rural areas of Pakistan, where the common source of energy is fuel wood, has already been reported above. The work employed local stoves. No attention was given to evaluating environmental performance for prospective markets in space heating, which should be of interest in the Kyrgyz Republic, or in industrial uses. However, the indications are that emissions of carcinogenous smoke and sulfur oxides should be no different.

Two industrial uses for smokeless, whole-coal briquettes are worthy of consideration. The first is in brick making and the other can be of particular importance in improving the environmental and thermal performances of the stoker-fired furnace equipment in the Kyrgyz Republic.

With respect to brick making kilns, the Scientific and Technological Corporation of Pakistan (STEDEC), a unit of the Pakistan Council for Scientific and Industrial Research, in 1989 undertook a market study for its briquettes in the areas of brick manufacture (a major labor-intensive industry in Pakistan), space heating for poultry farms, institutional users such as community kitchens and laundries, and domestic users.

One useful set of findings emerged from the STEDEC work. This is shown in Table a-7. Two kilns were fired simultaneously, one with untreated coal and the other with coal briquettes. Significant improvement in the emissions, impact on the operating personnel, and reduction in fuel consumption are indicated. However, a financial analysis of the results of this brick making operation could have established a premium for the briquettes over the price of coal, but such an analysis was not reported.

TABLE a-6
ESTIMATES FOR HEATING VALUE OF SMOKELESS, BRIQUETTED COAL
(Major Assumptions are Noted)

ITEM	LIGNITE	BITUMINOUS
1. Coal Analysis, wt. %		
Moisture	48.0	10.0
Ash	15.0	16.0
Sulfur	1.0	1.0
Heating Value, KgCal/Kg	1,900	6,000
Heating Value. Btu/lb	3,420	10,800
2. During coal preparation, high-pressure pneumatic grinding could reduce inherent moisture in lignite as much as 75%. No moisture reduction for bituminous coal. New analyses would be		
Component, wt. %		
Moisture	18.8	10.0
Ash	23.4	16.0
Sulfur	1.6	1.0
Heating Value, KgCal/Kg	2,969	6,000
Heating Value. Btu/lb	5,344	10,800
3. If, for sulfur suppression, lime is incorporated in the raw mix in a 2:1 Ca:S molar ratio, new analyses would be		
Component, wt. %		
Moisture	17.7	9.5
Ash	27.7	19.9
Sulfur	1.5	1.0
Heating Value, KgCal/Kg	2,801	5,725
Heating Value. Btu/lb	5,042	10,305
4. If, for smokeless combustion, 15% by weight of absorbent clay is added to the raw mix, final briquette analyses would be		
Component, wt. % Moisture	15.4	8.3
Ash	37.1	30.3
Sulfur	1.0	0.8
Heating Value, KgCal/Kg	2,436	4,978
Heating Value. Btu/lb	4,384	8,961
Heating Value, KgCal/Tonne	2,436,000	4,978,000
Heating Value, Btu/ton	8,768,000	17,922,000

An analogous market in the Kyrgyz Republic might be the replacement in stoker-fired steam generators of the current coal by the briquettes. The findings of the Assessment Team with respect to existing practices regarding stoker-fired equipment in the Kyrgyz Republic, reported elsewhere in this document, could be useful to summarize here.

The Assessment Team observed during its field work that the utilization efficiency of coal currently being consumed is unusually low. The basic reason is inadequate burnout of carbon from the residual ash. The Team observed residual carbon content in ash up to 40%. The expectation is that this residual content should fall usually below 1%.

The effects of high carbon fly-ash, other than high utilization cost, are unnecessarily high costs for the district heat and

TABLE a-7
COMPARISON OF RESULTS FOR BRICK KILNS
(Untreated Coal vs. Coal Briquettes)

ITEM	KILN NO. 1 Untreated Coal Firing	KILN NO. 2 Coal Briquette Firing
1	Feeding of coal required every 15 minutes	Feeding of coal briquettes required every 40 minutes.
2	Temperature fluctuated between 900°C and 1100°C	Temperature remained constant at 1000°C
3	Larger number of brick rejects due to uneven temperatures.	Very small number of rejects due to more even temperatures.
4	Very large emission of dust, grit and smoke and fumes of sulfur dioxide. Workers had to cover their faces with thick cloth in order to protect themselves	Emissions of dust, grit, smoke, and sulfur fumes was extremely low and workers could work comfortably without covering their faces.
5	Causes heavy environmental pollution.	Pollution caused is low and acceptable under the circumstances.

electricity production, reduced effectiveness of the ash collection equipment, and greater airborne emissions with potential carcinogenic properties. Also, a high carbon content renders the ash unusable for by-product purposes. Much of this high carbon content may arise from the friable nature of the coal being burned. Fine unburned coal particles can form during the combustion process and be entrained into the gases leaving for the chimney, before the entrained coal is completely burned.

This problem of incomplete burning of coal has been worked on locally aleady in Kyrgyzstan at the heat plant in Kara-Kol (Issyk-Kol Oblast). A stoker-fired boiler was modified to reduce the carbon content in the ash from 40% to 15%. The accomplishment is impressive, but further reduction in

the residual carbon content is still needed. The goal should be residual carbon content less than 1%. The savings in coal consumption from bringing the carbon content of the residual ash down from either 40% or 15% could be large and worth a concerted effort.

The effort could involve an alternative means to achieve a goal of high thermal efficiency for stoker-fired furnaces by the use of a tailored briquette as the stoker feed, instead of friable lump coal. The experience summarized in Table a-7 suggests that something similar could occur if comparable tests were made at the Kara-Kol heat plant, based on their improved operations, between the usual coal supply and a supply of smokeless whole-coal briquettes.

The expectation may be that (1) carbon burnout could be reduced to below 1%; (2) the presence of lime in the briquette could reduce sulfur dioxide emissions materially; (3) the briquette structure could be maintained during its traverse of the stoker grate, which would, in turn, reduce the amount of fly ash to be collected; (4) less fly ash could be deposited on the tubes of the boiler, thereby increasing the heat recovery from the combustion gases and increasing the thermal efficiency of the boiler; and (5) possibly, with a hotter grate and a less opaque atmosphere in the furnace, radiant heat transfer in the furnace could increase thereby further increasing the thermal efficiency of the boiler.

If such a test were to be run, part of the effort should be the determination of the premium on coal prices that briquettes should earn because of superior performance. The result could be compared with the cost of briquette manufacture in order to assess the profitability of such a market. In effect, if the test results support, the price which the consumer is willing to pay for briquettes over the price for coal, should be attractively less than the savings in his operating costs. At the same time, the price should be high enough to enable the manufacturer to produce briquettes at the required level of profitability.

Briquettes for the purpose of testing the hypothesis above, could be manufactured in the facilities at Osh. It may be necessary to acquire a Belgian-wheel briquetting press with spare rolls to enable determination of the optimum physical size and shape of the briquettes, or the volume in the briquettes. The volume may have to fit the residence time of the briquette on the grate to assure carbon burnout to the level desired.

A successful conclusion to a briquette marketing effort could lead to the prospect that much of the fine coal production from the mines would have a market through briquette manufacture.

OBSTACLES

Perhaps the three major obstacles to a successful introduction of a briquetting industry in the Kyrgyz Republic are (a) lack of adequate market knowledge for introducing briquettes; (b) the existence of barter; and (c) the existence of subsidies particularly on the pricing of electricity. These obstacles up to now outweigh the positive aspects that (a) a clay-based, smokeless, whole-coal briquette manufacturing technology exists and has been demonstrated and (b) available knowledge of the quality of a wide range of Kyrgyz coals indicate that suitable recipe can be found for briquette manufacture, and (c) the economic value of the fine-coal stockpiles in the Republic is zero.

Barter discourages investment in the development, construction, operation, and maintenance of industrial facilities. Subsidy of electricity prices such that consumer prices are an order of magnitude below world prices, and laxity in the collection of bills for electricity consumption, make

it impossible for an alternative fuel to compete in a free market. Meanwhile, the elimination of subsidy must be a gradual process to avoid hardship on the population.

On the other hand, nothing needs to stop efforts to obtain a better knowledge of the potential market for briquettes in the Kyrgyz Republic.

SUGGESTIONS

Given the will to pursue and evaluate the potential of briquetting, it appears that the institutional means to undertake the efforts could be through expansion of the scope of the Small Enterprise Coal Mining Program. The attention of the participants in this program could be focused on the existing fine-coal stockpiles while existing government policy to support this program could be modified to accommodate the increased scope.

In the event further investigation becomes justified and further details are desired concerning briquetting technology and capital investment and cost data, contact should be made with the author, care of Moseley, Bliss International Associates, Inc., 3133 Creswell Drive, Falls Church, VA 22044-1703, USA; Telephone: 703-241-1757; Fax/Voice Mail: 703-241-8689; Internet: cbliss1@mcimail.com

PRODUCTION OF SMOKELESS, WHOLE-COAL BRIQUETS IN THE KYRGYZ REPUBLIC

B -- AN ILLUSTRATIVE CONCEPT FOR AN ENTERPRISE

INTRODUCTION

The purpose of this addendum is to present a concept for a commercially-sized briquet manufacturing enterprise to provide guidance and relevant information which could be useful when the commercialization of briquet manufacture in the Kyrgyz Republic is considered. The expectation is that such an enterprise would be in the private sector.

The numerical data used below are illustrative and, therefore, not indicative of prospective costs of briquet manufacture in Kyrgyzstan. Labor and equipment costs in the Kyrgyz Republic can be considerably different. The numerical data actually are illustrative of costs in the United States at a coastal location on the Gulf of Mexico.

Nevertheless, an important and critical cost factor in the production of briquets is the cost of the presently stockpiled coal fines. The cost of this coal could range from only the costs of digging the fine coal from the stockpile and its transportation to the manufacturing plant to whatever the present owners of the coal stockpiles believe the coal should sell for.

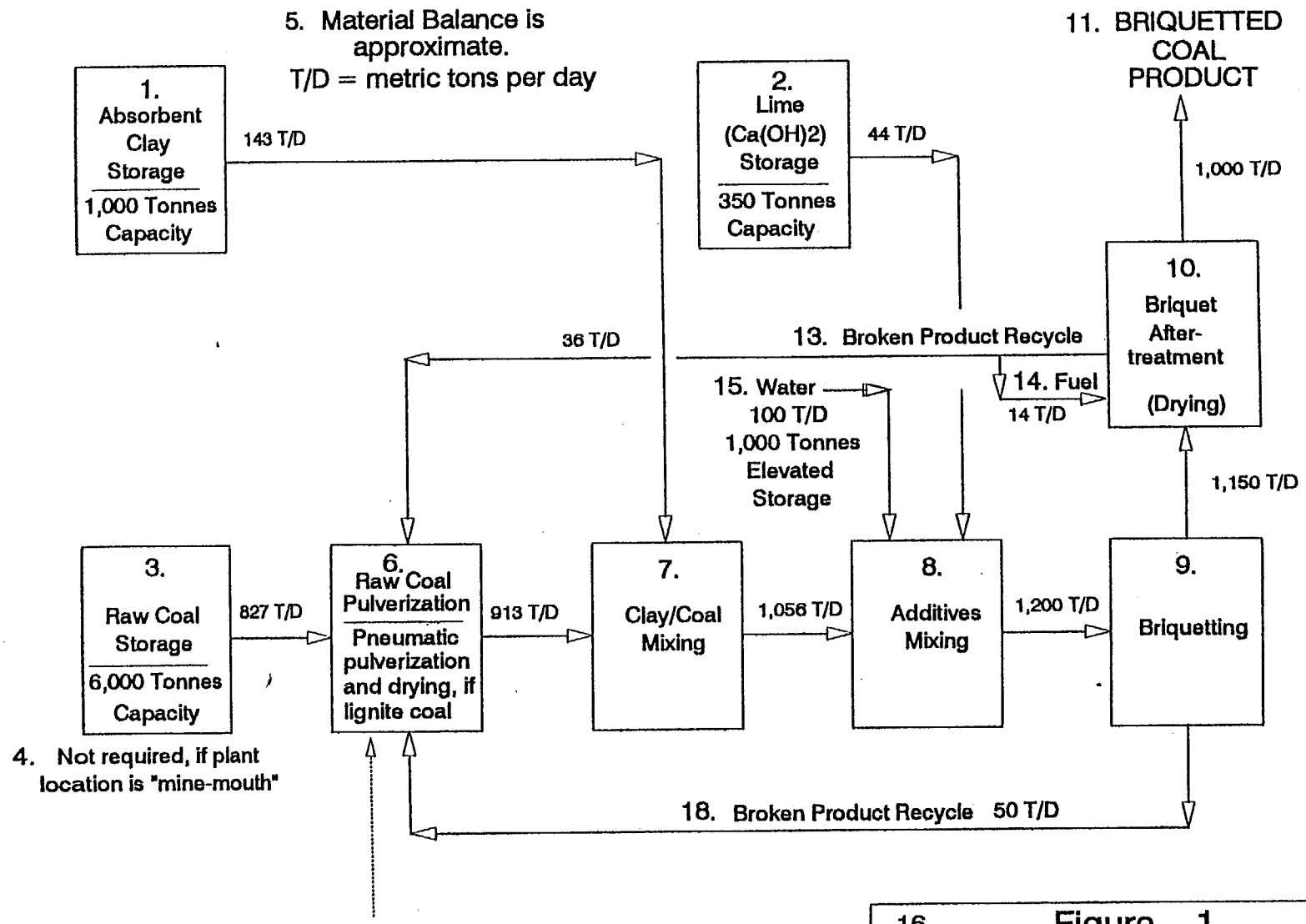
PRODUCTION SCALE

The illustrative briquetting enterprise is based on an arbitrary production scale of 1,000 metric tons per day of finished briquets. This scale is selected only for the purpose of convenience. The actual scale should be selected from market and coal supply conditions.

A block flow diagram showing the main functions for the equipment and an approximate material balance is in Figure 1. The processing shown in this figure should be self-explanatory.

One aspect of the process, which may require specific experimental investigation, is the inherent moisture content of sub-bituminous or lignitic (brown) coals, if this moisture content is substantial. Drying the coal irreversibly to remove its inherent moisture content to acceptable levels could pose a technical problem. The need for drying may depend on meeting a heating value specification for the briquet, on reducing shipping weight, or on both. A consequence of drying is the prospect that the pyrophoric properties of sub-bituminous or brown coals may be enhanced, which can lead to hazardous spontaneous combustion of the briquets during the marketing process.

The statements in Figure 1 concerned with lignite drying may be applicable to Kyrgyz brown coals, and the problem should be addressed with due caution. A demonstration that a brown coal briquet can be marketed successfully, without drying to remove inherent moisture, would be the simplest solution from a processing and production cost standpoint.



16. Figure 1
Process and Material Balance Block Diagram

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Table b-8 contains a list, with descriptions, of suggested equipment, corresponding to the functions shown in Figure 1.

CAPITAL AND OPERATING COSTS

Table b-9 contains an estimate of the capital requirements for the construction and commissioning of a commercial facility of the 1,000 tonnes/day capacity shown in Figure 1. The cost data are 1991 U.S. cost data, if such a plant were built in a location on the Gulf of Mexico coast of the United States. It follows, then, if interest develops to pursue this technology track further, that the estimate will have to be converted to reflect the current conditions in the Kyrgyz Republic.

Figures 2 and 3 are plant staffing diagrams, showing personnel requirements and levels of skills. The staffing is shown both for the construction period (in Figure 2) and for the operating period (in Figure 3).

Table b-10 contains an estimate of the payroll including social benefits for the plant staffing, and the build up of the payroll during the first three years of the construction and commissioning project. The cost figures should eventually be adjusted to reflect the current conditions in Kyrgyz Republic.

As already indicated above, the data shown in the figures and tables should be used with caution. The data are intended as a guide to planning for briquet development in the Kyrgyz Republic, rather than as inputs for industry development. It cannot be over-emphasized that local conditions in the country regarding costs and personnel should be recognized and the data in the figures and tables revised accordingly.

CONSTRUCTION SCHEDULE

Figure 4 is a schedule which should be possible to follow for the implementation of the construction and commissioning program, based on knowledge of the recipe for the mix to be fed to the presses, finance being available, and the construction of the plant adjacent to the stockpiles of finely-divided coal at the mine. The period of 21 months should be adjusted, depending on the supply of equipment and materials, and on the construction practices in the Kyrgyz Republic.

16.

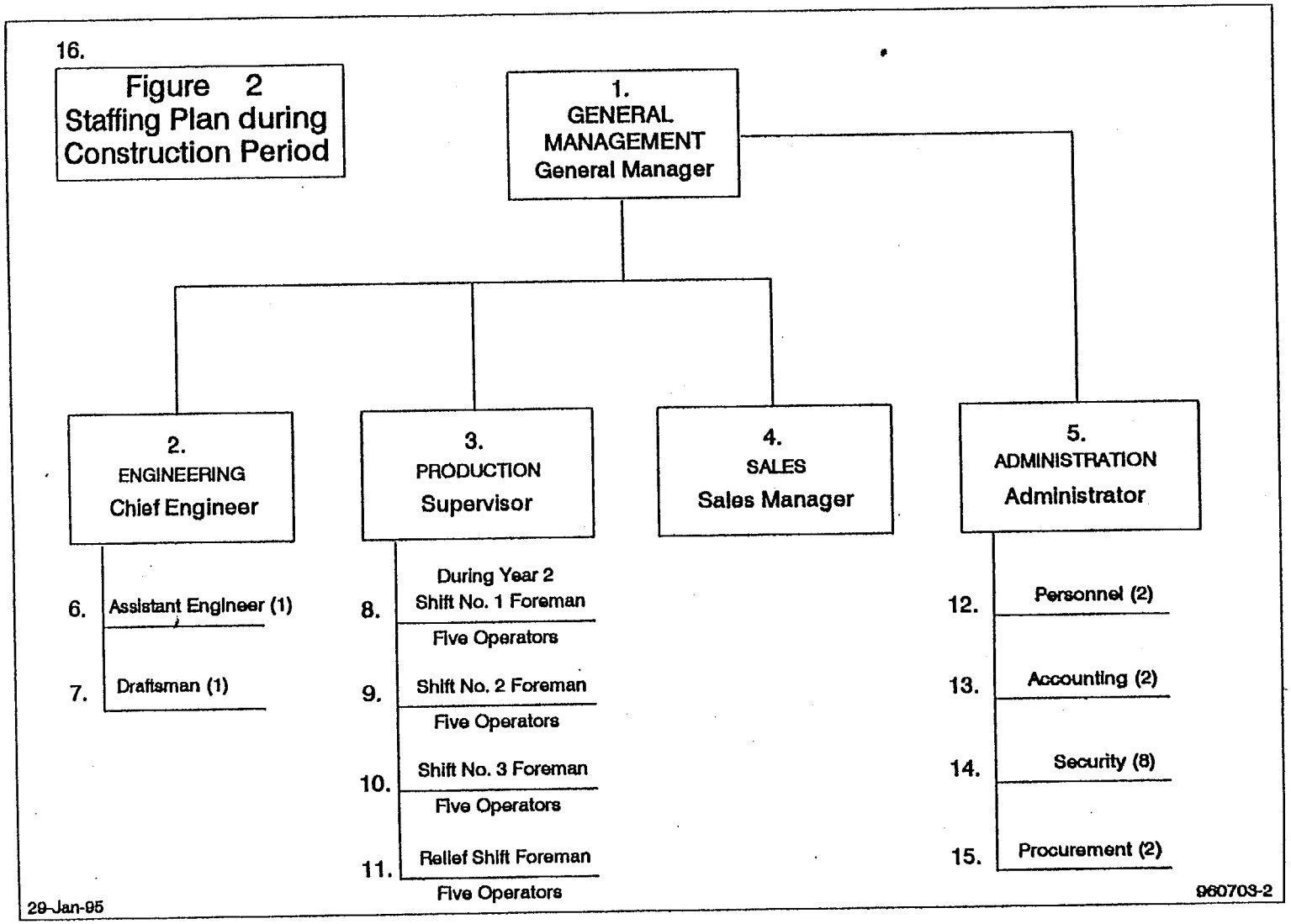
Figure 2
Staffing Plan during Construction Period
1. GENERAL MANAGEMENT General Manager
2. ENGINEERING Chief Engineer
3. PRODUCTION Supervisor
4. SALES Sales Manager
5. ADMINISTRATION Administrator
6. Assistant Engineer (1)
7. Draftsman (1)
During Year 2
8. Shift No. 1 Foreman
Five Operators
9. Shift No. 2 Foreman
Five Operators
10. Shift No. 3 Foreman
Five Operators
11. Relief Shift Foreman
Five Operators
12. Personnel (2)
13. Accounting (2)
14. Security (8)
15. Procurement (2)
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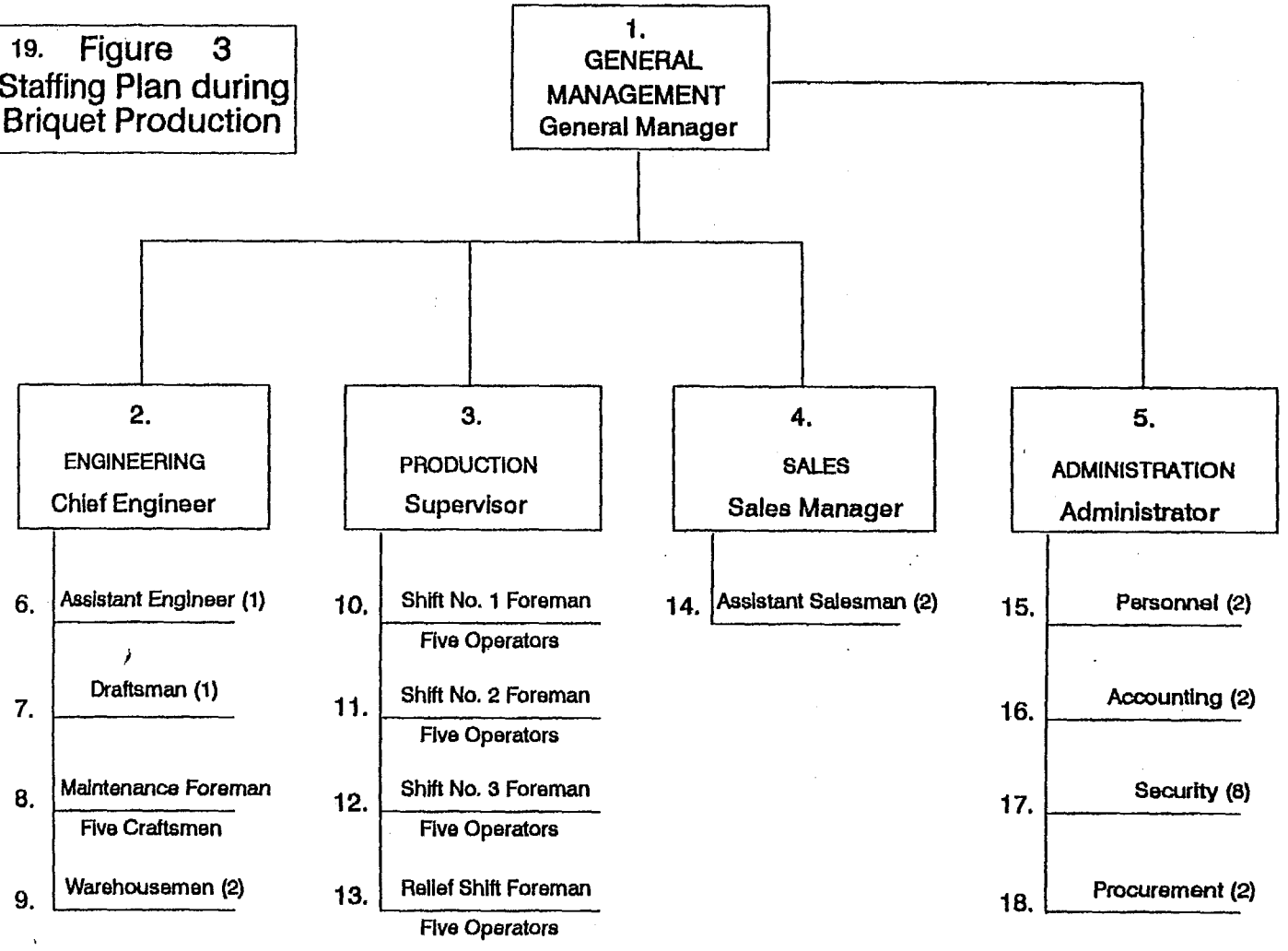
19. Figure 3
Staffing Plan during Briquet Production



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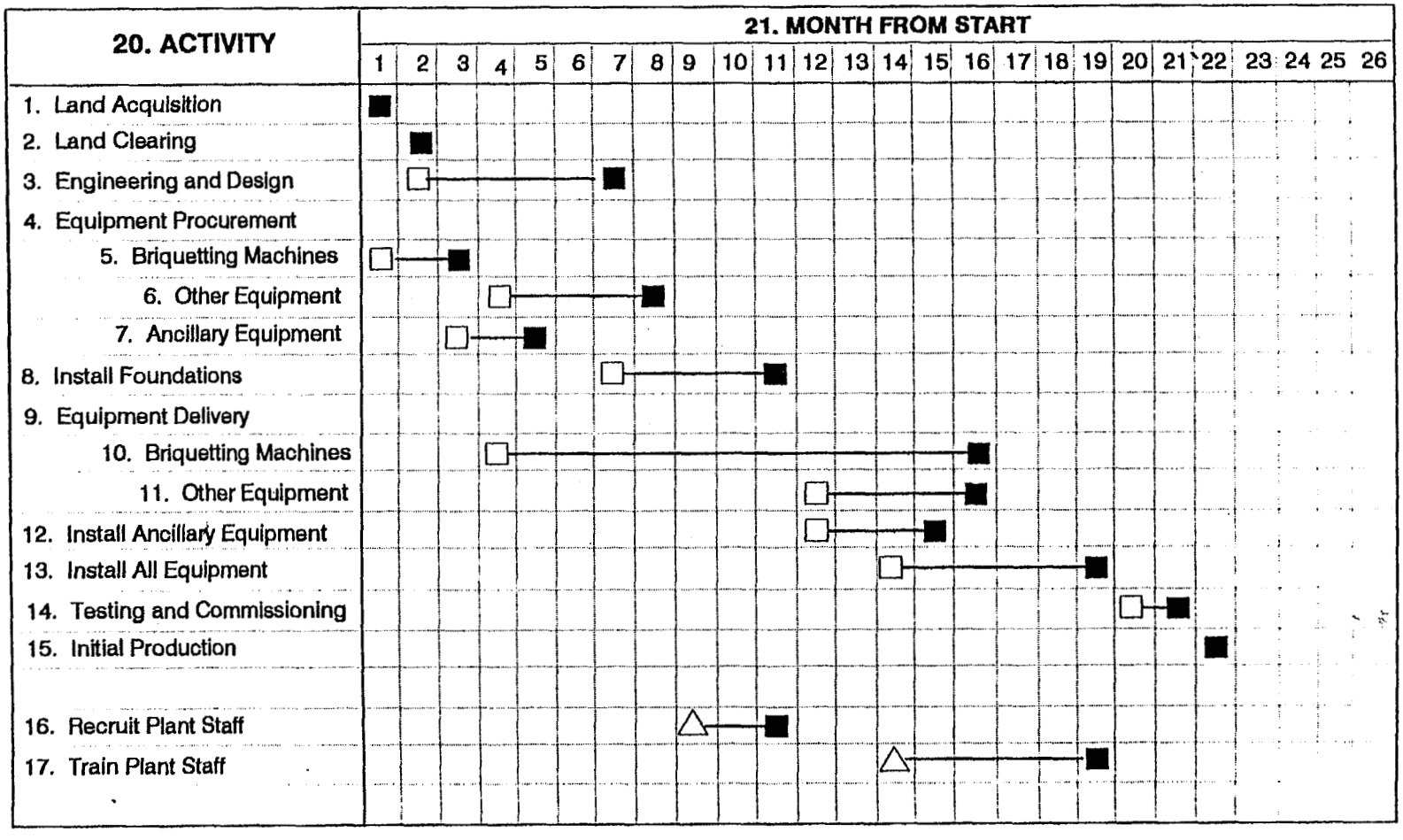
22. Figure 4
Briquet Plant Construction and Commissioning Schedule



18. Start □——■ 19. Finish

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TABLE b-8
SMOKELESS, WHOLE-COAL BRIQUET MANUFACTURING PROCESS
Major Equipment List and Preliminary Specifications
(See Block Flow Diagram, Figure 1)

1.	Absorbent Clay Storage.	Reinforced Concrete, vertical, cylindrical silo with capacity of 1,000 metric tons, with volume corresponding to the density of fine-particle bentonite clay.
2.	Raw Coal Storage.	(Note: If the plant is located adjacent to the mine producing the fine coal and depending on winter conditions, this equipment item could be deleted.) Reinforced Concrete, vertical, cylindrical silo with capacity of 6,000 tonnes, with volume corresponding to the bulk density of the fine coal by-product from mining.
3.	Raw-Coal Pulverization.	Conventional power plant pulverizer equipment, capable of pulverizing 813 T/D of raw coal combined with 100 T/D of broken briquetted coal to produce a pulverized coal distribution required by the recipe. If the feedstock is a lignitic coal, then the issue of drying will need to be resolved as discussed in the text of this annex.
4.	Clay-Coal Mixing.	Commercial equipment for dry mixing 913 T/D of pulverized coal with 143 T/D of bentonite clay, with a goal of approaching a uniform coating of the clay on the coal particles.
5.	Additives Mixing.	Commercial equipment for uniformly and thoroughly distributing 100 T/D of fresh water and 44 T/D of slaked lime ($Ca(OH)_2$) into 1,056 T/D of the clay coal mix. If an oxidizer (e.g., potassium nitrate) is needed, this can be dissolved in the water beforehand.
6.	Briquetting.	Conventional Belgian-wheel briquetting press(es), capable of continuous operation to produce 1,150 T/D of pillow shaped briquets suited to the market needs.
7.	Briquet Aftertreatment.	Probably a shaft drying tower to reduce the moisture content of 1,000 T/D of briquets to improve ignitability by moisture removal and concomitant development of porosity.
8.	Lime Storage.	Reinforced concrete, vertical, cylindrical silo with capacity of 350 metric tons, with volume corresponding to density of fine-particle slaked lime.
9.	Elevated Water Tank.	Elevated steel tank with a capacity to hold 1,000 tonnes of fresh water at height for gravity feeding water to the process.
10.	Miscellaneous.	Conveyors, elevators, piping, measuring devices and other auxiliary equipment to complete the installations for commissioning.

TABLE b-9
CAPITAL COST ESTIMATE
(U.S.$, Installed at a U.S. Gulf Coast Mine-Mouth Location)
Source: U.S. Engineering Firm - 1991

ITEM	LIGNITE	BITUMINOUS	REMARKS
Process Equipment Cost			
Briquetting Machines	1,500,000	1,500,000	Source: Manufacturer
Coal Pulverizer	44,000	44,000	Conventional Power Plant Type
Clay/Coal Mixer	112,000	112,000	
Additives Mixer	224,000	224,000	
Briquet Aftertreater	300,000	300,000	Shaft Dryer
Lignite Pulverizer	1,656,800	0	
Associated Equipment	200,000	200,000	
Subtotal	4,036,800	2,380,000	Process equipment cost, delivered
Process Equipment Erection	10,092,000	5,950,000	2.5 Multiplier to erect and complete
Auxiliary Equipment Cost			
Clay Storage	320,000	320,000	Reinforced Concrete Silo
Raw Coal Storage	0	0	
Lime Storage	160,000	160,000	Reinforced Concrete Silo
Water Tower	189,000	189,000	Elevated Steel Tank
Subtotal	669,000	669,000	Auxiliary Equipment Completed
Auxiliary Erection	602,100	602,100	0.9 multiplier to complete
TOTAL PROCESSING	15,399,900	9,601,100	
Additional Costs			
Plant Commissioning	100,000	100,000	Allocated Amount
Land Acquisition	200,000	200,000	Ten Acres at $20,000/acre
Land Clearance	50,000	50,000	Allocated Amount
Subtotal	350,000	350,000	
TOTAL PROCESS PLANT	15,749,900	9,951,100	
Contingency, 10%	1,574,990	995,110	
TOTAL INVESTMENT (Rounded)	16,975,000	10,946,000	

TABLE b-10
PLANT STAFFING AND SALARIES (Including Salary Burden)
See Figures 2 and 3, and 4

ITEM	Number	Salary	Lignite	Bituminous	Remarks
YEAR 1					
General Manager	1	30,000	30,000	30,000	
Chief Engineer	1	25,000	25,000	25,000	
Supervisor	1	25,000	25,000	25,000	
Sales Manager	1	25,000	25,000	25,000	
Administrator	1	25,000	25,000	25,000	
Assistant Engineer	1	20,000	25,000	25,000	
Draftsman	1	15,000	15,000	15,000	
Shift Foreman	0	20,000	0	0	
Shift Operators	0	11,250	0	0	
Personnel	2	15,000	30,000	30,000	
Accounting	2	15,000	30,000	30,000	
Security	8	10,000	80,000	80,000	
Procurement	2	15,000	30,000	30,000	
TOTAL	21		$335,000	$335,000	
YEAR 2					
General Manager	1	30,000	30,000	30,000	
Chief Engineer	1	25,000	25,000	25,000	
Supervisor	1	25,000	25,000	25,000	
Sales Manager	1	25,000	25,000	25,000	
Administrator	1	25,000	25,000	25,000	
Assistant Engineer	1	20,000	20,000	20,000	
Draftsman	1	15,000	15,000	15,000	
Shift Foreman	4	15,000	60,000	60,000	
Shift Operators for					
Lignite	24	11,250	270,000		Nine-month
Bituminous	20	11,250		225,000	year
Personnel	2	15,000	30,000	30,000	Nine month year
Accounting	2	15,000	30,000	30,000	
Security	8	10,000	80,000	80,000	
Procurement	2	15,000	30,000	30,000	
TOTAL Lignite	49		$665,000		
Bituminous	45			$620,000	

continued on the following page for Year 3

TABLE b-10 (Concluded)
PLANT STAFFING AND SALARIES (Including Salary Burden)
See Figures 2 and 3, and 4

ITEM	Number	Salary	Lignite	Bituminous	Remarks
YEAR 3					
General Manager	1	30,000	30,000	30,000	
Chief Engineer	1	25,000	25,000	25,000	
Supervisor	1	25,000	25,000	25,000	
Sales Manager	1	25,000	25,000	25,000	
Assistant Salesman	2	20,000	40,000	40,000	
Administrator	1	25,000	25,000	25,000	
Assistant Engineer	1	20,000	20,000	20,000	
Draftsman	1	15,000	15,000	15,000	
Maintenance Foreman	1	20,000	20,000	20,000	
Craftsman	5	15,000	75,000	75,000	
Warehouseman	2	10,000	20,000	20,000	
Shift Foreman	4	15,000	60,000	60,000	
Shift Operators for					
Lignite	24	11,250	270,000		Nine-month year
Bituminous	20	11,250		225,000	Nine-month year
Personnel	2	15,000	30,000	30,000	
Accounting	2	15,000	30,000	30,000	
Security	8	10,000	80,000	80,000	
Procurement	2	15,000	30,000	30,000	
TOTAL Lignite	59		$820,000		
Bituminous	55			$775,000	

ENTERPRISE ORGANIZATION

Ideally, the expectation should be that the management philosophy of a coal mining enterprise in the Kyrgyz Republic should be one of perceiving that the products of the mining operations are two: the marketable lump coal; and marketable smokeless fuel briquets. The transfer price for the fine coal to the briquetting operations then will become an internal matter, the management being concerned primarily with the revenue stream from the sale of the lump coal and the briquets.

Given such an integration of operations, staffing a briquetting operation should be reconsidered, since it should become practical to eliminate many positions. For example, maintenance could be combined as a single service for both the mining operations and the manufacturing operations. The same could apply to such overhead items as personnel, accounting, security, and procurement. A result would be a considerable reduction in the operating costs.

PROBLEMS OF FIGURING ACTUAL COSTS

Finally, no discussion can be useful at the present time with respect to calculating the total cost of production of briquets.
As already noted, the schedule in Figure 4 would begin when the development of the recipe for the mix to be fed to the briquetting presses has been identified and found suited to the market and also acceptable environmentally.

The staffing and staffing costs shown in Figures 2 and 3, and in Table b-10, could be subject to significant reduction through major modifications and revisions.

One example of a possibility in respect to cost reduction lies in the value of the coal fines that currently are unmarketable. On this basis, the fine coal has a zero or negative cost. It should be expected that as soon as interest is shown in acquiring these fines, they will be perceived by present stockpile owners as a "valuable, high-cost" material.

Knowledge of the recipe is required. Costs for the ingredients need to be established. Principles for capital recovery need to be adopted. Operating cost estimates and consequent financial analysis will have to come in due course.

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APPENDIX III. DAILY JOURNAL AND SITE VISITS

1. Daily Journal -- USGS team for assessment of the coal resource situation in the Kyrgyz Republic.

=October 4, 1994---Bostick, Johnson and Landis leave Denver, CO via UA200 at 1039, arrive IAD 1552. Leave IAD via DL60 at 1855.
=October 5, 1994---Arrive FRA at 0820. Leave FRA via DL72 at 1100, arrive IST at 1505.
=October 6, 1994---Leave IST via TK630 at 2100.
=October 7, 1994---Arrive ALA at 0835.
=October 8, 1994---Gluskoter arrives from FRA. Ned Popovich of Burns and Roe who will work on District Heating Systems in the area of Bishkek, Kyrgyzstan was also on the flight. Team spends afternoon and evening in company of Rolf Manfred of Idea, Inc., Popovich, and M.P. Gembol of the Institute of International Education. Interesting, enjoyable and very informative.
=October 9, 1994---Most of day in hotel room, reviewing reports.
=October 10, 1994--Huber and Harrison arrive from FRA early morning, team plus Manfred, Popovich and Gembol travel from ALA to Bishkek via automobiles, arrive at 1230. Rest of day obtaining hotel rooms and settling in.
=October 11, 1994--Critical meeting of team and Manfred with K.M. MUAMBETOV, Deputy Minister, Ministry of Industry and Trade, who issued our Invitation Letter and who represents our primary cooperator. Meeting goes very well and we are assigned for direct cooperation to N.T. KOZHOMATOV, Chief of the Department of Material Resources and Trade, and D. KAMCHEBYKOV, Head of the International Relations Department. At hotel meet Heinz Hendricks, mining engineer with the World Bank, who is here as part of a team conducting an Energy Sector Review of Kyrgyzstan for the bank.
=October 12, 1994--Make arrangements for trip to Kavak coal area on Thursday and Friday with Kojomotov and Kamchebekov. In afternoon, with Manfred, have meeting with OMURALIEV, First Deputy Chairman, State Committee on Economy of Kyrghyz Republic. He describes coal situation generally and suggests that major efforts are needed to reduce price of coal domestically so demand, production and consumption all increase. Suggests that underground mines will not be economic in the future and only surface mines will be possible. Important note: Says they have plans to build railroad from Balykchy at the western end of Issyk Kul to southwest to Toktogul Reservoir on the Naryn River and on to connect with the end of the railroad south of Tash-Kumyr. A bold concept! The railroad would connect the southwestern part of the country with both the central and northern parts on an internal route that could provoke development of the central part of the country and shorten the effective distance between the now poorly-connected parts of the Republic. For example, coal from the northern Fergana Valley deposits now must travel about 1000 km, through Tajikistan, Uzbekistan, and Kazakstan, to reach the Bishkek area. The proposed railroad would shorten the distance, avoid tariffs, and supply the energy needed in the northern part of the Republic. We were told that construction has started but that only a short stretch at the northern end is being worked on.
=October 13, 1994--Make arrangements for trips of team(s) next week. Whole team plus Kamchebekov and interpreters Janmilya and Elmira leave for Kavak coal area via Balykchy and Chaek. At road junction near latter are met by Alexander KADAZKI, Director of Mining at Kara Keche and Agulak near town of Min Kush. Visit surface mine at Kara Keche, collect samples, and travel to Min Kush for nite.

=October 14, 1994--From Min Kush to surface mine at Agulak (spelled a variety of ways). Agulak is the headquarters for mining at Kara Keche and Agulak. Part of team visits mine and collects samples, part of team remains with mining geologist, maps, cross-sections, reports, etc. Return to Bishkek late via Kyzyl Oy, Pass Tyuz Ashuu, and Kara Balta. Spectacular route, and some coal is trucked over it, perhaps for domestic use in the Chu River Valley area.
=October 15, 1994--Continue to make arrangements for next week, buy tickets, etc. Group will split into two teams. Gluskoter, Bostick and Harrison will travel to Kara Kol where Harrison will visit the district heating plant and Bostick and Gluskoter the underground mine at Dzhergalan that supplies coal to the plant at Kara Kol. They will visit the Kara Balta cogeneration facility following their return to Bishkek. Johnson, Huber and Landis will travel to Osh on Monday, visit KOMUR and its Director, Mr. SADABIEV, and undertake a trip to the Tash-Kumyr coal area and its five mines. They plan to return to Bishkek on Thursday afternoon.
=October 16, 1994--Work on notes, prepare for trip, but also visit Museum of Modern Art and the Lenin Museum. Gluskoter, Bostick, and Harrison with interpreter Elmira leave Bishkek for Kara Kol.
=October 17, 1994--Huber, Johnson and Landis with Kamchebekov and interpreter Janmilya travel to Osh, meet KOMUR Director Sadabiev and other personnel, plan remainder of week. Harrison in heat plant at Kara Kol and Bostick and Gluskoter tour underground mine (entry by 800' vertical air shaft by ladders).
=October 18, 1994--Leave Osh, travel to Tash Kumyr coal area. Accompanied from Osh by Genady T. IZUMOV, Deputy Director of Komur, and Toimat KYRMANBAEV, Surveyor of the Concern Kyrghyz Komur. Meet Rasul T. KALDYBAEV, Director of Mines at Tash Kumyr, and Kaldar MAMATKADYROV, Main Engineer. Visit surface mines Kara Soo, Kara Tut West which employ draglines, and Kara Tut Central which uses a shovel. Sample fresh face at latter, and visit site of new underground mine Tegenek which is under development. Go thru coal cleaning plant. Gluskoter, Bostick and Harrison return to Bishkek.
=October 19, 1994--Visit operating underground mine Severnau (northern) and traverse operating longwall face on Panel 56, which is mining the III bed. Collect samples from face with miners help. Visit coal analytical facilities and are guided by Chemist Lubov I. JUMABAEVA (35 years on job). Travel to Osh for nite. Gluskoter and Harrison arranging visit to Kara Balta electricity and steam plant. Bostick visiting Institute of Geology, Director Bakirov, and Deputy Director Bokombaev.
=October 20, 1994--To Komur office to arrange visit for following week. Meet Toktobek KYDYRBAEV, Main Geologist of Komur and Tynchibek BAKIROV, former Deputy Director of Komur. Travel to Bishkek in afternoon. Harrison and Gluskoter touring the Kara Balta cogeneration plant, Bostick again at Institute of Geology.
=October 21, 1994--Gluskoter and Harrison preparing draft version of report on utilization possibilities, and then travel to Almaty. Remainder of team working on notes, etc. Landis to Ministry of Industry and Trade with Kamchebekov arranging schedule for following week; and to Committee on Geology to confer with Kadyrbek KAKITAEV, Chief of Department on Geological Control, Usage and Protection of Natural Resources.
=October 22, 1994--Harrison and Gluskoter leave Almaty for FRA and USA. Bostick, Huber, Johnson and Landis working on report elements and preparing for visits planned for next week.
=October 23, 1994--Work on notes and organizing database.
=October 24, 1994--Bostick, Huber, Johnson and Landis accompanied by Kamchebekov, Kakitaev, and interpreter travel to Osh in morning, confer with Sadabaev and others about itinerary for week. Bostick and Huber travel to Kok Yangak coal area with Kamchebekov and Izumov, Johnson and

Landis travel to Kyzl-Bulak coal deposit with Kakitaev, Kydyrbaev, and Bakirov. Both teams arrive late and stay locally.
=October 25, 1994--Bostick and Huber visit Kok Yangak complex including the underground mine. Johnson and Landis visit Small Emterprise mine and exploration drilling activity nearby. Coal in demand locally in Kyrgyzstan and in nearby Tadjikistan. Both teams return to Osh for nite.
=October 26, 1994--Bostick and Huber leave Osh to visit the Almalyk coal mine complex, and the Kyzl Kiya complex, both in brown coal southwest of Osh. Johnson and Landis accompanied by Kakitaev, Kydyrbaev, Izumov, Mining Engineer for Association of Small Emterprises, visit the Kum Bel deposit north of Uzgen and spend nite in Uzgen.
=October 27, 1994--Bostick and Huber continue visits in Kyzl Kiya area and Johnson and Landis visit Kara-Tyube area proposed for a Small Emterprises mine to east of Uzgen. All return to Osh for nite.
=October 28, 1994--Rumor indicated the presence of some sort of coal laboratory in Osh. It is part of the Kyrgyz Academy of Sciences and has been attempting some briquetting tests and perhaps some gasification tests also. The Director is Zhapar Tekenovich TEKENOV and the coal petrologist is Nurzhamal AMATOVA. They have done some testing of binders, identified hardware for possible use, and made some briquettes. Communication between this lab and potential users of their research should be improved. Team returns to Bishkek in afternoon.
=October 29, 1994--Huber and Landis have meeting with Ian Robertson. He and Peter Bell are conducting economic analysis of the mines operated by Kyrgyz Komur, the government coal company, under funding from the EC. We have, necessarily, visited some of the Komur mines; they have presumably visited all of them and their economic analysis is confined to the Komur mines. We are told that their reports are not available to us. We are also surprised to learn that the EC had recently made some kind of analysis of briquetting possibilities in the Osh area.
=October 30, 1994--Work on report elements, prepare memo on plans for rest of visit for Manfred and USAID. Send by FAX from Postoffice. Prepare first draft of Introduction and Summary and Suggestions sections of preliminary report.
=October 31. 1994--Short discussion with Salem Ouahes, who is leading an Energy Sector Review of Kyrgyzstan for the World Bank [Heinz Hendricks is part of team]. Discussion with Peter Kemeney of Burns and Roe who is leading a study of the Bishkek heating and generating facility. He needs coal quality information which probably doesn't exist; for example, metal oxide in ash data for slagging and fouling predictions and considerations. A modern sampling and analytical program may be needed to understand problems and remedies.
=November 1, 1994--Kemeney says that he has seen a laboratory at the heating plant that can do proximate plus heat value [they have three older calorimeters plus a new device similar to the one we saw at Tash Kumyr]. To Committee on Geology to meet with Kakitaev for information needed for our datasheets. Meet SOLPUYEV,T.S., a senior coal man, and SATAROV,?, Head of the Central Laboratory of the ConG. Visit laboratory, tour with SASOVA, Lyudmila, Chief of the Chemical Laboratory of the Central Laboratory. Standard and adequate except for their single old calorimeter which is not operating but can be repaired if there is a reason to do so. They have not made a coal analysis for two years. Four years ago they were doing 500 per year when exploration was being done. Now, only exploration being done is in south and all analyses are done in a sister laboratory at Osh. They can do Proximate analyses plus heat value, and their spectrographic and wet chemical labs can do elemental analyses [like oxides in ash, I assume]. They do not do production samples, but could.

We discuss the idea of cooperative assistance with ConG. for exploration in coal areas poorly known but which could be mined by Small Enterprises or by Komur. Will return tomorrow for further discussion.

=November 2,1994--Visit Bakirov at the Institute of Geology of the Academy of Science. He has prepared a lecture on central Asian geology and the geologic history of Kyrgyzstan. In afternoon visit Kakitaev. He presents ideas of presently-unmined areas where coal is reported and reconnaissance exploration may be successful. Then to Kamchebekov for his reaction to our recommendations. He suggests that recommendaton #1 be to KyrgyzKomur because the Association of Small Enterprises is nascent, and Komur needs assistance to both large and small enterprises. He suggests that recommendation #2 make clear that we are recommending reconnaissance exploration in areas that are presently unmined, or nearly so. No changes suggested in the other three recommendations. He asks about training so we add a training component. We will try to see him again tomorrow

=November 3, 1994--To Committee on Geology for lecture session with Solpuyev and Kakitaev. Bakirov also for a short time. Very interesting. They recognize eight coal regions in the country. One is new to us- the Chu basin. There is coal in Kazakstan a short distance north of the border northwest of Bishkek and they feel that it may extend south into Kyrgyzstan a short way. All is under the surface and a few drill holes are needed. Visit Kamchebekov at Ministry of Industry and Trade. He wonders why we are not leaving a report with them and we try to explain that our report must first be submitted to USAID and that the final version will not be available for some time.

=November 4, 1994--Prepare weekly report for FAX transmittal to Manfred. Working on preliminary report. Worrying about how we will ship two metal boxes full of coal samples to Reston, VA., while keeping the sample integrity for analytical purposes. Manfred says to wait before talking further to Kamchebekov.

=November 5, 1994--Working on preliminary report, trying to have complete by tomorrow evening when Manfred arrives

=November 6, 1994--Still working on preliminary report. Operating on premise that it is better to get all information in now and integrate neatly later. Rolf Manfred arrives from Almaty and receives first complete preliminary report.

=November 7, 1994--Rolf makes constructive suggestions about the report. So we work on it somemore. Afternoon visit to Douglas Kent, First Secretary, Consul, of the Embassy of the U.S.A.

=November 8, 1994--Copies made of revised report, copy given to Rolf Manfred, who leaves for Almaty in afternoon. Team visits Kamchebekov at Ministry or Industry and Trade, and Kakitaev at Committee for Geology to tender thanks and goodbys.

=November 9, 1994--Leave Bishkek 8:20AM via two large automobiles, arrive Almaty 12:30PM. Then to Matrix International to leave three containers of coal samples, field equipment and clothes for padding, and much paper we brought. Meet with Barry Primm and Gordon Weynand at USAID office for presentation of conclusions and recommendations. Then to Rolf Manfred's office for meeting with William J. Crowl of Fluor Daniel, Inc., a member of the Kazakstan coal cleaning team. Also requested by Matrix to obtain permission to export the coal samples! Call Kamchebekov. Several informative hours spent with Crowl.

=November 10, 1994-To Manfred's office, wait for fax from Kamchebekov, and more discussion with Crowl and staff at office. Fax arrives, Bostick and Johnson picked up by Matrix, boxes thru City Customs (?), then to airport for country customs. Discuss Armenia mining situation with Crowl. He says they set up an Armenian company to control funds for mining and it seems to be working. This is possible mechanism for controlling and disbursing funds for Kyrgyzstan mining

industry. Gennady ? of office staff seems knowledgeable and could be very helpful. Bostick returns from airport, presumably our three boxes are clear and will be on their way shortly.
=November 11, 1994-To Manfred's office to leave items for recovery in a subsequent trip--tape, plastic bags, etc. Several hours discussion of the team's preliminary recommendations and conclusions. Make few changes in preliminary report and additions to this journal.
=November 12, 1994-Team from hotel to airport at 6:30A, plane late, leave late, arrive Frankfurt ca 12N. Bostick and Johnson to continue to USA, Huber remains in Germany, Landis to continue to Indonesia. End of this part of the journal.

Resume journal April, 1996.

=April 22, 1996-Monday-N.H. Bostick and E.R. Landis leave Denver, CO, 0855 via UA278; arrive Wash/Dulles 1400.
=April 23, 1996-Tuesday-National Center, Reston.
Leave IAD 1915 via DL60
=April 24, 1996-Wednesday-Arrive FRA 0920; leave FRA 1205 via DL72; arrive IST 1605
=April 25, 1996-Thursday-Leave IST 2025 via TK630
=April 26, 1996-Friday-Arrive Almaty (ALA), Kazakstan, 0800. Meet fellow traveler Tom Ewert, Director, Mercy Corps International, who headquarters in Bishkek, Kyrgyzstan. Met by USAID Travel Office (Madina Baedilova) who expedites Immig. and Customs and arranges transportation to Bishkek on April 28. Telephone USAID/CAR/ALMATY, no appointments have been made, Primm (EEU Officer)on TDY elsewhere, Mission Director and acting EEU Officer committed.
=April 27, 1996-Saturday-Reviewing files and documents. Rain all nite, snow this morning, surly day.
=April 28, 1996-Sunday-Leave Almaty 0900, arrive Bishkek, Kyrgyzstan, 0100. Hotel Dostuk same as before but Eternal Flame at memorial nearby is out.
=April 29, 1996-Monday-Arrange appointment with Fred Huston, Senior Privatization Specialist, USAID/BISHKEK, for 1300. CJ Rushin-Bell, USAID Representative/Kyrgyzstan committed. Leave English version of draft final report with Huston and a Russion version that Huston plans to transmit to Kyrgyzstan officials. He suggests we contact Jay Madigan of Price Waterhouse (subcontractor to Hagler Bailey) who have privatization tasks.

Contact Ministry of Industry, Material Resources and Trade. (sometimes Ministry of Industry and Trade) All three primary counterparts gone; two retired and one now in "Presidential Apparatus". Contact K. KAKITAEV primary counterpart in Committee of Geology, make appointment for tomorrow.

=April 30, 1996-Tuesday-Renew acquaintance with Janet A. Koch, Senior Energy Specialist, World Bank. She says WB funding upgrading of Chu Valley TETS (thermal electric and heat station). Upgrading may include new transmission station and line to allow more electricity to Naryn Valley area. We are later told about $75 million. Suggests we contact WB Resident Mission and the EU/TACIS office here.

Meet with Kadyrbek KAKITAEV, Chief of Department on Geological Control, Utilization and Conservation of Natural Resources, Ministry of Geology and Mineral Resources (formerly the Committee on Geology--) and T.S. Solpuyev, Head of the Coal Department. Kakitaev has recently completed (part of a group) a new "Law of the Kyrgyz Republic on

Resources" Resources defined as "everything under the soil and under the waters". New law to be submitted May 6 to Parliament. Expects quick passage and presidential approval because contains provisions favored by highest. Says important for foreign investors because guarantees for investment and profits are included. [Taxation may be a separate matter]

Contact made with former primary counterpart in Ministry, Duyshenbek K. KAMCHYBEKOV, who wants to see report and then will contact us. We will leave copy at Ministry for him to pick up.

Make appointment for 0900 Thursday with Solpuyev for updates on report.

To Ministry of Industry and Trade. Meet Mukhtar M. KHUDOYAROV, Head of Coal Section, who will transmit report to Kamchybekov. No sign of the two copies sent to the Ministry by USAID in (probably) December(?). Then meet Abdizhalil PACHRIDIN, Chief Specialist, Head of the Utilization Section. Interesting discussion follows. Pachridin favors subsidy for coal because says productive capability is now ahead of the ability of people to pay for the coal they need. Dismisses possibility of using Dzhergalan coal in Bishkek area because handling for barge transport on Lake Issyk Kul would increase costs too much. Have considered pipelining of coal in several routes to Bishkek from Kavak Coal Region and thinks only economic possibility is tunnel through mountains to Chu Valley area because is all downhill and protected from freezing. Says have four proposals for research/pilot studies submitted to Ministry for funding. He has recommended that they be lumped together and all done in Kyzyl Kiya instead at other places. One is creation of a thermal briquetting industry with first emphasis on coal from Agulak. [reasons unclear but a mention of high germanium content --coals in that area were also mined for recovery of uranium in the past--also says some coals have gold] Strongly favors thermal process [which means carbonization ?] because says coals to be used will have 40% ash and clay-binder briquettes would not burn. Another proposal is creation of crawler-mounted pneumatic hammer drills to be used in both underground and surface mining. Third is proposal for production of humic fertilizer from weathered coal. Fourth is hydraulic jackhammers. Asks to read the report also, as does Khudoyarov, so Bostick takes another copy to them.

Make appointment with Orinbek SHAMKANOV, Operations Officer, of the World Bank/Bishkek for 1400 Thursday May 2. Attempt to contact Sean Curley, in charge of Energy Managemant Training, TACIS, Bishkek. [Their training facility is in Osh]

Make appointment to meet Erwin Geiger, Senior Advisor to Price Waterhouse in privatization program, and wife Marcia for dinner. Geiger says that their Mass Privatization effort is about done but he will be in Bishkek for a longer period dealing with privatization of different categories of enterprises including mining. Our report could be of considerable assistance to him and he requests a copy as soon as possible.

=May 1, 1996-Wednesday-Mayday Holiday, prepare this journal and notes, and setup printer.

=May 2, 1996-Thursday--All morning with Solpuyev at Ministry of Geology and Mineral Resources. We discuss each of the operating coal areas in each of the coal regions, including new coal areas and new mines. The Small Enterprise Program has grown and changed. [We are later informed that it is now the Private Enterprises Mine Program] It has problems of overproduction in some areas and may be unable to meet demand in others. Two of the six frontier coal areas proposed for exploration and development in our discussions of November, 1994, are now licensed (by Ministry of Geology) and should produce coal for their local area from here on. One, the Turuk Area, was inaugurated by the President of the Republic in December, 1995. This mine has produced 6,000 tonnes to date in the energy-poor Naryn City area and is hoping to produce 20 to 30,000 tonnes next heating season. The other, Ming-Teke,is now licensed to produce coal for use in the Makh-Mal gold area long operated by Kyrgyz Gold. Another newly-licensed area called Suku-Tash is in the headwaters of the Tar River near the southern boundary of the nation. All three of the above-cited areas contain bituminous coal but another newly-licensed area in the Kavak Coal Region (called Besh-Saray) will produce subbituminous coal. The operators of the Osh Bazaar in Bishkek are financial partners in the mines producing coal in two of the above-cited four new operations under the Private Enterprises Mine Program. We have asked for a comprehensive list of all the licensed Private Enterprises mines.

In early afternoon we visit Orinbek Shamkanov, the Operations Officer of the World Bank office in Bishkek. We learn that EU/TACIS is going to undertake a coal industry support program and a request for tenders has been available. Several other individuals and agencies are suggested as being interested in our final report.

Rest of afternoon with CJ Rushin-Bell, USAID Representative for the Kyrgyz Republic. Many helpful facts and suggestions emerge from the discussion. Also trying to obtain confirmation that our travel plans for Gluskoter are possible in Almaty.

=May 3,1996-Friday-All morning with telephones. Bostick ill but valiant. Early afternoon with Kakitaev and Solpuyev. Solpuyev is now preparing a "Handbook" which will address the geologic setting (shown on maps, measured sections, drill holes, and cross-sections), quantity and quality, mining and utilization, and citation list of each of the 60+ coal deposits of the Republic. This will be available in Russian in a year or so, and would be valuable in English. We are given table of the licensed Private Enterprise Mines started under what was previously called the Small Enterprise Mining Program. Informative, especially when he suggests that as many as a dozen more ventures may be operating to supply energy needs in local areas without licensing. Licensing means governmental assistance, operational oversee, and taxes (5% on value of product produced).

Kakitaev advances idea of a planned or model Private Enterprise that would be an example for all other Private Enterprise Mining Program ventures. The planned enterprise would include the human needs, science, engineering and economic factors that should comprise a complete enterprise (for want of a better word). [A demonstration of western-style, market-oriented small private enterprise?]

Kakitaev also says that they are eager to field test briquetting technology, especially if any hardware is ready to transport to a field situation. Suggests Kara Keche where there are large quantities of fine coal stockpiled. Not sure that he is aware of the large amount of

research, pilot testing and market studies that may still be required. He is tired of talking and wants to produce briquettes.

Meet Minister Baiseit TURSUNGAZIEV, head of the Ministry of Geology and Mineral Resources. Primarily a metallic ore person but with some experience in oil and gas resources. Quiet, attentive. Says they would commit their available resources to the model (plan) program and are also interested in cooperative work on briquetting [Bostick says "model" doesn't carry idealization concept very well in Russian so we should use "plan"].

To Ministry of Industry, Material Resources and Trade. Am put in contact with SADABAEV, Head of KYRGYZKOMUR in Osh. We are invited to visit for an update on the mining activities and plans of the company (or companies) and will arrange visit with the laboratory that conducted briquetting tests in the past. We will try to go Tuesday morning and return to Bishkek on Thursday, which is a holiday.

USAID Office confirms travel arrangements for Gluskoter. We hope he arrives in Bishkek mid-morning Monday, May 6 so he can accompany us to Osh.

=May 4-Saturday-Beautiful day with Sun and 60's. Finally find electric adaptor plug, most unlikely place. Find recent edition maps and usable small dictionary. Work on files.

=May 5-Sunday-Work on files and make table of private small coal enterprises.

=May 6-Monday-Gluskoter arrives before dawn from Almaty. Says Fred Simon, USGS but cooperating with UNESCO on this occasion, will arrive in Bishkek in late May. Simon requests starting point for geophysical (seismology) monitoring discussions. We contact Apas BAKIROV, head of the Geological Institute of the Academy of Science because Bakirov told us of a seismic monitoring system that exists (or existed) to check movement of major fault systems in the country. Bakirov will welcome Simon and assist if possible. Simon requests we alert the Economic Officer at the Embassy as they are acquantances from some African tours. We try but Embassy phone always busy.

Gluskoter had established contact with Ned Popovich of Burns and Roe re their activities in the country. Ned now is only involved in planning for major hydropower development. Confirms the US$75 million from WB for upgrading the Bishkek thermoelectric/heat plant (as a start they will scrap the oldest six boilers of the present 24 and upgrade another 10) along with upgrading transmission lines and at least one (new?) substation. Says Asian Development Bank involved along with WB.

Talk with Wilson and Gurba of KYRGOIL CORPORATION who are Canadians involved in establishing an oil refinery near Dzhalal Abad. They claim it is the only refinery in the country. The company home is Calgary, Alberta. They say that they will truck some refinery products to Bishkek and that the WB is to supply $60 million to improve the highway from Tash-Kumyr to Bishkek.

To Ministry of Industry to make appointments in Osh. Turns out that Khudoyarov helped Gluskoter and Harrison during their visit to the Kara Balta heat and power station a year and a half ago. General discussion with him and several others follows. They say that Ministry of Industry and Kyrgyzkomurholding relationship exists primarily by "inertia" because of changes in both organizations (perhaps mostly in Kyrgyzkomurholding). They explain the loan guarantee program for Small Mining Enterprises. In September, 1994 and again in April, 1995, they were authorized to issue loan guarantees in the amount of 1.5 million soms and 910 thousand soms, respectively. The 1.5 million went to 7 small enterprises and the 910 thousand to 4 other enterprises. They say that only 2 of the 11 firms are actually repaying the banks who provided the money. The Ministry of Industry never had any money for the program, and there is no expectation that the Ministry will be involved in payments to the banks.

The Ministry of Industry statistics for coal production do not include the coal produced by the small mine enterprises and state that the small mines produced a total of 77,000 tonnes in '93, 55,000 tonnes in '94, and 56,000 tonnes in '95.

In the Small Enterprises Mine Program the mines were required to provide coal to "Budget Institutes" (schools, hospitals, etc.) who could not, of course, pay for the coal. However, this "free" coal was credited against the taxes they would otherwise have to pay on their production. [See later description of taxes] Under the present Private Enterprise Mine Program the mines are no longer obligated to provide unpaid-for coal to the Budget Institutes. The Ministry Of Industry does not involve themselves with the small Private Enterprises. Perhaps they also do not involve themselves with the large State Stock Companies who operate under Kyrgyzkomurholding and that may be reason for the "inertia" statement.

Pachridin wishes to see us. He has read our preliminary report, apparently has no problems but wishes to reaffirm his ideas about briquetting at Kyzyl-Kiya. Also firmly links the production of humic fertilizer to briquetting and says one without the other may be economically impossible.

Drop off copy of Daily Journal thru May 5 at USAID office.

=May 7-Tuesday-Leave Bishkek at 0855 via Kyrgyzstan Airways, arrive Osh at 1000, to Hotel and then to Kyrgyzkomurholding. Meet General Director Isabek BEKISHEV who leads us to the newly-moved Institute for the Complex Utilization of Natural Resources. Tekenov, the Head of the Institute (Also chairman? president? of southern branch of Acad.Sci.), is not present (at yearly Academy meeting in Bishkek). This institute is one of four in Osh and two in Dhzalal-Abad that form the Southern Branch of the Kyrgyz Academy of Science. This is the only one with interest in coal. This institute has four sections and we meet the head of the Section on the Utilization of Coal as a Fuel. The head of the section that runs the Laboratory for Briquetting and Coking is elsewhere (we will meet her tomorrow).

Section Leader ARDZIEV, Ddzhoromamat says that people want coal but can't afford it. Says that most coal costs 220 to 240 soms at the mine and transport cost must be added.

[Note that we are given more detailed prices later] The minimum wage per month is 78 soms, pensioners receive 200 soms per month, so coal is too expensive for many people. In USSR days about 40 to 60 percent of the production cost was subsidized, so more coal was used.

He, too, (see Pachridin, May 6) links coal briqueting with production of humic fertilizer. Is not sure who can afford briquets but is certain that the fertilizer would be welcome. [Are they both saying that the fertilizer can subsidize the briquets?] They have apparently done considerable work on the fertilizer and says that the lab has prepared a demonstration (small pilot) proposal to make 20 tonnes of fertilizer per day, perhaps for larger-scale testing than they have done to date. Says that 800,000 tonnes of mineral fertilizer (nitrates and phosphates) are imported per year from Uzbekistan,Kazakstan and Russia, presumably are paid for in hard currency, and cost the farmers $150 per ton. Also feels that the humic fertilizer is better for their soils because breaks up crust that otherwise may form when using mineral fertilizer. Thinks the humic fertilizer might cost 200 to 500 soms per ton and their tests to date indicate that the normal application might be about 300 kilograms per hectare. Fine coal would be used. We did not get into the process they would use. This suggestion might deserve further consideration or investigation.

Return to Kyrgyzkomurholding. Technical Director IZUMOV is present as well as General Director Bekishev. A short visit with President Tulegen SADABAEV, who is pleased to see our report because they had never received any copies requesting comments. Promises that he will respond shortly, but probably not before we leave the country. He plans to send their comments to the USAID/Bishkek office for transmittal to us. Continue discussion with Izumov and Bekishev.

The Kyrgyzkomur of our former visit is now a State Stock Society called Kyrgyzkomurholding. To date it has created five State Stock Societies (GAO) from parts of the old Kyrgyzkomur. These five are:

GAO Kyzlkiyakomur--operating the Abshir and Valakish surface mines and includes an old shaft to be closed under the PESAC program.

GAO Solyuktakomur--Both surface and underground. Another old shaft to be closed shortly.

GAO Tash-Kymyr--The Severnaya underground mine and the three nearby surface mines.

GAO Tegenekkomur--A new(?) small surface mine near the undeveloped Tegenek underground mine.

GAO Almalykkomur--Primarily the surface mine but hope to produce some coal from the new underground mine.

In addition,they list the Central Underground Mine in the Soguty area on the south shore of Issyk Kul, but state that it will be closed permanently very shortly.

They list eight other enterprises that they plan to separate as State Stock Societies (GAO):

Kok-Yangak coal area

Dzhergalan coal area

Agulak and Kara-Keche area

Coal Construction Trust-responsible for opening new shafts.
Kyzyltsemn-the Kyzl-Kiya Central Electrical Workshop.
UMTS-Management of Supply Services, responsible for equipment for all mines.
Coal Transport-Makes equipment for all mines.
Communications Department-will be State Stock Company very soon.

Conversion of the Dzhergalan coal area (mine) to a GAO is apparently in the works and they cite it as an example. Twenty five percent of the stock of the Dzhergalan State Stock Society will be offered for sale. This twenty five percent is supposed to have a value of 500,000 soms. Five percent of the stock will be distributed to the workers, free. The remaining 70 percent stays with the company with the understanding that eventually the workers will be able to buy it.

The Bishkek TETS, which in this case includes the heat plant at Kara-Kol at the east end of Issyk Kul, has requested that they be shipped 300,000 tonnes of Kyrgyz fine coal. Kyrgyzkomurholding is prepared to supply 160,000 tonnes of bituminous coal from Tash-Kymyr, Tegenekkomur and Kok-Yangak. They propose to send 140,000 tonnes of subbituminous coal to satisfy the remainder of the request, but do not have actual agreement with the TETS. This coal would have to travel by train through Uzbekistan and Kazakstan and be subject to tariffs (perhaps in hard currency). We will return to this subject tomorrow.

Planned production for 1996 (this is really potential production) for the eight mining enterprises are: Kizylkiyakomur-120 thousand tonnes, Solyuktakomur-150 thousand tonnes, Tassh-Kymyr-90 thousand, Tegenukkomur-20 thousand, Almalykkomur-110 thousand, Kok-Yangak-50 thousand, Dzhergalan-50 thousand, Agulak and Kara-Keche-50 thousand. A total of 640 thousand, of which 210 thousand is bituminous coal and 430 thousand are subbituminous.

We ask about export coal. In the first four months of 1996 they sent 34,400 tonnes to Uzbekistan, 1,800 tonnes to Tajikistan, and 2,800 tonnes to Kazakstan. Of this 39 thousand tones all but 600 is fine coal that presumably is used in district heating plants. Unfortunately, the different currencies are not convertible so Kyrgyzkomurholding receives barter in return; some items like cement but mostly in foodstuffs which are then distributed to the coalmine workers in lieu of wages. [This arrangement does supply food to the workers and their families, otherwise they might receive neither food or wages.]

=May 8-Wednesday-Izumov has perused the report overnite but we receive no written comments yet, just congratulations on the depth and detail of our work. He accompanies us to meeting with KYDYRBAEV, Toktobek, former chief geologist of Kyrgyzkomur at the time of our previous visit. He is presently an Inspector and reports directly to Kakitaev in the Ministry of Geology and Mineral Resources in Bishkek. His duties include monitoring all activities extracting mineral resources in Dzhalal-Abad and Osh Oblasts, maintaining documentation of licensing program and procedures, assisting operators with the paper work necessary for their activities, and providing technical expertise as needed. Also present is BAKIROV, Tynchybek, President of the Association of Small Enterprises Coal Miners (Komurken) and General Director of the KEN Firm which operates the largest of the two pits producing coal from the Kyzyl-Bulak area in the Alay Valley. The small

mines operating under the program now called the Private Enterprises Mine Program reach an agreement quarterly with the local tax office on the value per ton of the coal that they have mined or will mine. This is called the Tax Price. They are then required to pay a 5% tax on the coal produced, regardless of whether they sell it or not. They can sell the coal for more or less than the Tax Price but they pay the 5% on the agreed-upon tax price. The 5% tax is distributed 20% to local settlement, 30% to the Oblast, and 50% to the Federal Government. In addition to the 5% tax on production they pay 25% tax on sales to the Federal Government, 5% insurance (social liability?), 1.5% for Road Maintenance, 1.5% to a Water and Air Quality Protection Fund, and these taxes must be paid on barter transactions also. They say is same tax structure for all coal mines regardless of ownership or operators.

In the 4th quarter of 1995, the value of coal (the Tax Price) from small Private Enterprises ranged from 90 to 120 coms per ton with an average of about 100coms per ton. The average for the state-owned mines was about 185coms per ton and the range was as follows: Kyzyl-Kiya-182coms per ton, Solyukta-195, Almalyk-142, Agulak (and Kara-Keche?)-96, Tash-Kymyr-173, Kok-Yangak-175, Dzhergalan-242, and the mine at the Soguty area on the south shore of Issyk Kul was 322coms per ton.

The Southern Expedition of the Ministry of Geology and Mineral Resources has been active in the Abshir coal area of the Southern Fergana coal region, at various areas in the Alay coal region, and in the Uzgen Basin part of the East Fergana coal region. At Abshir one drill rig is exploring a possible expansion of the area. The exploration tract is two Kilometers long along a steeply-dipping coal seam. The feel they need a minimum of 50 drill holes to establish B1 category reserves (100m spacing of data points on the seam). This exploration is being performed at the request of Kyzylkiyakomur.

In the Alay coal region they have one drill rig exploring at the request of the regional people. They completed six drill holes in the Kyzyl-Bulak area and are now exploring other areas where Jurassic-age coal-bearing rocks have been previously noted. In the Uzgen Basin they are exposing outcrops by trenching, and other surface activities. The small mines requesting help are paying for these activities.

Bakirov says his duties (unpaid) as President of the Small Miners Association are small, primarily providing advice, acting as an intermediary, assisting with year-end and quarterly reports, etc. We asked about coal exports to Tajikistan. He says there is need by the mountain people but they have no money. He adds that the Red Cross has bought 2,500 tonnes of coal from his mine in the Kyzyl-Bulak area to give to the people in adjacent Tajikistan.

Return to Kyrgyzkomurholding offices. Meet Ms. DZHOLDOSHEVA, Tolgonai Dzhanarovna, who is in charge of briquetting activities at the Institute we visited yesterday. Forthright. Says they need help in testing their ideas, and are open to new ideas and approaches. They are trying with whatever equipment is available. They recently made about 700 briquets, three at a time on a modified brick press, trying to test various binders such as clays, lime powders and cotton residue. All coal used was fines, of course. Is planning to prepare a cooperative proposal requesting assistance from USAID. We told her

to send it to CJ in Bishkek but did not encourage her or raise any false hopes. She reports that the Shargun coal mine in Uzbekistan is producing briquettes, but does not know the method or scale.

Various subjects, some new, some returnees. It appears that the Dzhergalan mine has the most assurred market among the coal mines of the country, and is unable to produce as much coal as their market, the Kara Kol heat plant, requires. Izumov says that they have prepared a proposal for 15 million coms to develop the mine for greater production. He did not indicate to who this proposal would be submitted. We return to the matter of the Uzbekistan tariff on coal shipments. They say that the Bishkek receivers must pay the tariff, it is not the problem of Kyrgyzkomurholding.

They report that Uzbekistan has recently made a requirement that each of their Thermal Energy Heat Stations must establish a one million ton stockpile before the coming heating season. The feel certain that the mines presently operating in Uzbekistan cannot supply the quantity indicated and are quietly hopeful of an export market. However, they are not aware of any plans for discussions about supplying the coal.

Short meeting with President Sadabaev. He has recently returned from Brussels where tenders were accepted in response to a request for tenders regarding a coal industry support program for Kyrgyzkomurholding. The program will be sponsored by EU/TACIS. The program as described in the request for tenders is a training program of one-year duration with emphasis on financial systems, mine management, marketing, and mineplanning and design techniques. The request for tenders stipulates that no more than fifteen percent of the total project funding can be spent on equipment. Presumably, most of that would be for computers. Five tenders were evaluated and Sadabaev believes that the tender from Rheinbraunkohle of Germany will be favorably viewed.

=May 9-Thursday-Holiday celebrating the termination of the Great Patriotic War, we call it V-E Day. Leave Osh about 1100 via Kyrgyzstan Airways, arrive Bishkek about noon. Update this Journal from May 5, finish 2300. Very busy days.

=May 10-Friday-Make appointment with CJ Rushin-Bell for this afternoon. Make appointment with Barry Primm in Almaty for either Sunday afternoon or Monday. Call Embassy, advise Economic Officer of the coming arrival of Fred Simon. Making copies of some documents.

Long meeting with Rushin-Bell. Again, very helpful and interested in our current information on the status of the coal industry.

Short meeting with Khudoyarov, make appointment with Kamchybekov for tomorrow.

=May 11-Saturday-Meeting at the Ministry of Industry, Material Resources and Trade with Khudoyarov and Duyshenbek KAMCHYBEKOV of the International Section of the Presidents Administration. He was our primary counterpart during earlier phases of the assessment project. He wants to read the report and promises to send us his comments through USAID/Bishkek. We

discuss our recommendations with him. He adds that legal assistance might be a necessary part of program to help private enterprise small miners. He emphasizes importance of the fine coal problem and the necessity for a solution, soon. Thinks that our ideas for information handling and annual up-dates are okay and useful.

Update this journal and prepare memorandum transmitting our daily journal and describing the four positive recommendations we will make for activities, within the USAID program for Kyrgyzstan, needed to support the coal industry of the Kyrgyz Republic in its change from the monolith of the past to a privatized, market-oriented, economically-viable member of the energy system of Kyrgyzstan.

=May 12-Sunday-Leave Bishkek 0830 via vehicle, arrive Almaty, Kazakstan, 1200.

=May 13-Monday-Appointment with Barry Primm, Phillipe Chabot, and Talgat SEITKAZIN, all of USAID Regional Mission to Central Asia. Discuss TDY, final report and recommendations. We offer to prepare ideas in form useful to USAID if they want to implement the needed activities. Decision made to have Bostick stop in Tashkent for two days to determine fate of the former central asian coal management depository in Tashkent. Prior to break-up of the Union all coal exploration, development and industry direction for Kyrgyzstan, Uzbekistan, Tajikistan and Turkmenistan was done from a regional center in Tashkent [Sredazugol']. He is also to attempt to determine the status of briquetting efforts in Uzbekistan.

Make copies of Daily Journal and memo with recommendations [to diskette for Primm], update this journal, get airline tickets validated for tomorrow for Gluskoter and Landis and visa and ticket changes for Tashkent for Bostick on Wednesday, odds and ends.

=May 14-Tuesday-Day starts at 0220. Leave Almaty at 0525 via UA, travel via Frankfurt and Washington, DC to Denver where at residence 2100. 31 1/2 hour travel day. Gluskoter to Washington only.

Bostick meets with P. Chabot: a) He will send Landis e-mail to authorize Bostick detour to Tashkent for Sredazugol' contacts there. b) He suggests meet with Barbara Britton, Almaty, on environmental policy and technology for other contacts in Tashkent.

=May 15-Wednesday. 0800 Bostick to Tashkent. Met and helped with local phone contacts as personal favor by Vladimir KONOVALOV, Deputy director of SANIGMI [Cent.Asia Hydrometeorology Inst.]. Tracked down <Sredazugol'> [now named, on paper, <Coal> joint stock company or <Kymir> AB] and met with Gayrat IBRAGIMOV, coal utilization specialist, and Server TOMALIK, First deputy director.

Summary (see separate report): Shargun' coals (low-volatile bituminous) made into briquettes with bitumen binders [petroleum residues?] using several roller presses at 20 and 50 ton/hour rated capacity. Product cost high (3,400 sum/ton) and environmental problems in handling and use. Briquettes on same presses successful using cotton oil residues @ 2,900 sum/ton. Have explored purcase of smaller presses. Igor BAYMIROV from Kyrgyzsan (Osh) doing coop work at Shargun briquette works. Told that there is (was?) an

ore pelleting press unused in Kyrgyzstan that might make good pellets from coal fines using clay or other binders. According to them, <Sredazugol'> has great repository of info on coals throughout Central Asia [probably true, but info not likely available 'for free'.]

=May 16-17 Thursday, Friday. Bostick work with local hydrologists on organizational details of American Institute of Hydrology meeting in Tashkent, Sept. 22-27, 1996. Expenses met by Uzbek hydrologists.

=May 18-Saturday. 0400 Bostick depart Tashkent homeward for Denver. Arrive 1900 Denver. End of journal.

APPENDIX III. 2. DESCRIPTIONS OF SITE VISITS

a. Alay Coal Region

1. - Kyzyl-Bulak Area

This area is the site of a new open-cut mine operated by a small enterprise. The mine is located about 40 km west of Sary Tash. The coal is contained in a Lower Jurassic unit referred to by mine personnel as the coal-bearing formation. The presence of coal was unreported till very recently when coal fragments were observed in diggings by marmots. The rocks strike north and dip steeply to the east. Only one bed, reported to be 16 m thick, is present.

Mining is by truck and excavator. Overburden is removed by bulldozer and excavator and the coal is transported by private truck to local and distant communities for domestic heating. FOB prices are reported to be about $8.40 per tonne to local users, and at least $9.35 per tonne for more distant users. Because production has been intermittent since the mine opened in 1994, tonneage figures are sketchy, but during October of this year an average of 100 tonnes per day has been produced. This property is currently being explored, and at the time of our visit one core hole had been completed to a depth of 194 m, and a second core hole was being drilled. Future exploration plans call for at least five additional exploration drill holes in the immediate area of the open-cast mine.

b. South Fergana Coal Region

1. Kyzyl-Kiya Area

The mine at Kyzyl-Kiya operates the Lenin-Komsomol shafts and workings 6 km southeast of the town Kyzyl-Kiya and produces sub-bituminous coal. The market for local uses demands lump coal so there is a screening plant. Until the recent economic/political disruption, fine coal was shipped by rail to thermal plants in Uzbekistan and Kazhakhstan. Mining started at the end of the last century, and the present mine produced about 450 K.T./year in the mid '70s and again toward the end of the '80s. The present two shafts (700 m deep), plus a slope and ventilation portals date from about 1964. Several other mines are, or have been, operated from this mine headquarters and supply point, with coal hauled here for shipping, so production, size, reserves, etc. may be confused in some reports.

The mine is essentially shut down now because a spontaneous fire in a longwall gob area was incompletely controlled by grout sealing. Further steps to control the fire are in progress, but bad air and high temperature (reported as 35-40 C) limit the operation, and commercial production is just incidental to the cleanup. Our statements about the "present" mine may not, therefore, imply any future. The coal seam is about 8 m thick, with two 3.5 m benches separated by a clay parting. The strata dip 60 deg. in the upper levels and flatten to 18 deg. at 700 m depth. Longwall mining has been done in two benches, with a year interval between, and where possible entries have been driven in rock to provide longer life. In spite of the 12 M.T. balance reserves, the viability of the mine is in doubt because of the fire and the great depth of the operation.

Coal character has been reported as 24% moisture, 20% ash, 0.7% sulfur, 37% VM and 6700 Kc/Kg heating value (daf). The number of analyses and type of samples in these averages is not reported.

2. Almalyk Area

The Almalyk opencast mine produces sub-bituminous coal from pits about 25 km southwest of Osh; it opened in 1961. Production is from a single seam, "Kyzylkiyskiy", about 29 meters thick, though it contains clay partings in the upper portion which total 4 to 9 meters in thickness. The dip of the seam is reported as 12 to 55 deg. south in the present pit which is on the south flank of an anticline that was probably mined earlier at its crest. Farther south the seam forms a syncline or is cut off by a thrust fault below Paleozoic rocks. Overburden rock is presently hauled by trucks about 2.5 km, after excavation at an average ratio of 16 cubic meters per ton of coal. Landslides are very extensive in the pit, and are said to be a cause of significant drop in production even before the present difficult situation with shortages of spare parts and uncertain payments for the product. The coal is screened near the mine and, at least until recently, was shipped by rail from a station 37 km from the mine.

About 40% of the produced coal is fines (< 13mm), which formerly was sold to plants in Uzbekistan and Kasakstan. Presently the price for graded (13-50 mm) coal is said to be 185 som/ton fob mine, and for >50 mm lump is 225 som/ton. Four years ago production was 400,000 tonnes/year, from more than 500 workers. In 1994 production is expected to be only 80,000 tonnes, with about 400 workers.

Blasted overburden is loaded by 5, 8, and 10 cubic meter electric shovels into two 40-ton trucks. Water is not a problem in this pit. Local managers said that only one more cut is planned, and surface operations will cease, though a report dated as recently as 1993 listed commercial reserves of 19 M.T and expected pit life of 60 years.

The operation has proved 1 million cubic meters of cement grade limestone available for development.

An experimental sublevel caving mine is planned at the 1200 m level with the 15 m deep concrete portal to be installed in the coal face below apparently-stable highwall. Experienced underground miners from Kyzyl-Kiya are due to start this work in November, 1994; eventually, it is expected that many local miners can be trained for underground work. Anticipated production is 110,000 tonnes/year, with a minimum 5 year life.

3. Valakish Area

The Valakish mine (probably at a deposit sometimes named Uch-Korgon) is 27 km by road south of Kyzyl-Kiya. The coal seam is essentially vertical, about 15 meters thick in much of the mine, and thins to 4 meters in the upper portion of the mine. Reserves of 3 million tonnes have been blocked out, though exploration is incomplete, and the initial production target is 110,000 tonnes/year. The mining system is an adaption of sub-level caving. Entries are driven in country rock, including a 400 m slope with belt haulage to the surface. A horizontal entry is driven off the slope bottom with cross cuts driven off at angles to the entry into the thick coal seam, using

yieldable arches and lagging. Overhead drilling locations are supported with hydraulic posts and heavy timber lagging. These holes are drilled fan-wise overhead twenty meters into the coal, and then loaded and lightly blasted to induce caving. The caved coal is loaded out, working under the heavy timber lagging, onto a chain conveyor and thence out to the slope belt.

Level entries are planned at 20 meters intervals. The system is working according to plan, although we had the impression that one diagonal that "should" have been in rock was actually cut in coal and corners were difficult to maintain.

Unfortunately about 50% fines (< 13mm) are produced, and after screening these are presently stockpiled for lack of market. (We estimate about 2,000 tonnes in the pile.) All coarser coal is sold for household heating and hauled away by single or dual-axle trucks. Except for one kilometer of steep road to the mine, the road through the populated areas is level and asphalted. A 30 ton scale was nearly complete at the mine at the time of our visit. The outside beltways, screens and bins are in the shade much of the winter so sometimes the mine is down because of freezing. And currently diesel fuel for the trucks (probably mostly private) is in short supply. This innovative mine (similar in some ways to the operation in Dzhergalan, though much smaller) is said to produce coal at 80 to 90 som/ton, and the near future looks bright. The exact relationship to the Kyzyl-Kiya coal operations is not clear. Valakish seems to be simply an offshoot, but some people spoke of a "more independent operation than in the past". A small open pit on a nearby saddle was operated by miners from Abshir at one time, but we could not determine the potential for renewed operation there.

4. Abshir Area

The Abshir surface coal mine is about 22 km by road east of Kyzyl-Kiya (about 5 km into the hills from the main Osh / Kyzyl-Kiya highway). It was opened in 1967 with a planned 300,000 ton/year production. The coal seam is an overturned fold, steeply dipping to vertical. Presently mined coal is 8-10 meters thick, although a range of 3-30 meters has been reported. The coal is highly broken, producing almost no lump coal (> 13 mm). It is sub-bituminous, with 20-23% moisture (recorded to 30%), about 25% ash, 0.9-1.5% sulfur.

Some clinker from burning exists in outcrop areas, and a small burn was observed in the pit wall. Reserves are limited to 100-300 K.T., and the economics dictate that the pit will be closed soon because the stripping ratio is now about 20 cubic meters / ton. Water is a major problem in the old pit.

A reserve of 1.2 million tonnes of minable coal in a seam about 5 m thick exist beyond the present pit at one end and development is underway with 10 cubic meters / ton ratio. Much of the present production from the developing pit is weathered coal, and it is sold as a humic soil conditioner and as additive to drilling mud. The market for both is in Uzbekistan - with significant potential if monetary exchange could be arranged.

Abshir was started in the 1930s and modernized in 1967 to reach a maximum production of 500,000 tonnes/year. In 1989 there were 480 employees, but now there are 220. Additional layoffs are planned unless there is a turnaround in production and sales. Coal is trucked the 22 km to the

Kyzyl-Kiya cleaning plant. A large deposit of plaster grade gypsum is exposed at the mine and exists for several kilometers at 4:1 stripping ratio. A test shipment of 100 tonnes was made to Uzbekistan, but concrete results are not yet available, and no deal can be made until general agreements for monetary exchange between Uzbekistan and Kyrgyzstan are reached. A mining cost of 60-70 som/ton is estimated. There is a small test facility for gypsum processing at the mine.

c. East Fergana Coal Region

1. Kumbel Area

Kumbel is a complex of open-cut mines located about 65 km northeast of Uzghen. The area is reached by a difficult road that shows evidence of relatively recent damage by stream erosion and mudslides. We were told that the road was closed on March 8, 1994, when a mudslide covered a village along the road and killed about 50 people, some of whom are still entombed. The road was reopened in September. Coal in the Kumbel area is contained in the Lower Jurassic Tuyuk Formation. Mine personnel report a maximum of 53 coal beds, in ascending numerical order, in the sequence, although only 10 are considered to be of economic interest. Beds 9 and 22 are reported to be the thickest. The mine is actually a group of five individual properties: Tashim, Jabad, Malik, Alty Bai, and Nichke. All of these are part of the Small Enterprises Mining Program. Tashin has been operating for three years, and Jabad, Alty Bai, and Nichke started limited operation this year. Malik has yet to be developed.

We visited the Tashim site, where bed 22 is mined. The bed averages about 5.54 m thick and dips about 20 degrees to the east. The overburden is removed by shovel and bulldozer. The coal is mined by a large excavator and trucks, The trucks commonly must be assisted by bulldozer for short distances in and out of the pit. The coal is black coal (bituminous), and is shipped by private truck, presumably as far as Uzghen, for domestic heating. FOB prices are reported to be $9 per tonne with credit, and $7.50 per tonne for cash. Our observations of the site were rendered surrealistic by dense fog (cloud) and we could not observe the relationship of Tashim to the other four actual and prospective mining sites.

Mine personnel report annual production for 1993 of 8,400 tonnes, a significant decline from 1992. No reason was given. Production so far in 1994, basically the month of October, was reported as 2,000 tonnes.

2. Kara-Tyube Area

Kara-Tyube is an undeveloped coal site located about 72 km east- northeast of Uzghen. The last several kilometers of an old road are closed because of rockslides. The coal is contained in the Lower Jurassic Tuyuk Formation and crops out on the steep sides of a valley reminiscent, except for slightly less vegetation, of parts of Appalachia in the eastern United States. The beds dip at an angle of about 20 degrees. Available reports list at least nine beds. In ascending numerical order: 2, 3, 3c, 4, 4-1, 4a, 5, 5a, and 6. Beds 3 and 4 are the most significant with thicknesses of as much as 3.71 and 3.60, respectively. The coal was discovered in 1938, and during the period from 1942 to 1945 at least 16 short tunnels were driven into various beds as a form of exploration. Interest in the area resummed in 1994, but no holes have been drilled. The coal is reported to be black coal

(bituminous) of coking quality. Because of a lack of demand for coking coal, this property is of low priority. However, anthracitic coal that may be desirable for domestic use is reportedly present nearby and presumably is of similar thickness and structural situation. The area containing anthracitic coal has reportedly not been explored as much as the coking coal area.

3. Kok-Yangok Area

The Kok-Yangok area is about 63 km northeast of Osh and 18 km north of the Oblast' center of Dzhalabad. The town Kok-Yangok is shown to have 10-50,000 population in the Kyrgyz atlas, and it is served by a good asphalt road (20 km from Dzhalabad) and by a rail line from Dzhalabad and farther east in the Fergana Valley. The mine was operated on the surface, perhaps as early as 1932, and since 1937 through several entries underground. The present extent is about 9.5 square km, with the 72-South and 72-North entries at the +1600 m level and the Kapital-North and Kapital-South entries at +1370m. These latter include the main haulway now. There is an entry at +1200 used as an airway and manway and for rock removal, and another entry is under construction at +1000 m with an incline up to +1200 m. This will provide gravity-flow water for development below +1200 m. Two mechanized longwall complexes have been operated, and odd-shaped sectors are worked in room and pillar system with a "roadheader-type" continuous miner. This is the only continuous miner observed during our site visits.

The mine works three seams, "5", "6", and "M" (Moshchnyy), but the latter appears to have been worked only slightly. In parts of the workings "5" and "6" are close to each other or combined so they are worked as one seam. The general structure is monoclinal in the mine, with 17-21 degree dip to the west. The coal is "D" (long-flame) rank, with 8-12% moisture, and about 7750 kc/kg (daf) calorific value. Ash is listed at 9-16%, and sulfur as 0.7 -0.9%. Written reports show 31-33% VM, but at the mine we we were told of 45% unusual VM and "extra quality" utility. Recoverable reserves are stated to be 9 million tonnes out of 32 M.T. balance reserves. The expected life is stated as 13 years. A possible eastward extension to the Markay sector would add 9 M.T. balance reserves. The complicated transport net within the mine (which requires much maintenance), the long haul distances, and the rather complex geological structure at a small scale limit productive capacity to 500 K.T./year. The production in 1994 is expected to reach only 70 K.T., however, because of lack of repair parts, structural materials, etc. In a sense, they have lost market also, but that is not clearly a loss of demand, but rather a loss of cash flow within the whole economy. A few years ago 1000 workers were underground, but the present force is 450, with further reductions anticipated. Cash pay apparently stopped last spring. Coal distribution has been by rail directly from the mine, but the present low production appears to be removed by small trucks only.

d. North Fergana Coal Region

1. Tash Kumyr Area

The Tash Kumyr coal enterprise is located about 140 km northwest of Osh just north of the city of Tash Kumyr in and near the valley of the Naryn River. Four individual mining operations are currently active at the enterprise, another is under development, and at least two other mining operations were previously conducted. The coal is contained in a Lower Jurassic unit referred to by mine personnel as "the coal-bearing formation". This unit is present in a series of west-trending

folds that plunge gently toward the west. At least five significant coal beds are reported. In ascending numerical order these are: 0, 3, upper 3, 3g, and 4; evidently other less important beds are also present. The main operation is an underground mine, the Severnay (northern) mine, located at the south end of the property near the mine headquarters. Bed 3, averaging 3 m thick, is currently being mined from a 120m working face by longwall methods. The longwall panel is about 500m long and will be mined out by the end of this year. The coal is removed from the mine by conveyer belt to a cleaning facility where the ash content is reduced from an average of 38% to 32% prior to loading on rail cars for transport to somewhere. Another longwall panel is being mined at another place in the mine from the 0 bed. That panel has water problems and the present panel may be the last coal available in that part of the mine. Bed 3 has recoverable reserves available in two or three more panels. Apparently the mine will be finished at that time, a few years hence.

Just north of Severnay lies the Kara Soo open cut mine. Here the 3 and 3g beds are being mined by truck and shovel with overburden being removed by dragline. Several kilometers north of Severnay and Kara Soo, two additional open cut mines are operating, Kara Tut Central and Kara Tut West. At Kara Tut Central a single coal bed is being mined by truck and shovel; at Kara Tut West a single bed is being mined by truck and shovel with overbuden removed by dragline. This area is also the location of the new Tegenek underground mine, which is presently under construction. Mine personnel report the product to be black coal, which is equivalent to bituminous coal.

All of the equipment in the Severnay underground mine is well worn and extensively repaired. Two generations of longwall equipment are represented and neither is state-of-the-art. The two draglines used for overburden removal in the open-cast mines have ten cubic meter buckets with seventy meter booms. We did not inspect them but one was working, apparently efficiently.

The coal cleaning operations use a pneumatic system in conjunction with screens and, reportedly, some hand-picking, to reduce the amount of ash in the product and separate the portion more than 13mm in size from the remainder. Reportedly, the ash content is reduced from 38 or more percent to about 32 percent.

The small coal analytical facility near the cleaning plant was a pleasant surprise. Clean, neat, but not overburdened. They know nothing of the sample but routinely determine moisture, ash and heat content when requested. The equipment is reasonably new and seems well-cared for.

Most of the coal being mined (85%) is for domestic heating, with the remainder (15%) used for power generation. The 1994 production from all of the mining operations is expected to be 140,000 tonnes, a sharp drop from annual production in the past. A large variety of reasons seem to be responsible for the decline in production, ranging from worn-out equipment, fuel shortages, loss of markets [especially for the fine portion of the production], to lack of payment for coal previously produced, and others.

e. Kavak Coal Region

1. Kara Kiche Area

Kara Kiche is an open-cut mine located northeast of the town of Min Kush, but can only be reached by traveling 29 km south from the small town of Chaek, which is about 150 km southwest of Balykchy, the city at the west end of Issyk Kul. Here, two coal beds are present in the Lower Jurassic Tura Kavak Formation. This unit strikes west and dips about 45 degrees to the south as the northern limb of a west-trending syncline. The upper bed, called the compound bed, ranges from 1 to 10 m thick and is not mined. The lower bed, called the basic bed, is reported to average about 50 m thick. The coal is reported to be brown coal, equivalent to subbituminous coal. Mining is by excavator (backhoe) and truck, with overburden removed by shovel. The coal is reported to be transported by private trucks to Balykchy, Naryn, and to nearby communities. Personnel at the mine cite FOB prices as $4 per tonne for fines (less than 3-5 mm) and $8 to $9 per tonne for lump. There appears to be little demand for the fines. Production from this mine will probably reach only 50,000 tonnes this year, a significant decline from past years. Although small-scale mining apparently began about 1940 and recent exploration activities have ceased, this mine is still officially considered under development.

Two shovels, about 5 cubic meter capacity, were removing overburden. Two 45 cubic meter trucks for hauling overburden were present and two excavators, perhaps only one operable, were also present. About eight meters of coal were exposed in the operating pit and trucks were being loaded with coarse coal by the excavator. Two small pumps were attempting with indifferent success to keep water out of the area where overburden was being removed.

We never received a definitive answer as to why production had decreased. At a later time we were told by other parties that overburden removal was the problem and that perhaps the large trucks for overburden haulage were not operating as needed. We have had no chance to confirm this report. We asked and were told that the sale prices cited for the coal only covered direct mining costs and did not include capital recovery for maintenance and repair of equipment etc.

2. Agulak Area

The Agulak mine is an opencast operation located about 15 km southwest of Min Kush. The coal is in the Lower Jurassic Tura Kavak Formation, which here strikes west and dips about 30 degrees to the north as the southern limb of a west-trending syncline. Eight coal beds, in ascending numerical order, are present in the unit but only two of these have been mined, and only one of these, number 6, is currently being mined. This bed is reported to range from 10 to 40 m thick, and to consist of brown coal (subbituminous). Mining is by truck and shovel, and the coal is reported to be transported by private trucks to Balykchy, Naryn, and to local communities. Personnel at the mine cite FOB prices as about $11 per tonne for fines and about $12 per tonne for lump. 1994 production will probably not exceed 50,000 tonnes, a considerable drop from years past. Mining at this site began about 1959 and exploration has apparently ceased.

The known south limb of the syncline has an east-west extent of about seven kilometers with the present Agulak mine area occupying about 2.4 km at the eastern end. About 3.6 km underlies

villages, farms, etc., and is considered unavailable for mining. An "old" mining area is present at the western end of the known coal area and an unexplored coal area is present north of the old area. There appear to be no plans for exploration because the measured (B1) and indicated (C1) reserves in the Agulak mine area are about 46 million tonnes and the inferred reserves (C2) are about 18 million. The measured and indicated reserves are at depths of less than 240m.

f. Issyk Kul Coal Region

1. Dzhergalan Area

Members of the team visited the black coal (bituminous) coal mine at Dzhergalan in eastern Kyrgyzstan. They were accompanied by Dokturbi Asanbaevech Marshirov of the Department of Fuel Industry, Ministry of Industry and Trade, Kyrgyz Republic. Marshirov is from the region, has worked in this mine and has many relatives in the area.

The mine is producing 100,000 tonnes per year from Jurassic strata overlain by Paleogene and underlain by Carboniferous. The coal is very steeply dipping, sometimes vertical, but generally is overturned and dips 65-75 degrees to the south. The strike is N 65 E. There are either three beds, two beds, or one bed and they speak of them splitting and coming together. In the area sampled, they are mining two beds, the number 5 and number 4. Number 5 is 7.4 meters thick and number 4 is 3 meters thick, with a 15m interval between them. However, at the next level lower in the mine, from which the stoped coal is now hauled, the two beds appear to have merged into one. We were able to obtain reasonably representative samples by hand picking horizontally across the beds. The sample of number 5 is essentially complete and that of number 4 is missing only the stratigraphically uppermost 20-30cm. Note: the miners refer to the geometrically upper surface as the roof of the bed, although it is actually the base of the coal bed as it was deposited. We sampled at the 2240m level, and they now consider the 2200m level as the deepest that they can go without encountering problems supporting the coal. The overburden increases rapidly at the lower levels because the coal dips beneath the mountain to the south. They now do the stoping under unsupported coal.

The coal is mined by drilling and shooting the coal in stopes, with each stope level being approximately 18-20 meters apart (vertically). The coal is gravity or hand loaded onto conveyors imbedded in the floor, dropped into chutes and then into mine cars, and hauled out of the mine on the cars. There is currently only one haulage entry. The coal is prepared by hand picking and is then screened by size. Two women do the picking and maintain the cleaning/sorting equipment on each shift. Coal is mined on four shifts of 6 hours each. The 100,000 tonnes are produced by a total work force of approximately 470 people.

The team members had the opportunity of spending quite a bit of time talking to the Mine "Director", Akachaev. He is worried that the mine may not stay in operation and that the community of 2000 plus could lose their only source of support. He said that, with input of some capital, the mine could produce 300,000 tonnes per year of high quality coal, and that the coal was desired by the users. There is a problem in that those who want the coal do not always have means of paying for it. He is currently in a bartering mode with some, or much, of the output, including, apparently, delivery to the city heating plant in Kara-Kol inexchange for electricity (which is distributed by the heating plant, though not produced there). The miners have not been paid for the

past few months (we do not know precisely for how long) although there has been a distribution of flour and sugar.

The price that the coal sells for is apparently about $20 per ton and that includes an 18% markup over production costs. That is not enough to cover the depreciation or to allow for replacement of cable, etc. Because the miners pay is in arrears, it is assumed that the mine does not receive cash payment for all of the coal. The coal observed underground and on stockpiles at the surface appears to be of good quality with relatively little noncombustible material. We anticipate that it will be of much lower ash content than the coal currently being delivered to the heat and power plant at Bishkek.

2. Soguty Area

The coal mine at Soguty (also identified as Kadzhy Sai) was visited briefly following the visit to Dzhergalan. The mine, which was reportedly closed, is apparently still producing small amounts of coal for local consumption. In the past, the coal was shipped by truck to the Kara Kol heating station but this is apparently not so anymore.

APPENDIX IV. ANALYTICAL INFORMATION

Appendix IVa. Standard coal analyses

GEOCHEMICAL TESTING
a division of Energy Center, Inc.

RD2, Box 124
Somerset, PA 15501

814/443-1671
814/445-6666
FAX: 814/445-6729

COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-1 Abshir-1

LAB NO. 94-043141

	As Received	Dry	Dry Ash-Free
PROXIMATE ANALYSIS D3172			
Moisture	28.92		
Ash	4.69	6.60	
Volatile Matter	31.58	44.42	47.56
Fixed Carbon	34.81	48.98	52.44
	100.00	100.00	100.00
ULTIMATE ANALYSIS D3176			
Hydrogen	6.71	4.88	5.23
Carbon	50.73	71.38	76.42
Nitrogen	0.92	1.29	1.39
Sulfur	2.53	3.56	3.81
Oxygen	34.42	12.29	13.15
Ash	4.69	6.60	
	100.00	100.00	100.00
Heating Value(BTU/Lb) D1989	8927	12560	13447
FORMS OF SULFUR D2492			
Sulfate Sulfur	0.07	0.10	0.11
Pyritic Sulfur	0.95	1.34	1.43
Organic Sulfur	1.51	2.12	2.27

Free Swelling Index D720 0.0

Equilibrium Moisture D1412 27.47

Hardgrove Grind.Index D409 63

Forrest E. Walker
Director of Technical Services

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-1 Abshir-1

LAB NO. 94-043141

Ash Fusion (Reducing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2250	2280	2290	2300

Ash Fusion (Oxidizing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2360	2390	2450	2590

Apparent Specific Gravity = 1.29

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Director of Technical Services

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-2 AgUlaK 1A + 1B

LAB NO. 94-043142

	As Received	Dry	Dry Ash-Free
PROXIMATE ANALYSIS D3172			
Moisture	23.68		
Ash	11.18	14.64	
Volatile Matter	24.28	31.81	37.27
Fixed Carbon	40.86	53.55	62.73
	100.00	100.00	100.00
ULTIMATE ANALYSIS D3176			
Hydrogen	5.66	3.95	4.62
Carbon	52.22	68.42	80.16
Nitrogen	0.66	0.87	1.02
Sulfur	0.94	1.23	1.44
Oxygen	29.34	10.89	12.76
Ash	11.18	14.64	
	100.00	100.00	100.00
Heating Value(BTU/Lb) D1989	8812	11546	13527
FORMS OF SULFUR D2492			
Sulfate Sulfur	0.03	0.04	0.05
Pyritic Sulfur	0.42	0.55	0.65
Organic Sulfur	0.49	0.64	0.74

Free Swelling Index D720 0.0

Equilibrium Moisture D1412 17.64

Hardgrove Grind.Index D409 78

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-2 AgUlaK 1A + 1B

LAB NO. 94-043142

Ash Fusion (Reducing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2240	2310	2340	2390

Ash Fusion (Oxidizing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2340	2390	2430	2480

Apparent Specific Gravity = 1.31

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-3 Almalyk

LAB NO. 94-043143

	As Received	Dry	Dry Ash-Free
PROXIMATE ANALYSIS D3172			
Moisture	22.83		
Ash	27.17	35.21	
Volatile Matter	25.50	33.05	51.00
Fixed Carbon	24.50	31.74	49.00
	100.00	100.00	100.00
ULTIMATE ANALYSIS D3176			
Hydrogen	5.22	3.45	5.32
Carbon	35.54	46.06	71.09
Nitrogen	0.39	0.50	0.78
Sulfur	2.30	2.98	4.61
Oxygen	29.38	11.80	18.20
Ash	27.17	35.21	
	100.00	100.00	100.00
Heating Value(BTU/Lb) D1989	6154	7975	12308
FORMS OF SULFUR D2492			
Sulfate Sulfur	0.07	0.10	0.15
Pyritic Sulfur	1.15	1.49	2.30
Organic Sulfur	1.08	1.39	2.16

Free Swelling Index D720 0.0

Equilibrium Moisture D1412 22.54

Hardgrove Grind.Index D409 61

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-3 Almalyk

LAB NO. 94-043143

Ash Fusion (Reducing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2450	2580	2620	2700

Ash Fusion (Oxidizing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2600	2640	2690	2740

Apparent Specific Gravity = 1.52

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-4 Dzhergalan-1

LAB NO. 94-043144

	As Received	Dry	Dry Ash-Free
PROXIMATE ANALYSIS D3172			
Moisture	8.33		
Ash	6.61	7.21	
Volatile Matter	35.27	38.47	41.46
Fixed Carbon	49.79	54.32	58.54
	100.00	100.00	100.00
ULTIMATE ANALYSIS D3176			
Hydrogen	5.06	4.51	4.86
Carbon	68.62	74.85	80.67
Nitrogen	0.86	0.94	1.01
Sulfur	0.76	0.83	0.90
Oxygen	18.09	11.66	12.56
Ash	6.61	7.21	
	100.00	100.00	100.00
Heating Value(BTU/Lb) D1989	11759	12828	13824
FORMS OF SULFUR D2492			
Sulfate Sulfur	0.02	0.02	0.02
Pyritic Sulfur	0.53	0.58	0.62
Organic Sulfur	0.21	0.23	0.26

Free Swelling Index D720 0.5

Equilibrium Moisture D1412 7.81

Hardgrove Grind.Index D409 48

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Director of Technical Services

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-4 Dzhergalan-1

LAB NO. 94-043144

Ash Fusion (Reducing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2200	2290	2300	2320

Ash Fusion (Oxidizing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2210	2300	2320	2410

Appparent Specific Gravity = 1.35

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-5 Dzhergalan-2

LAB NO. 94-043145

	As Received	Dry	Dry Ash-Free
PROXIMATE ANALYSIS D3172			
Moisture	9.02		
Ash	8.92	9.80	
Volatile Matter	29.58	32.51	36.04
Fixed Carbon	52.48	57.69	63.96
	100.00	100.00	100.00
ULTIMATE ANALYSIS D3176			
Hydrogen	4.66	4.02	4.45
Carbon	66.78	73.40	81.37
Nitrogen	0.83	0.92	1.02
Sulfur	0.33	0.37	0.41
Oxygen	18.48	11.49	12.75
Ash	8.92	9.80	
	100.00	100.00	100.00
Heating Value(BTU/Lb) D1989	11353	12478	13834
FORMS OF SULFUR D2492			
Sulfate Sulfur	0.10	0.11	0.12
Pyritic Sulfur	0.10	0.11	0.12
Organic Sulfur	0.13	0.15	0.17

Free Swelling Index D720 0.0

Equilibrium Moisture D1412 7.89

Hardgrove Grind.Index D409 51

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-5 Dzhergalan-2

LAB NO. 94-043145

Ash Fusion (Reducing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2330	2380	2400	2530

Ash Fusion (Oxidizing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2370	2410	2490	2560

Apparent Specific Gravity = 1.41

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-6 Kara-Dobo

LAB NO. 94-043146

	As Received	Dry	Dry Ash-Free
PROXIMATE ANALYSIS D3172			
Moisture	11.19		
Ash	19.56	22.03	
Volatile Matter	13.74	15.47	19.84
Fixed Carbon	55.51	62.50	80.16
	100.00	100.00	100.00
ULTIMATE ANALYSIS D3176			
Hydrogen	3.54	2.57	3.30
Carbon	60.05	67.61	86.71
Nitrogen	0.65	0.73	0.94
Sulfur	0.32	0.36	0.46
Oxygen	15.88	6.70	8.59
Ash	19.56	22.03	
	100.00	100.00	100.00
Heating Value(BTU/Lb) D1989	9799	11034	14151
FORMS OF SULFUR D2492			
Sulfate Sulfur	0.02	0.02	0.03
Pyritic Sulfur	0.03	0.03	0.04
Organic Sulfur	0.27	0.31	0.39

Free Swelling Index D720 0.0

Equilibrium Moisture D1412 4.85

Hardgrove Grind.Index D409 93

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-6 Kara-Dobo

LAB NO. 94-043146

Ash Fusion (Reducing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2480	2600	2650	2770

Ash Fusion (Oxidizing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2500	2670	2720	2780

Apparent Specific Gravity = 1.53

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-7 Kara-Keche-1

LAB NO. 94-043147

	As Received	Dry	Dry Ash-Free
PROXIMATE ANALYSIS D3172			
Moisture	22.45		
Ash	6.83	8.81	
Volatile Matter	25.71	33.15	36.36
Fixed Carbon	45.01	58.04	63.64
	100.00	100.00	100.00
ULTIMATE ANALYSIS D3176			
Hydrogen	5.10	3.33	3.65
Carbon	55.89	72.07	79.03
Nitrogen	0.59	0.76	0.84
Sulfur	0.43	0.55	0.60
Oxygen	31.16	14.48	15.88
Ash	6.83	8.81	
	100.00	100.00	100.00
Heating Value(BTU/Lb) D1989	8991	11594	12714
FORMS OF SULFUR D2492			
Sulfate Sulfur	0.03	0.04	0.05
Pyritic Sulfur	0.15	0.19	0.21
Organic Sulfur	0.25	0.32	0.34

Free Swelling Index D720 0.0

Equilibrium Moisture D1412 18.47

Hardgrove Grind.Index D409 71

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-7 Kara-Kache-1

LAB NO. 94-043147

Ash Fusion (Reducing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2410	2450	2470	2480

Ash Fusion (Oxidizing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2430	2460	2480	2510

Apparent Specific Gravity = 1.30

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-8 Kara-Tut-2

LAB NO. 94-043148

	As Received	Dry	Dry Ash-Free
PROXIMATE ANALYSIS D3172			
Moisture	23.07		
Ash	14.17	18.42	
Volatile Matter	29.27	38.05	46.64
Fixed Carbon	33.49	43.53	53.36
	100.00	100.00	100.00
ULTIMATE ANALYSIS D3176			
Hydrogen	5.67	4.01	4.91
Carbon	47.81	62.15	76.18
Nitrogen	0.72	0.94	1.15
Sulfur	2.22	2.88	3.53
Oxygen	29.41	11.60	14.23
Ash	14.17	18.42	
	100.00	100.00	100.00
Heating Value(BTU/Lb) D1989	8420	10945	13417
FORMS OF SULFUR D2492			
Sulfate Sulfur	0.05	0.06	0.08
Pyritic Sulfur	1.41	1.84	2.25
Organic Sulfur	0.76	0.98	1.20

Free Swelling Index D720 0.0

Equilibrium Moisture D1412 19.56

Hardgrove Grind.Index D409 73

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-8 Kara-Tut-2

LAB NO. 94-043148

Ash Fusion (Reducing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2010	2060	2080	2210

Ash Fusion (Oxidizing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2310	2380	2450	2530

Apparent Specific Gravity = 1.35

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-9 Kara-Tut-1

LAB NO. 94-043149

	As Received	Dry	Dry Ash-Free
PROXIMATE ANALYSIS D3172			
Moisture	20.96		
Ash	13.34	16.88	
Volatile Matter	29.83	37.74	45.40
Fixed Carbon	35.87	45.38	54.60
	100.00	100.00	100.00
ULTIMATE ANALYSIS D3176			
Hydrogen	5.64	4.16	5.01
Carbon	50.33	63.68	76.61
Nitrogen	0.79	1.00	1.20
Sulfur	1.16	1.47	1.77
Oxygen	28.74	12.81	15.41
Ash	13.34	16.88	
	100.00	100.00	100.00
Heating Value(BTU/Lb) D1989	8747	11067	13313
FORMS OF SULFUR D2492			
Sulfate Sulfur	0.07	0.09	0.11
Pyritic Sulfur	0.43	0.55	0.66
Organic Sulfur	0.66	0.83	1.00

Free Swelling Index D720 0.0

Equilibrium Moisture D1412 20.14

Hardgrove Grind.Index D409 62

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-9 Kara-Tut-1

LAB NO. 94-043149

Ash Fusion (Reducing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2150	2190	2220	2600

Ash Fusion (Oxidizing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2310	2390	2460	2630

Apparent Specific Gravity = 1.37

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: Bostick

Sampling Date: 12/27/94 TO 12/27/94

Analyzed on: 12/31/94

Description: K-10 KOK-Yangok

LAB NO. 94-043723

	As Received	Dry	Dry Ash-Free
PROXIMATE ANALYSIS D3172			
Moisture	9.27		
Ash	11.64	12.83	
Volatile Matter	25.87	28.51	32.71
Fixed Carbon	53.22	58.66	67.29
	100.00	100.00	100.00
ULTIMATE ANALYSIS D3176			
Hydrogen	4.09	3.37	3.86
Carbon	66.07	72.82	83.54
Nitrogen	0.66	0.73	0.83
Sulfur	0.67	0.74	0.85
Oxygen	16.87	9.51	10.92
Ash	11.64	12.83	
	100.00	100.00	100.00
Heating Value(BTU/Lb) D1989	10966	12087	13866
FORMS OF SULFUR D2492			
Sulfate Sulfur	0.05	0.06	0.07
Pyritic Sulfur	0.45	0.49	0.57
Organic Sulfur	0.17	0.19	0.21

Free Swelling Index D720 0.0

Equilibrium Moisture D1412 7.37

Hardgrove Grind.Index D409 68

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: Bostick

Sampling Date: 12/27/94 TO 12/27/94

Analyzed on: 12/31/94

Description: K-10 KOK-Yangok

LAB NO. 94-043723

Ash Fusion (Reducing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2080	2130	2180	2220

Ash Fusion (Oxidizing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2380	2410	2460	2490

Apparent Specific Gravity = 1.34

REVISED REPORT - (01/11/95) - Description Corrected per Client Request.

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: Bostick

Sampling Date: 12/27/94 TO 12/27/94

Analyzed on: 12/31/94

Description: K-11 Kum-Bel

LAB NO. 94-043722

	As Received	Dry	Dry Ash-Free
PROXIMATE ANALYSIS D3172			
Moisture	5.13		
Ash	8.31	8.76	
Volatile Matter	37.13	39.14	42.89
Fixed Carbon	49.43	52.10	57.11
	100.00	100.00	100.00
ULTIMATE ANALYSIS D3176			
Hydrogen	5.12	4.80	5.26
Carbon	71.42	75.28	82.51
Nitrogen	1.02	1.07	1.17
Sulfur	0.80	0.84	0.92
Oxygen	13.33	9.25	10.14
Ash	8.31	8.76	
	100.00	100.00	100.00
Heating Value(BTU/Lb) D1989	12482	13157	14420
FORMS OF SULFUR D2492			
Sulfate Sulfur	0.05	0.05	0.06
Pyritic Sulfur	0.08	0.08	0.09
Organic Sulfur	0.67	0.71	0.77

Free Swelling Index D720 4.0

Equilibrium Moisture D1412 4.60

Hardgrove Grind.Index D409 47

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: Bostick

Sampling Date: 12/27/94 TO 12/27/94

Analyzed on: 12/31/94

Description: K-11 Kum-Bel

LAB NO. 94-043722

Ash Fusion (Reducing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2800 +	2800 +	2800 +	2800 +

Ash Fusion (Oxidizing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2800 +	2800 +	2800 +	2800 +

Apparent Specific Gravity = 1.31

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-13 Sary-Mongol

LAB NO. 94-043150

	As Received	Dry	Dry Ash-Free
PROXIMATE ANALYSIS D3172			
Moisture	16.76		
Ash	3.18	3.82	
Volatile Matter	31.26	37.55	39.04
Fixed Carbon	48.80	58.63	60.96
	100.00	100.00	100.00
ULTIMATE ANALYSIS D3176			
Hydrogen	5.52	4.38	4.56
Carbon	64.31	77.26	80.33
Nitrogen	0.59	0.71	0.74
Sulfur	0.37	0.44	0.46
Oxygen	26.03	13.39	13.91
Ash	3.18	3.82	
	100.00	100.00	100.00
Heating Value(BTU/Lb) D1989	10914	13111	13632
FORMS OF SULFUR D2492			
Sulfate Sulfur	0.04	0.05	0.05
Pyritic Sulfur	0.15	0.17	0.18
Organic Sulfur	0.18	0.22	0.23

Free Swelling Index D720 0.5

Equilibrium Moisture D1412 12.81

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-13 Sary-Mongol

LAB NO. 94-043150

Ash Fusion (Reducing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2510	2590	2600	2630

Ash Fusion (Oxidizing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2610	2670	2690	2720

Apparent Specific Gravity = 1.29

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-14 Tash-Kumyr-1

LAB NO. 94-043151

	As Received	Dry	Dry Ash-Free
PROXIMATE ANALYSIS D3172			
Moisture	16.69		
Ash	6.81	8.18	
Volatile Matter	31.88	38.26	41.67
Fixed Carbon	44.62	53.56	58.33
	100.00	100.00	100.00
ULTIMATE ANALYSIS D3176			
Hydrogen	5.76	4.67	5.09
Carbon	60.52	72.65	79.11
Nitrogen	0.87	1.05	1.14
Sulfur	0.85	1.02	1.12
Oxygen	25.19	12.43	13.54
Ash	6.81	8.18	
	100.00	100.00	100.00
Heating Value(BTU/Lb) D1989	10340	12411	13516
FORMS OF SULFUR D2492			
Sulfate Sulfur	0.02	0.02	0.02
Pyritic Sulfur	0.45	0.54	0.59
Organic Sulfur	0.38	0.46	0.51

Free Swelling Index D720 0.0

Equilibrium Moisture D1412 16.09

Hardgrove Grind.Index D409 69

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: N.H Bostick

Sampling Date: 12/08/94 TO 12/08/94

Analyzed on: 12/10/94

Description: K-14 Tash-Kumyr-1

LAB NO. 94-043151

Ash Fusion (Reducing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2000	2050	2070	2190

Ash Fusion (Oxidizing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2260	2290	2320	2360

Apparent Specific Gravity = 1.37

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: Bostick

Sampling Date: 12/27/94 TO 12/27/94

Analyzed on: 12/31/94

Description: K-15 Tash-Kumis-2

LAB NO: 94-043724

	As Received	Dry	Dry Ash-Free
PROXIMATE ANALYSIS D3172			
Moisture	14.46		
Ash	13.13	15.36	
Volatile Matter	31.52	36.85	43.54
Fixed Carbon	40.89	47.79	56.46
	100.00	100.00	100.00
ULTIMATE ANALYSIS D3176			
Hydrogen	5.30	4.31	5.09
Carbon	56.19	65.68	77.60
Nitrogen	0.90	1.05	1.24
Sulfur	1.51	1.77	2.09
Oxygen	22.97	11.83	13.98
Ash	13.13	15.36	
	100.00	100.00	100.00
Heating Value(BTU/Lb) D1989	9779	11432	13506
FORMS OF SULFUR D2492			
Sulfate Sulfur	0.03	0.03	0.04
Pyritic Sulfur	0.96	1.12	1.32
Organic Sulfur	0.52	0.62	0.73

Free Swelling Index D720 0.0

Equilibrium Moisture D1412 14.75

Hardgrove Grind.Index D409 61

Forrest E. Walker
Director of Technical Services

GEOCHEMICAL TESTING
a division of Energy Center, Inc.

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: Bostick

Sampling Date: 12/27/94 TO 12/27/94

Analyzed on: 12/31/94

Description: K-15 Tash-Kumis-2

LAB NO. 94-043724

Ash Fusion (Reducing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2110	2150	2180	2210

Ash Fusion (Oxidizing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2340	2440	2490	2550

Apparent Specific Gravity = 1.40

Forrest E. Walker
Director of Technical Services

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: Bostick

Sampling Date: 12/27/94 TO 12/27/94

Analyzed on: 12/31/94

Description: K-16 Valakish

LAB NO. 94-043725

	As Received	Dry	Dry Ash-Free
PROXIMATE ANALYSIS D3172			
Moisture	22.54		
Ash	8.88	11.47	
Volatile Matter	29.69	38.34	43.30
Fixed Carbon	38.89	50.19	56.70
	100.00	100.00	100.00
ULTIMATE ANALYSIS D3176			
Hydrogen	6.07	4.58	5.17
Carbon	52.92	68.32	77.17
Nitrogen	0.47	0.61	0.69
Sulfur	0.77	0.99	1.12
Oxygen	30.89	14.03	15.85
Ash	8.88	11.47	
	100.00	100.00	100.00
Heating Value(BTU/Lb) D1989	9025	11652	13161
FORMS OF SULFUR D2492			
Sulfate Sulfur	0.03	0.03	0.04
Pyritic Sulfur	0.41	0.53	0.60
Organic Sulfur	0.33	0.43	0.48

Free Swelling Index D720 0.0

Equilibrium Moisture D1412 20.24

Hardgrove Grind.Index D409 73

Forrest E. Walker
Director of Technical Services

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COAL ANALYSIS REPORT

Client: U.S. GEOLOGICAL SURVEY

Sampled by: Bostick

Sampling Date: 12/27/94 TO 12/27/94

Analyzed on: 12/31/94

Description: K-16 Valakish

LAB NO. 94-043725

Ash Fusion (Reducing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2120	2160	2200	2220

Ash Fusion (Oxidizing Atmosphere)

	Initial D.	Softening T.	Hemi T.	Fluid T.
Temp o F	2180	2210	2250	2310

Apparent Specific Gravity = 1.33

Forrest E. Walker
Director of Technical Services

Appendix IVb. Standard coal analyses -- equilibrium moisture basis

COAL ANALYSIS
USING EQUILIBRIUM MOISTURE

SAMPLE NUMBER	STATE	COAL BED NAME	FIELD NUMBER
94-043141	Kyrgyzstan		K-1

****

PROXIMATE ANALYSIS

	AS-RECEIVED BASIS	AS-RECEIVED TO EQUILIBRIUM MOISTURE	DRY BASIS	DRY ASH-FREE
% MOISTURE.....	28.92	27.47	0.00	0.00
% ASH.....	4.69	4.79	6.60	0.00
% VOLATILE.....	31.58	32.22	44.43	47.57
% FIXED CARBON...	34.81	35.52	48.97	52.43
TOTAL.....	100.00	100.00	100.00	100.00

ULTIMATE ANALYSIS

% HYDROGEN.....	6.71	6.62	4.89	5.23
% CARBON.....	50.73	51.76	71.37	76.41
% NITROGEN.....	0.92	0.94	1.29	1.39
% SULFUR.....	2.53	2.58	3.56	3.81
% OXYGEN.....	34.42	33.31	12.29	13.16
% ASH.....	4.69	4.79	6.60	0.00
TOTAL.....	100.00	100.00	100.00	100.00

FORMS OF SULFUR

% SULFATE S.....	0.07	0.07	0.10	0.11
% PRYTIC S.....	0.96	0.98	1.35	1.45
% ORGANIC S.....	1.51	1.54	2.12	2.27
HEAT VALUE(BTU/LB)	8930	9110	12560	13450

MOIST-MINERAL-MATTER-FREE BTU/LB USING PARR FORMULA IS 9610

MOIST-MINERAL-MATTER-FREE BTU/LB USING APPROXIMATE FORMULA IS 9640

RANK BY APPROXIMATION FORMULA IS SUBBITUMINOUS B COAL

RANK BY PARR FORMULA IS SUBBITUMINOUS B COAL

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COAL ANALYSIS
USING EQUILIBRIUM MOISTURE

SAMPLE NUMBER	STATE	COAL BED NAME	FIELD NUMBER
94-043142	Kyrgyzstan		K-2

****

PROXIMATE ANALYSIS

	AS-RECEIVED BASIS	AS-RECEIVED TO EQUILIBRIUM MOISTURE	DRY BASIS	DRY ASH-FREE
% MOISTURE.....	23.68	17.64	0.00	0.00
% ASH.....	11.18	12.06	14.65	0.00
% VOLATILE.....	24.28	26.20	31.81	37.27
% FIXED CARBON...	40.86	44.09	53.54	62.73
TOTAL.....	100.00	100.00	100.00	100.00

ULTIMATE ANALYSIS

% HYDROGEN.....	5.66	5.22	3.94	4.62
% CARBON.....	52.22	56.35	68.42	80.17
% NITROGEN.....	0.66	0.71	0.86	1.01
% SULFUR.....	0.94	1.01	1.23	1.44
% OXYGEN.....	29.34	24.63	10.89	12.76
% ASH.....	11.18	12.06	14.65	0.00
TOTAL.....	100.00	100.00	100.00	100.00

FORMS OF SULFUR

% SULFATE S.....	0.03	0.03	0.04	0.05
% PRYTIC S.....	0.42	0.45	0.55	0.64
% ORGANIC S.....	0.49	0.53	0.64	0.75
HEAT VALUE(BTU/LB)	8810	9510	11550	13530

MOIST-MINERAL-MATTER-FREE BTU/LB USING PARR FORMULA IS 10950

MOIST-MINERAL-MATTER-FREE BTU/LB USING APPROXIMATE FORMULA IS 10980

RANK BY APPROXIMATION FORMULA IS SUBBITUMINOUS A COAL

RANK BY PARR FORMULA IS SUBBITUMINOUS A COAL

COAL ANALYSIS
USING EQUILIBRIUM MOISTURE

SAMPLE NUMBER	STATE	COAL BED NAME	FIELD NUMBER
94-043143	Kyrgyzstan		K-3

****

PROXIMATE ANALYSIS

	AS-RECEIVED BASIS	AS-RECEIVED TO EQUILIBRIUM MOISTURE	DRY BASIS	DRY ASH-FREE
% MOISTURE.....	22.83	22.54	0.00	0.00
% ASH.....	27.17	27.27	35.21	0.00
% VOLATILE.....	25.50	25.60	33.04	51.00
% FIXED CARBON...	24.50	24.59	31.75	49.00
TOTAL.....	100.00	100.00	100.00	100.00

ULTIMATE ANALYSIS

% HYDROGEN.....	5.22	5.20	3.45	5.33
% CARBON.....	35.54	35.67	46.05	71.08
% NITROGEN.....	0.39	0.39	0.51	0.78
% SULFUR.....	2.30	2.31	2.98	4.60
% OXYGEN.....	29.38	29.16	11.80	18.21
% ASH.....	27.17	27.27	35.21	0.00
TOTAL.....	100.00	100.00	100.00	100.00

FORMS OF SULFUR

% SULFATE S.....	0.07	0.07	0.09	0.14
% PRYTIC S.....	1.15	1.15	1.49	2.30
% ORGANIC S.....	1.08	1.08	1.40	2.16
HEAT VALUE(BTU/LB)	6150	6180	7970	12310

MOIST-MINERAL-MATTER-FREE BTU/LB USING PARR FORMULA IS 8750

MOIST-MINERAL-MATTER-FREE BTU/LB USING APPROXIMATE FORMULA IS 8850

RANK BY APPROXIMATION FORMULA IS SUBBITUMINOUS C COAL

RANK BY PARR FORMULA IS SUBBITUMINOUS C COAL

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COAL ANALYSIS
USING EQUILIBRIUM MOISTURE

SAMPLE NUMBER	STATE	COAL BED NAME	FIELD NUMBER
94-043144	Kyrgyzstan		K-4

****

PROXIMATE ANALYSIS

	AS-RECEIVED BASIS	AS-RECEIVED TO EQUILIBRIUM MOISTURE	DRY BASIS	DRY ASH-FREE
% MOISTURE.....	8.33	7.81	0.00	0.00
% ASH.....	6.61	6.65	7.21	0.00
% VOLATILE.....	35.27	35.47	38.47	41.46
% FIXED CARBON...	49.79	50.07	54.31	58.54
TOTAL.....	100.00	100.00	100.00	100.00

ULTIMATE ANALYSIS

% HYDROGEN.....	5.06	5.03	4.50	4.85
% CARBON.....	68.62	69.01	74.86	80.67
% NITROGEN.....	0.86	0.86	0.94	1.01
% SULFUR.....	0.76	0.76	0.83	0.89
% OXYGEN.....	18.09	17.69	11.66	12.57
% ASH.....	6.61	6.65	7.21	0.00
TOTAL.....	100.00	100.00	100.00	100.00

FORMS OF SULFUR

% SULFATE S.....	0.02	0.02	0.02	0.02
% PRYTIC S.....	0.53	0.53	0.58	0.62
% ORGANIC S.....	0.21	0.21	0.23	0.25
HEAT VALUE(BTU/LB)	11760	11830	12830	13820

MOIST-MINERAL-MATTER-FREE BTU/LB USING PARR FORMULA IS 12760

MOIST-MINERAL-MATTER-FREE BTU/LB USING APPROXIMATE FORMULA IS 12770

RANK BY APPROXIMATION FORMULA IS HIGH VOLATILE C BITUMINOUS COAL

RANK BY PARR FORMULA IS HIGH VOLATILE C BITUMINOUS COAL

COAL ANALYSIS
USING EQUILIBRIUM MOISTURE

SAMPLE NUMBER	STATE	COAL BED NAME	FIELD NUMBER
94-043145	Kyrgyzstan		K-5

****

PROXIMATE ANALYSIS

	AS-RECEIVED BASIS	AS-RECEIVED TO EQUILIBRIUM MOISTURE	DRY BASIS	DRY ASH-FREE
% MOISTURE.....	9.02	7.89	0.00	0.00
% ASH.....	8.92	9.03	9.80	0.00
% VOLATILE.....	29.58	29.95	32.51	36.05
% FIXED CARBON...	52.48	53.13	57.68	63.95
TOTAL.....	100.00	100.00	100.00	100.00

ULTIMATE ANALYSIS

% HYDROGEN.....	4.66	4.58	4.01	4.45
% CARBON.....	66.78	67.61	73.40	81.38
% NITROGEN.....	0.83	0.84	0.91	1.01
% SULFUR.....	0.33	0.33	0.36	0.40
% OXYGEN.....	18.48	17.61	11.51	12.76
% ASH.....	8.92	9.03	9.80	0.00
TOTAL.....	100.00	100.00	100.00	100.00

FORMS OF SULFUR

% SULFATE S.....	0.10	0.10	0.11	0.12
% PRYTIC S.....	0.10	0.10	0.11	0.12
% ORGANIC S.....	0.13	0.13	0.14	0.16
HEAT VALUE(BTU/LB)	11350	11490	12480	13830

MOIST-MINERAL-MATTER-FREE BTU/LB USING PARR FORMULA IS 12740

MOIST-MINERAL-MATTER-FREE BTU/LB USING APPROXIMATE FORMULA IS 12770

RANK BY APPROXIMATION FORMULA IS HIGH VOLATILE C BITUMINOUS COAL

RANK BY PARR FORMULA IS HIGH VOLATILE C BITUMINOUS COAL

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COAL ANALYSIS
USING EQUILIBRIUM MOISTURE

SAMPLE NUMBER	STATE	COAL BED NAME	FIELD NUMBER
94-043146	Kyrgyzstan		K-6

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PROXIMATE ANALYSIS

	AS-RECEIVED BASIS	AS-RECEIVED TO EQUILIBRIUM MOISTURE	DRY BASIS	DRY ASH-FREE
% MOISTURE	11.19	4.85	0.00	0.00
% ASH	19.56	20.96	22.02	0.00
% VOLATILE	13.74	14.72	15.47	19.84
% FIXED CARBON	55.51	59.47	62.50	80.16
TOTAL	100.00	100.00	100.00	100.00

ULTIMATE ANALYSIS

% HYDROGEN	3.54	2.99	2.58	3.30
% CARBON	60.05	64.34	67.62	86.71
% NITROGEN	0.65	0.70	0.73	0.94
% SULFUR	0.32	0.34	0.36	0.46
% OXYGEN	15.88	10.67	6.69	8.58
% ASH	19.56	20.96	22.02	0.00
TOTAL	100.00	100.00	100.00	100.00

FORMS OF SULFUR

% SULFATE S	0.02	0.02	0.02	0.03
% PRYTIC S	0.03	0.03	0.03	0.04
% ORGANIC S	0.27	0.29	0.30	0.39
HEAT VALUE(BTU/LB)	9800	10500	11030	14150

MOIST-MINERAL-MATTER-FREE BTU/LB USING PARR FORMULA IS 13580

MOIST-MINERAL-MATTER-FREE BTU/LB USING APPROXIMATE FORMULA IS 13650

RANK BY APPROXIMATION FORMULA IS LOW VOLATILE BITUMINOUS COAL

RANK BY PARR FORMULA IS LOW VOLATILE BITUMINOUS COAL

COAL ANALYSIS
USING EQUILIBRIUM MOISTURE

SAMPLE NUMBER	STATE	COAL BED NAME	FIELD NUMBER
94-043147	Kyrgyzstan		K-7

****

PROXIMATE ANALYSIS

	AS-RECEIVED BASIS	AS-RECEIVED TO EQUILIBRIUM MOISTURE	DRY BASIS	DRY ASH-FREE
% MOISTURE.....	22.45	18.47	0.00	0.00
% ASH.....	6.83	7.18	8.81	0.00
% VOLATILE.....	25.71	27.03	33.15	36.35
% FIXED CARBON...	45.01	47.32	58.04	63.65
TOTAL.....	100.00	100.00	100.00	100.00

ULTIMATE ANALYSIS

% HYDROGEN.....	5.10	4.79	3.34	3.66
% CARBON.....	55.89	58.76	72.07	79.03
% NITROGEN.....	0.59	0.62	0.76	0.83
% SULFUR.....	0.43	0.45	0.55	0.61
% OXYGEN.....	31.16	28.20	14.47	15.87
% ASH.....	6.83	7.18	8.81	0.00
TOTAL.....	100.00	100.00	100.00	100.00

FORMS OF SULFUR

% SULFATE S.....	0.03	0.03	0.04	0.04
% PRYTIC S.....	0.15	0.16	0.19	0.21
% ORGANIC S.....	0.25	0.26	0.32	0.35
HEAT VALUE(BTU/LB)	8990	9450	11590	12710

MOIST-MINERAL-MATTER-FREE BTU/LB USING PARR FORMULA IS`10250

MOIST-MINERAL-MATTER-FREE BTU/LB USING APPROXIMATE FORMULA IS 10270

RANK BY APPROXIMATION FORMULA IS SUBBITUMINOUS B COAL

RANK BY PARR FORMULA IS SUBBITUMINOUS B COAL

COAL ANALYSIS
USING EQUILIBRIUM MOISTURE

SAMPLE NUMBER	STATE	COAL BED NAME	FIELD NUMBER
94-043148	Kyrgyzstan		K-8

****

PROXIMATE ANALYSIS

	AS-RECEIVED BASIS	AS-RECEIVED TO EQUILIBRIUM MOISTURE	DRY BASIS	DRY ASH-FREE
% MOISTURE.....	23.07	19.56	0.00	0.00
% ASH.....	14.17	14.82	18.42	0.00
% VOLATILE.....	29.27	30.61	38.05	46.64
% FIXED CARBON...	33.49	35.02	43.53	53.36
TOTAL.....	100.00	100.00	100.00	100.00

ULTIMATE ANALYSIS

% HYDROGEN.....	5.67	5.42	4.01	4.92
% CARBON.....	47.81	49.99	62.15	76.18
% NITROGEN.....	0.72	0.75	0.94	1.15
% SULFUR.....	2.22	2.32	2.89	3.54
% OXYGEN.....	29.41	26.70	11.60	14.22
% ASH.....	14.17	14.82	18.42	0.00
TOTAL.....	100.00	100.00	100.00	100.00

FORMS OF SULFUR

% SULFATE S.....	0.05	0.05	0.06	0.08
% PRYTIC S.....	1.41	1.47	1.83	2.25
% ORGANIC S.....	0.76	0.79	0.99	1.21
HEAT VALUE(BTU/LB)	8420	8800	10950	13420

MOIST-MINERAL-MATTER-FREE BTU/LB USING PARR FORMULA IS 10500

MOIST-MINERAL-MATTER-FREE BTU/LB USING APPROXIMATE FORMULA IS 10550

RANK BY APPROXIMATION FORMULA IS SUBBITUMINOUS A COAL

RANK BY PARR FORMULA IS SUBBITUMINOUS B COAL

COAL ANALYSIS
USING EQUILIBRIUM MOISTURE

SAMPLE NUMBER	STATE	COAL BED NAME	FIELD NUMBER
94-043149	Kyrgyzstan		K-9

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PROXIMATE ANALYSIS

	AS-RECEIVED BASIS	AS-RECEIVED TO EQUILIBRIUM MOISTURE	DRY BASIS	DRY ASH-FREE
% MOISTURE.....	20.96	20.14	0.00	0.00
% ASH.....	13.34	13.48	16.88	0.00
% VOLATILE.....	29.83	30.14	37.74	45.40
% FIXED CARBON...	35.87	36.24	45.38	54.60
TOTAL.....	100.00	100.00	100.00	100.00

ULTIMATE ANALYSIS

% HYDROGEN.....	5.64	5.58	4.17	5.01
% CARBON.....	50.33	50.85	63.68	76.61
% NITROGEN.....	0.79	0.80	1.00	1.20
% SULFUR.....	1.16	1.17	1.47	1.77
% OXYGEN.....	28.74	28.12	12.81	15.41
% ASH.....	13.34	13.48	16.88	0.00
TOTAL.....	100.00	100.00	100.00	100.00

FORMS OF SULFUR

% SULFATE S.....	0.07	0.07	0.09	0.11
% PRYTIC S.....	0.43	0.43	0.54	0.65
% ORGANIC S.....	0.66	0.67	0.84	1.00
HEAT VALUE(BTU/LB)	8750	8840	11070	13310

MOIST-MINERAL-MATTER-FREE BTU/LB USING PARR FORMULA IS 10350

MOIST-MINERAL-MATTER-FREE BTU/LB USING APPROXIMATE FORMULA IS 10390

RANK BY APPROXIMATION FORMULA IS SUBBITUMINOUS B COAL

RANK BY PARR FORMULA IS SUBBITUMINOUS B COAL

COAL ANALYSIS
USING EQUILIBRIUM MOISTURE

SAMPLE NUMBER	STATE	COAL BED NAME	FIELD NUMBER
94-043723	Kyrgyzstan		K-10

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PROXIMATE ANALYSIS

	AS-RECEIVED BASIS	AS-RECEIVED TO EQUILIBRIUM MOISTURE	DRY BASIS	DRY ASH-FREE
% MOISTURE.....	9.27	7.37	0.00	0.00
% ASH.....	11.64	11.88	12.83	0.00
% VOLATILE.....	25.87	26.41	28.51	32.71
% FIXED CARBON...	53.22	54.33	58.66	67.29
TOTAL.....	100.00	100.00	100.00	100.00

ULTIMATE ANALYSIS

% HYDROGEN.....	4.09	3.94	3.36	3.86
% CARBON.....	66.07	67.45	72.82	83.54
% NITROGEN.....	0.66	0.67	0.73	0.83
% SULFUR.....	0.67	0.68	0.74	0.85
% OXYGEN.....	16.87	15.36	9.52	10.92
% ASH.....	11.64	11.88	12.83	0.00
TOTAL.....	100.00	100.00	100.00	100.00

FORMS OF SULFUR

% SULFATE S.....	0.05	0.05	0.06	0.06
% PRYTIC S.....	0.45	0.46	0.50	0.57
% ORGANIC S.....	0.17	0.17	0.19	0.21
HEAT VALUE(BTU/LB)	10970	11200	12090	13860

MOIST-MINERAL-MATTER-FREE BTU/LB USING PARR FORMULA IS 12860

MOIST-MINERAL-MATTER-FREE BTU/LB USING APPROXIMATE FORMULA IS 12890

RANK BY APPROXIMATION FORMULA IS HIGH VOLATILE C BITUMINOUS COAL

RANK BY PARR FORMULA IS HIGH VOLATILE C BITUMINOUS COAL

COAL ANALYSIS
USING EQUILIBRIUM MOISTURE

SAMPLE NUMBER	STATE	COAL BED NAME	FIELD NUMBER
94-043722	Kyrgyzstan		K-11

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PROXIMATE ANALYSIS

	AS-RECEIVED BASIS	AS-RECEIVED TO EQUILIBRIUM MOISTURE	DRY BASIS	DRY ASH-FREE
% MOISTURE.....	5.13	4.60	0.00	0.00
% ASH.....	8.31	8.36	8.76	0.00
% VOLATILE.....	37.13	37.34	39.14	42.90
% FIXED CARBON...	49.43	49.71	52.10	57.10
TOTAL.....	100.00	100.00	100.00	100.00

ULTIMATE ANALYSIS

% HYDROGEN.....	5.12	5.09	4.79	5.25
% CARBON.....	71.42	71.82	75.28	82.51
% NITROGEN.....	1.02	1.03	1.08	1.18
% SULFUR.....	0.80	0.80	0.84	0.92
% OXYGEN.....	13.33	12.91	9.25	10.14
% ASH.....	8.31	8.36	8.76	0.00
TOTAL.....	100.00	100.00	100.00	100.00

FORMS OF SULFUR

% SULFATE S.....	0.05	0.05	0.05	0.06
% PRYTIC S.....	0.08	0.08	0.08	0.09
% ORGANIC S.....	0.67	0.67	0.71	0.77
HEAT VALUE(BTU/LB)	12480	12550	13160	14420

MOIST-MINERAL-MATTER-FREE BTU/LB USING PARR FORMULA IS 13820

MOIST-MINERAL-MATTER-FREE BTU/LB USING APPROXIMATE FORMULA IS 13830

RANK BY APPROXIMATION FORMULA IS HIGH VOLATILE B BITUMINOUS COAL

RANK BY PARR FORMULA IS HIGH VOLATILE B BITUMINOUS COAL

COAL ANALYSIS
USING EQUILIBRIUM MOISTURE

SAMPLE NUMBER	STATE	COAL BED NAME	FIELD NUMBER
94-043150	Kyrgyzstan		K-13

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PROXIMATE ANALYSIS

	AS-RECEIVED BASIS	AS-RECEIVED TO EQUILIBRIUM MOISTURE	DRY BASIS	DRY ASH-FREE
% MOISTURE.....	16.76	12.81	0.00	0.00
% ASH.....	3.18	3.33	3.82	0.00
% VOLATILE.....	31.26	32.74	37.55	39.05
% FIXED CARBON...	48.80	51.12	58.63	60.95
TOTAL.....	100.00	100.00	100.00	100.00

ULTIMATE ANALYSIS

% HYDROGEN.....	5.52	5.25	4.38	4.55
% CARBON.....	64.31	67.36	77.26	80.33
% NITROGEN.....	0.59	0.62	0.71	0.74
% SULFUR.....	0.37	0.39	0.44	0.46
% OXYGEN.....	26.03	23.05	13.39	13.92
% ASH.....	3.18	3.33	3.82	0.00
TOTAL.....	100.00	100.00	100.00	100.00

FORMS OF SULFUR

% SULFATE S.....	0.04	0.04	0.05	0.05
% PRYTIC S.....	0.15	0.16	0.18	0.19
% ORGANIC S.....	0.18	0.19	0.22	0.22
HEAT VALUE(BTU/LB)	10910	11430	13110	13630

MOIST-MINERAL-MATTER-FREE BTU/LB USING PARR FORMULA IS 11860

MOIST-MINERAL-MATTER-FREE BTU/LB USING APPROXIMATE FORMULA IS 11870

RANK BY APPROXIMATION FORMULA IS HIGH VOLATILE C BITUMINOUS COAL

RANK BY PARR FORMULA IS HIGH VOLATILE C BITUMINOUS COAL

COAL ANALYSIS
USING EQUILIBRIUM MOISTURE

SAMPLE NUMBER	STATE	COAL BED NAME	FIELD NUMBER
94-043151	Kyrgyzstan		K-14

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PROXIMATE ANALYSIS

	AS-RECEIVED BASIS	AS-RECEIVED TO EQUILIBRIUM MOISTURE	DRY BASIS	DRY ASH-FREE
% MOISTURE.....	16.69	16.09	0.00	0.00
% ASH.....	6.81	6.86	8.17	0.00
% VOLATILE.....	31.88	32.11	38.27	41.67
% FIXED CARBON...	44.62	44.94	53.56	58.33
TOTAL.....	100.00	100.00	100.00	100.00

ULTIMATE ANALYSIS

% HYDROGEN.....	5.76	5.72	4.67	5.09
% CARBON.....	60.52	60.96	72.64	79.11
% NITROGEN.....	0.87	0.88	1.04	1.14
% SULFUR.....	0.85	0.86	1.02	1.11
% OXYGEN.....	25.19	24.73	12.44	13.55
% ASH.....	6.81	6.86	8.17	0.00
TOTAL.....	100.00	100.00	100.00	100.00

FORMS OF SULFUR

% SULFATE S.....	0.02	0.02	0.02	0.03
% PRYTIC S.....	0.45	0.45	0.54	0.59
% ORGANIC S.....	0.38	0.38	0.46	0.50
HEAT VALUE(BTU/LB)	10340	10410	12410	13520

MOIST-MINERAL-MATTER-FREE BTU/LB USING PARR FORMULA IS 11260

MOIST-MINERAL-MATTER-FREE BTU/LB USING APPROXIMATE FORMULA IS 11270

RANK BY APPROXIMATION FORMULA IS SUBBITUMINOUS A COAL

RANK BY PARR FORMULA IS SUBBITUMINOUS A COAL

COAL ANALYSIS
USING EQUILIBRIUM MOISTURE

SAMPLE NUMBER	STATE	COAL BED NAME	FIELD NUMBER
94-043724	Kyrgyzstan		K-15

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PROXIMATE ANALYSIS

	AS-RECEIVED BASIS	AS-RECEIVED TO EQUILIBRIUM MOISTURE	DRY BASIS	DRY ASH-FREE
% MOISTURE.....	14.46	14.75	0.00	0.00
% ASH.....	13.13	13.09	15.35	0.00
% VOLATILE.....	31.52	31.41	36.85	43.53
% FIXED CARBON...	40.89	40.75	47.80	56.47
TOTAL.....	100.00	100.00	100.00	100.00

ULTIMATE ANALYSIS

% HYDROGEN.....	5.30	5.32	4.30	5.08
% CARBON.....	56.19	56.00	65.69	77.60
% NITROGEN.....	0.90	0.90	1.05	1.24
% SULFUR.....	1.51	1.50	1.77	2.09
% OXYGEN.....	22.97	23.19	11.84	13.99
% ASH.....	13.13	13.09	15.35	0.00
TOTAL.....	100.00	100.00	100.00	100.00

FORMS OF SULFUR

% SULFATE S.....	0.03	0.03	0.04	0.04
% PRYTIC S.....	0.96	0.96	1.12	1.33
% ORGANIC S.....	0.52	0.52	0.61	0.72
HEAT VALUE(BTU/LB)	9780	9750	11430	13500

MOIST-MINERAL-MATTER-FREE BTU/LB USING PARR FORMULA IS 11370

MOIST-MINERAL-MATTER-FREE BTU/LB USING APPROXIMATE FORMULA IS 11400

RANK BY APPROXIMATION FORMULA IS SUBBITUMINOUS A COAL

RANK BY PARR FORMULA IS SUBBITUMINOUS A COAL

COAL ANALYSIS
USING EQUILIBRIUM MOISTURE

SAMPLE NUMBER	STATE	COAL BED NAME	FIELD NUMBER
94-043725	Kyrgyzstan		K-16

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PROXIMATE ANALYSIS

	AS-RECEIVED BASIS	AS-RECEIVED TO EQUILIBRIUM MOISTURE	DRY BASIS	DRY ASH-FREE
% MOISTURE.....	22.54	20.24	0.00	0.00
% ASH.....	8.88	9.14	11.46	0.00
% VOLATILE.....	29.69	30.57	38.33	43.29
% FIXED CARBON...	38.89	40.04	50.21	56.71
TOTAL.....	100.00	100.00	100.00	100.00

ULTIMATE ANALYSIS

% HYDROGEN.....	6.07	5.92	4.58	5.17
% CARBON.....	52.92	54.49	68.32	77.17
% NITROGEN.....	0.47	0.48	0.61	0.69
% SULFUR.....	0.77	0.79	0.99	1.12
% OXYGEN.....	30.89	29.17	14.04	15.85
% ASH.....	8.88	9.14	11.46	0.00
TOTAL.....	100.00	100.00	100.00	100.00

FORMS OF SULFUR

% SULFATE S.....	0.03	0.03	0.04	0.04
% PRYTIC S.....	0.41	0.42	0.53	0.60
% ORGANIC S.....	0.33	0.34	0.43	0.48
HEAT VALUE(BTU/LB)	9030	9290	11650	13160

MOIST-MINERAL-MATTER-FREE BTU/LB USING PARR FORMULA IS 10320

MOIST-MINERAL-MATTER-FREE BTU/LB USING APPROXIMATE FORMULA IS 10340

RANK BY APPROXIMATION FORMULA IS SUBBITUMINOUS B COAL

RANK BY PARR FORMULA IS SUBBITUMINOUS B COAL

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Appendix IVc. Analyses of coal ash -- reported as metal oxides

LAB NO.		D-577492	D-577493	D-577494	D-577495	D-577496	D-577497	D-577498	D-577499
FIELD NO.		K1	K2	K3	K4	K5	K6	K7	K8
SIO2	%	5.18	41.3	44.6	20.8	45.6	57.1	22.3	46.1
AL2O3	%	5.90	20.2	27.6	10.3	20.7	24.6	17.8	17.7
FETO3	%	35.6	8.52	7.25	10.6	3.08	2.22	4.76	15.6
MGO	%	3.84	2.05	1.25	1.40	0.84	1.89	3.55	1.69
CAO	%	13.7	8.72	5.18	26.6	12.5	2.86	23.2	4.84
NA2O	%	0.81	<0.15	0.39	0.91	1.14	0.29	<0.15	0.75
K2O	%	0.17	1.34	0.58	0.47	1.28	3.13	0.16	1.13
TIO2	%	0.13	0.76	2.45	0.46	0.79	1.42	0.57	0.72
P2O5	%	0.07	0.15	0.31	<0.05	0.07	0.09	0.11	0.08
MNO	%	0.16	0.06	0.07	0.29	0.11	0.01	0.24	0.07
LOI 925C		10.2	6.11	5.48	14.5	6.67	4.39	8.38	6.83

LAB NO.		D-577500	D-577501	D-577502	D-577503	D-577504	D-577505	D-577506
FIELD NO.		K9	K10	K11	K13	K14	K15	K16
SIO2	%	51.8	24.8	52.6	43.2	37.5	53.5	23.7
AL2O3	%	20.3	12.6	33.3	27.4	18.0	18.0	13.4
FETO3	%	8.04	30.6	3.64	8.68	12.7	9.17	5.68
MGO	%	2.10	1.56	1.45	0.65	1.49	0.85	1.64
CAO	%	4.00	10.9	0.50	4.13	7.94	4.34	23.8
NA2O	%	0.91	<0.15	0.17	0.48	2.73	1.32	0.32
K2O	%	1.28	0.31	3.50	0.24	1.17	0.75	0.45
TIO2	%	0.80	0.79	0.68	1.14	0.73	1.51	0.79
P2O5	%	0.08	0.12	0.10	0.39	0.06	0.08	1.28
MNO	%	0.04	0.79	0.01	<0.01	0.02	0.01	0.18
LOI 925C		6.59	6.60	2.69	6.87	6.85	5.83	9.99

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Appendix IVd. Minor and trace elements

LAB NO.		D-577492	D-577493	D-577494	D-577495	D-577496	D-577497	D-577498	D-577499
FIELD NO.		K1	K2	K3	K4	K5	K6	K7	K8
AL	%-S	3.1	10.	14.	5.7	11.	13.	9.7	9.1
CA	%-S	9.6	6.1	3.7	19.	9.1	2.3	17.	3.5
FE	%-S	26.	5.9	4.8	7.6	2.1	1.5	3.2	11.
K	%-S	0.15	1.1	0.46	0.42	1.0	2.5	0.13	0.89
MG	%-S	2.3	1.2	0.74	0.95	0.51	1.2	2.2	1.0
NA	%-S	0.61	0.10	0.30	0.82	0.95	0.21	0.14	0.55
P	%-S	0.02	0.05	0.13	0.01	0.02	0.03	0.04	0.02
TI	%-S	0.08	0.40	1.6	0.28	0.40	0.66	0.30	0.36
MN	PPM-S	1200.	450.	570.	2300.	870.	89.	1900.	490.
AG	PPM-S	<4.	<4.	<4.	<4.	<4.	<4.	<4.	<4.
AS	PPM-S	140.	<20.	36.	<20.	<20.	27.	120.	130.
AU	PPM-S	<20.	<20.	<20.	<20.	<20.	<20.	<20.	<20.
B	PPM-S	-	-	-	-	-	-	-	-
BA	PPM-S	130.	130.	490.	250.	280.	590.	260.	460.
BE	PPM-S	11.	3.	4.	16.	8.	4.	2.	6.
BI	PPM-S	<20.	<20.	<20.	<20.	<20.	<20.	<20.	<20.
CD	PPM-S	<4.	<4.	<4.	<4.	<4.	<4.	<4.	<4.
CE	PPM-S	38.	100.	150.	120.	120.	130.	57.	88.
CO	PPM-S	28.	14.	51.	190.	72.	24.	12.	29.
CR	PPM-S	120.	78.	380.	97.	64.	150.	46.	210.
CU	PPM-S	240.	78.	260.	130.	140.	170.	86.	160.
EU	PPM-S	4.	<4.	<4.	<4.	<4.	<4.	<4.	<4.
GA	PPM-S	26.	25.	53.	12.	23.	38.	16.	34.
GE	PPM-S	-	-	-	-	-	-	-	-
HO	PPM-S	<8.	<8.	<8.	<8.	<8.	<8.	<8.	<8.
LA	PPM-S	11.	63.	80.	73.	79.	76.	26.	50.
LI	PPM-S	9.	84.	98.	22.	52.	120.	210.	54.
MO	PPM-S	89.	<4.	12.	<4.	<4.	<4.	27.	45.
NB	PPM-S	<8.	24.	45.	14.	24.	34.	18.	22.
ND	PPM-S	48.	45.	70.	62.	49.	57.	35.	48.
NI	PPM-S	580.	41.	180.	160.	130.	55.	7.	100.
PB	PPM-S	24.	58.	51.	96.	53.	82.	47.	73.
SC	PPM-S	32.	18.	59.	20.	23.	32.	18.	32.
SN	PPM-S	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.
SR	PPM-S	1600.	1400.	710.	360.	260.	550.	4100.	820.
TA	PPM-S	<80.	<80.	<80.	<80.	<80.	<80.	<80.	<80.
TH	PPM-S	<8.	21.	17.	20.	21.	34.	23.	17.
U	PPM-S	<200.	<200.	<200.	<200.	<200.	<200.	<200.	<200.
V	PPM-S	160.	100.	500.	81.	81.	200.	41.	220.
W	PPM-S	-	-	-	-	-	-	-	-
Y	PPM-S	130.	38.	61.	130.	63.	39.	38.	81.
YB	PPM-S	10.	2.	6.	16.	5.	4.	3.	6.
ZN	PPM-S	190.	130.	1100.	110.	170.	250.	27.	320.
ZR	PPM-S	-	-	-	-	-	-	-	-

LAB NO.		D-577500	D-577501	D-577502	D-577503	D-577504	D-577505	D-577506
FIELD NO.		K9	K10	K11	K13	K14	K15	K16
AL	%-S	10.	6.7	17.	14.	9.2	9.3	7.5
CA	%-S	2.9	7.9	0.41	3.1	5.9	3.2	17.
FE	%-S	5.6	23.	2.7	6.1	8.3	6.1	4.0
K	%-S	0.99	0.26	2.8	0.18	0.90	0.59	0.39
MG	%-S	1.2	0.98	0.85	0.39	0.89	0.50	1.1
NA	%-S	0.69	0.07	0.16	0.07	2.1	0.94	0.30
P	%-S	0.02	0.04	0.04	0.18	0.02	0.02	0.62
TI	%-S	0.40	0.32	0.44	0.71	0.41	0.86	0.39
MN	PPM-S	330.	6300.	110.	140.	110.	87.	1400.
AG	PPM-S	<4.	<4.	<4.	<4.	<4.	<4.	<4.
AS	PPM-S	53.	<20.	100.	100.	110.	270.	270.
AU	PPM-S	<20.	<20.	<20.	<20.	<20.	<20.	<20.
B	PPM-S	-	-	-	-	-	-	-
BA	PPM-S	490.	270.	1500.	220.	110.	510.	250.
BE	PPM-S	7.	6.	10.	5.	27.	16.	3.
BI	PPM-S	<20.	<20.	<20.	<20.	<20.	<20.	<20.
CD	PPM-S	<4.	<4.	<4.	<4.	<4.	26.	<4.
CE	PPM-S	130.	76.	110.	180.	86.	100.	85.
CO	PPM-S	44.	72.	100.	93.	83.	48.	37.
CR	PPM-S	200.	110.	270.	150.	250.	240.	160.
CU	PPM-S	200.	67.	450.	160.	170.	170.	190.
EU	PPM-S	<4.	<4.	<4.	<4.	4.	<4.	<4.
GA	PPM-S	45.	28.	56.	18.	140.	51.	21.
GE	PPM-S	-	-	-	-	-	-	-
HO	PPM-S	<8.	<8.	<8.	<8.	<8.	<8.	<8.
LA	PPM-S	72.	45.	57.	94.	43.	59.	52.
LI	PPM-S	75.	57.	130.	94.	60.	33.	37.
MO	PPM-S	14.	<4.	18.	9.	15.	16.	8.
NB	PPM-S	24.	11.	38.	35.	24.	30.	15.
ND	PPM-S	76.	35.	66.	94.	54.	49.	35.
NI	PPM-S	140.	110.	240.	240.	300.	220.	150.
PB	PPM-S	70.	27.	98.	84.	84.	250.	34.
SC	PPM-S	43.	17.	55.	36.	70.	40.	27.
SN	PPM-S	<10.	<10.	<10.	<10.	<10.	<10.	<10.
SR	PPM-S	530.	340.	65.	1300.	1600.	920.	1700.
TA	PPM-S	<80.	<80.	<80.	<80.	<80.	<80.	<80.
TH	PPM-S	20.	18.	38.	42.	21.	43.	20.
U	PPM-S	<200.	<200.	<200.	<200.	<200.	<200.	<200.
V	PPM-S	240.	120.	460.	170.	390.	190.	190.
W	PPM-S	-	-	-	-	-	-	-
Y	PPM-S	120.	17.	100.	70.	150.	110.	37.
YB	PPM-S	12.	<2.	9.	5.	13.	9.	4.
ZN	PPM-S	120.	150.	310.	11000.	430.	3100.	44.
ZR	PPM-S	-	-	-	-	-	-	-

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950302 JOB NO. WF50 15 SAMPLES

REQUESTOR : BOSTICK N

PROJECT : 09600-21100
BILL TO : 09600-21100

LABORATORY REPORT
U. S. GEOLOGICAL SURVEY
OFFICE OF MINERAL RESOURCES
BRANCH OF GEOCHEMISTRY
LAKEWOOD, COLORADO

LAB NO.	FIELD NO.	A SE PPM	HG PPM	ASH %	SAMPLE DESCRIPTION
D-577492	K1	1.4	0.26	6.2	COAL: GRAB
D-577493	K2	0.3	0.02	13.7	COAL: RUN-M
D-577494	K3	1.2	0.33	31.1	COAL: P=1/3 CHANNEL
D-577495	K4	0.3	0.02	8.1	COAL: CHANNEL
D-577496	K5	0.2	<0.02	9.6	COAL: CHANNEL
D-577497	K6	0.4	0.20	21.9	COAL: CHANNEL
D-577498	K7	0.1	<0.02	8.8	COAL: CHANNEL
D-577499	K8	0.8	0.30	16.0	COAL: L=1.23 CHANNEL
D-577500	K9	0.6	0.23	17.0	COAL: U=2.95 CHANNEL
D-577501	K10	0.2	0.08	13.4	COAL: CHANNEL
D-577502	K11	0.1	0.04	7.9	COAL: GRAB
D-577503	K13	0.4	<0.02	3.5	COAL: CHANNEL
D-577504	K14	0.3	0.14	8.2	COAL: U=CHANNEL
D-577505	K15	0.4	0.28	14.4	COAL: L=CHANNEL
D-577506	K16	1.0	0.17	11.9	COAL: CHANNEL

UNCOMPLETED WORK
LATA AA Hydride generation

PROJECT : Trace Analysis + Chem Sep.
LAB. CHIEF : J. G. Crock
ANALYSTS : P. L. Hageman, R. J. Knight, P. M. Theodorakos

PROVISIONAL REPORT
Branch of Geochemistry
Lakewood, Colorado 80225

950301 JOB NO. WF50 15 SAMPLES

REQUESTOR : BOSTICK N

PROJECT : 09600-21100
BILL TO : 09600-21100

LABORATORY REPORT
U. S. GEOLOGICAL SURVEY
OFFICE OF MINERAL RESOURCES
BRANCH OF GEOCHEMISTRY
LAKEWOOD, COLORADO

LAB NO.	FIELD NO.	CL %	F %	SAMPLE DESCRIPTION
D-577492	K1	<0.015	0.02	COAL: GRAB
D-577493	K2	<0.015	0.02	COAL: RUN-M
D-577494	K3	0.020	0.04	COAL: P=1/3 CHANNEL
D-577495	K4	<0.015	0.02	COAL: CHANNEL
D-577496	K5	<0.015	0.02	COAL: CHANNEL
D-577497	K6	0.089	0.03	COAL: CHANNEL
D-577498	K7	<0.015	0.03	COAL: CHANNEL
D-577499	K8	<0.015	0.02	COAL: L=1.23 CHANNEL
D-577500	K9	<0.015	0.03	COAL: U=2.95 CHANNEL
D-577501	K10	<0.015	0.01	COAL: CHANNEL
D-577502	K11	0.041	0.02	COAL: GRAB
D-577503	K13	<0.015	0.01	COAL: CHANNEL
D-577504	K14	0.036	0.02	COAL: U=CHANNEL
D-577505	K15	<0.015	0.02	COAL: L=CHANNEL
D-577506	K16	<0.015	0.04	COAL: CHANNEL

UNCOMPLETED WORK
LATA AA Hydride generation

PROJECT : Rock Analysis
LAB. CHIEF : C. S. Papp
ANALYSTS : W. M. d'Angelo, J. H. Bullock

APPROVED
Branch of Geochemistry
Lakewood, Colorado 80225

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Appendix IVe. Coal sample field data sheets

COAL SAMPLE DATA SHEET

SAMPLE NO: K 1 (Abshir 1)

NUMBER OF BAGS: 1

COLLECTOR: N. Bostick and D. Huber

COAL FIELD: South Fergana

LATITUDE: 40° 12' N

LONGITUDE: 72° 24' E

OBLAST: Osh

RAYON: Naukat

DRILL HOLE:

MINE NAME: Abshir

DATE SAMPLED: 10-26-94

FORMATION:

SERIES: Lower Jurassic

COAL SEAM:

ESTIMATED RANK: subbituminous

TOTAL SEAM THICKNESS: ft

8 to 10 m

THICKNESS SAMPLED: ft

m

DEPTH TO TOP OF COAL: ft

m

SURFACE ELEVATION: ft

m

ROOF ROCK:

FLOOR ROCK:

SAMPLE TYPE: grab

COMMENTS: Sample collected was of block size

COAL SAMPLE DATA SHEET

SAMPLE NO: K 2 (Agulak 1)

NUMBER OF BAGS: 2

COLLECTOR: E. Johnson and H. Gluskoter

COAL FIELD: Kavak

LATITUDE: 41° 42' N

LONGITUDE: 74° 32' E

OBLAST: Naryn

RAYON: Dzhumgal

DRILL HOLE:

MINE NAME: Ak-Ulak

DATE SAMPLED: 10-14-94

FORMATION: Tura-Kiche

SERIES: Lower Jurassic

COAL SEAM: no. 6

ESTIMATED RANK: subbituminous

TOTAL SEAM THICKNESS: ft

m

THICKNESS SAMPLED: ft

m

DEPTH TO TOP OF COAL: ft

m

SURFACE ELEVATION: ft

m

ROOF ROCK:

FLOOR ROCK:

SAMPLE TYPE: grab

COMMENTS: The two sample bags collected, labeled in the field 1A and 1B, represent a mixture of one run-of-mine grab sample from an active mine dump.

COAL SAMPLE DATA SHEET

SAMPLE NO: K 3 (Almalyk 1)

NUMBER OF BAGS: 3

COLLECTOR: N. Bostick and D. Huber

COAL FIELD: South Fergana

LATITUDE: 40° 18'N

LONGITUDE: 72° 42' E

OBLAST: Osh

RAYON: Naukat

DRILL HOLE:

MINE NAME: Almalyk

DATE SAMPLED: 10-26-94

FORMATION:

SERIES: Lower Jurassic

COAL SEAM:

ESTIMATED RANK: subbituminous

TOTAL SEAM THICKNESS: ft

29 m

THICKNESS SAMPLED: ft

m

DEPTH TO TOP OF COAL: ft

m

SURFACE ELEVATION: ft

m

ROOF ROCK:

FLOOR ROCK:

SAMPLE TYPE: channel

COMMENTS: Sampled upper 1/3 of seam at 1,165 m level. Collected three bags intended to be mixed for one analysis.

COAL SAMPLE DATA SHEET

SAMPLE NO: K 4 (Dzhergalan 1)

NUMBER OF BAGS: 2

COLLECTOR: N. Bostick and H. Gluskoter

COAL FIELD: Issyl-Kul

LATITUDE: 42° 30' N

LONGITUDE: 78° 48' E

OBLAST: Issyl-Kul

RAYON: Ak-Suy

DRILL HOLE:

MINE NAME: Dzhergalan

DATE SAMPLED: 10-17-94

FORMATION:

SERIES: Lower Jurassic

COAL SEAM: no. 5

ESTIMATED RANK: bituminous

TOTAL SEAM THICKNESS: ft

m

THICKNESS SAMPLED: ft

m

DEPTH TO TOP OF COAL: ft

m

SURFACE ELEVATION: ft

m

ROOF ROCK:

FLOOR ROCK:

SAMPLE TYPE: channel

COMMENTS: Collected two bags of upper and lower parts of seam intended to be combined into one single analysis. Sampled from block no. 6, pesh no. 3, strek no. 3.

COAL SAMPLE DATA SHEET

SAMPLE NO: K 5 (Dzhergalan 2)

NUMBER OF BAGS: 1

COLLECTOR: N. Bostick and H. Gluskoter

COAL FIELD: Issyk-Kul

LATITUDE: 42° 30' N

LONGITUDE: 78° 48' E

OBLAST: Issyk-Kul

RAYON: Ak-Suy

DRILL HOLE:

MINE NAME:

DATE SAMPLED: 10-17-94

FORMATION:

SERIES: Lower Jurassic

COAL SEAM: no. 4

ESTIMATED RANK: bittuminous

TOTAL SEAM THICKNESS: ft

m

THICKNESS SAMPLED: ft

m

DEPTH TO TOP OF COAL: ft

m

SURFACE ELEVATION: ft

m

ROOF ROCK:

FLOOR ROCK:

SAMPLE TYPE: channel

COMMENTS: Sampled from block no. 6, pesh no. 3.

COAL SAMPLE DATA SHEET

SAMPLE NO: K 6 (Kara Dobo 1)

NUMBER OF BAGS: 1

COLLECTOR: E. Johnson

COAL FIELD: East Fergana

LATITUDE: 40° 48' N

LONGITUDE: 73° 48' E

OBLAST: Osh

RAYON: Uzgen

DRILL HOLE:

MINE NAME: Kara-Tyube

DATE SAMPLED: 10-27-94

FORMATION: Tuyuk

SERIES: Lower Jurassic

COAL SEAM: no. 3

ESTIMATED RANK: bituminous

TOTAL SEAM THICKNESS: ft

m

THICKNESS SAMPLED: ft

1.15 m

DEPTH TO TOP OF COAL: ft

m

SURFACE ELEVATION: ft

m

ROOF ROCK:

FLOOR ROCK:

SAMPLE TYPE: channel

COMMENTS: Sample collected from an outcrop exposed with hand tools

COAL SAMPLE DATA SHEET

SAMPLE NO: K 7 (Kara-Kechi 1)

NUMBER OF BAGS: 2

COLLECTOR: N. Bostick and E. Johnson

COAL FIELD: Kavak

LATITUDE: 41° 44' N

LONGITUDE: 74° 48' E

OBLAST: Naryn

RAYON: Dzhumgal

DRILL HOLE:

MINE NAME: Kara-Kiche

DATE SAMPLED: 10-13-94

FORMATION: Tura-Kavak

SERIES: Lower Jurassic

COAL SEAM: Basic

ESTIMATED RANK: subbituminous

TOTAL SEAM THICKNESS: ft

50? m

THICKNESS SAMPLED: ft

3 m

DEPTH TO TOP OF COAL: ft

m

SURFACE ELEVATION: ft

m

ROOF ROCK:

FLOOR ROCK:

SAMPLE TYPE: channel

COMMENTS: The two sample bags, labeled in the field 1a and 1B, represent a mixture of one channel sample.

COAL SAMPLE DATA SHEET

SAMPLE NO: K 8 (Kara Tut 2)

NUMBER OF BAGS: 1

COLLECTOR: E. Landis and E. Johnson

COAL FIELD: North Fergana

LATITUDE: 41° 25' N

LONGITUDE: 72° 14' E

OBLAST: Dzhalal-Abad

RAYON: Dzhany-Dzhol?

DRILL HOLE:

MINE NAME: Kara-Tut Central

DATE SAMPLED: 10-18-94

FORMATION: Coal Bearing

SERIES: Lower Jurassic

COAL SEAM:

ESTIMATED RANK: bituminous

TOTAL SEAM THICKNESS: ft

4.91+ m

THICKNESS SAMPLED: ft

1.23 m

DEPTH TO TOP OF COAL: ft

m

SURFACE ELEVATION: ft

m

ROOF ROCK:

FLOOR ROCK:

SAMPLE TYPE: channel

COMMENTS: Kara-Tut Centeral is a mine at the Tash-Kumyr mining complex. Sampled from lower part of seam.

COAL SAMPLE DATA SHEET

SAMPLE NO: K 9 (Kara-Tut 1)

NUMBER OF BAGS: 1

COLLECTOR: E. Landis and E. Johnson

COAL FIELD: North Fergana

LATITUDE: 41° 25' N

LONGITUDE: 72° 14' E

OBLAST: Dzhalal-Abad

RAYON: Dzhany-Dzhol?

DRILL HOLE:

MINE NAME: Kara-Tut Central

DATE SAMPLED: 10-18-94

FORMATION: Coal Bearing

SERIES: Lower Jurassic

COAL SEAM:

ESTIMATED RANK: bituminous

TOTAL SEAM THICKNESS: ft

4.91+ m

THICKNESS SAMPLED: ft

2.29 m

DEPTH TO TOP OF COAL: ft

m

SURFACE ELEVATION: ft

m

ROOF ROCK:

FLOOR ROCK:

SAMPLE TYPE: channel

COMMENTS: Kara-Tut Central is a mine at the Tash-Kumyr mining complex. Sampled from upper part of seam.

COAL SAMPLE DATA SHEET

SAMPLE NO: K 10 (Kok-Yangak 1)

NUMBER OF BAGS: 1

COLLECTOR: N. Bostick and D. Huber

COAL FIELD: East Fergana

LATITUDE: 41° 00' N

LONGITUDE: 73° 12' E

OBLAST: Dzhalal-Abad

RAYON: Suzan

DRILL HOLE:

MINE NAME: Kok-Yangak

DATE SAMPLED: 10-25-94

FORMATION:

SERIES: Lower Jurassic

COAL SEAM: no. 6

ESTIMATED RANK: bituminous

TOTAL SEAM THICKNESS: ft

2.4 m

THICKNESS SAMPLED: ft

m

DEPTH TO TOP OF COAL: ft

m

SURFACE ELEVATION: ft

m

ROOF ROCK:

FLOOR ROCK:

SAMPLE TYPE: channel

COMMENTS: Seam no. 6 is below seam no. 5. Sampled panel no. 630 at the +1,200 m level.

COAL SAMPLE DATA SHEET

SAMPLE NO: K 11 (Kum-Bel 1)

NUMBER OF BAGS: 1

COLLECTOR: E. Landis and E. Johnson

COAL FIELD: East Fergana

LATITUDE: 41° 00' N

LONGITUDE: 73° 30' E

OBLAST: Osh

RAYON: Uzgen

DRILL HOLE:

MINE NAME: Tashim

DATE SAMPLED: 10-26-94

FORMATION: Tuyuk

SERIES: Lower Jurassic

COAL SEAM: no. 22

ESTIMATED RANK: bituminous

TOTAL SEAM THICKNESS: ft

m

THICKNESS SAMPLED: ft

m

DEPTH TO TOP OF COAL: ft

m

SURFACE ELEVATION: ft

m

ROOF ROCK:

FLOOR ROCK:

SAMPLE TYPE: grab

COMMENTS:

COAL SAMPLE DATA SHEET

SAMPLE NO: K 12 (Soguty 1)

NUMBER OF BAGS: 1

COLLECTOR: N. Bostick and H. Gluskoter

COAL FIELD: Issyk-Kul

LATITUDE:

LONGITUDE:

OBLAST: Issyk-Kul

RAYON: Tonsk

DRILL HOLE:

MINE NAME: Soguty

DATE SAMPLED: 10-18-94

FORMATION:

SERIES: Lower Jurassic

COAL SEAM: no. 2

ESTIMATED RANK: subbituminous

TOTAL SEAM THICKNESS: ft

m

THICKNESS SAMPLED: ft

m

DEPTH TO TOP OF COAL: ft

m

SURFACE ELEVATION: ft

m

ROOF ROCK:

FLOOR ROCK:

SAMPLE TYPE: grab

COMMENTS: Local people noted that sample included some roof rock. Sample lost in mail between Reston and the laboratory

COAL SAMPLE DATA SHEET

SAMPLE NO: K 13 (Sari-Mongol)

NUMBER OF BAGS: 1

COLLECTOR: E. Johnson and E. Landis

COAL FIELD: Alay

LATITUDE: 39° 42' N

LONGITUDE: 72° 56' East

OBLAST: Osh

RAYON: Alay

DRILL HOLE:

MINE NAME: Kyzyl-Bulak

DATE SAMPLED: 10-25-94

FORMATION: Coal Bearing

SERIES: Lower Jurassic

COAL SEAM:

ESTIMATED RANK:

TOTAL SEAM THICKNESS: ft

16 m

THICKNESS SAMPLED: ft

m

DEPTH TO TOP OF COAL: ft

m

SURFACE ELEVATION: ft

m

ROOF ROCK:

FLOOR ROCK:

SAMPLE TYPE: channel

COMMENTS:

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COAL SAMPLE DATA SHEET

SAMPLE NO: K 14 (Severnay 1)

NUMBER OF BAGS: 1

COLLECTOR: E. Johnson and E. Landis

COAL FIELD: North Fergana

LATITUDE: 41° 18' N

LONGITUDE: 72° 12' E

OBLAST: Dzhalal-Abad

RAYON: Dzhany-Dzhol?

DRILL HOLE:

MINE NAME: Severnay

DATE SAMPLED: 10-19-94

FORMATION: Coal Bearing

SERIES: Lower Jurassic

COAL SEAM: no. 3

ESTIMATED RANK: bituminous

TOTAL SEAM THICKNESS: ft

m

THICKNESS SAMPLED: ft

m

DEPTH TO TOP OF COAL: ft

m

SURFACE ELEVATION: ft

m

ROOF ROCK:

FLOOR ROCK:

SAMPLE TYPE: channel

COMMENTS: Severnay is a mine at the Tash-Kumyr mining complex. Collected from upper part of seam.

COAL SAMPLE DATA SHEET

SAMPLE NO: K 15 (Severnay 2)

NUMBER OF BAGS: 1

COLLECTOR: E. Johnson and E. Landis

COAL FIELD: North Fergana

LATITUDE: 41° 18' N

LONGITUDE: 72° 12' E

OBLAST: Dzhalal-Abad

RAYON: Dzhany-Dzhol?

DRILL HOLE:

MINE NAME: Severnay

DATE SAMPLED: 10-19-94

FORMATION: Coal Bearing

SERIES: Lower Jurassic

COAL SEAM: no. 3

ESTIMATED RANK: bituminous

TOTAL SEAM THICKNESS: ft

m

THICKNESS SAMPLED: ft

m

DEPTH TO TOP OF COAL: ft

m

SURFACE ELEVATION: ft

m

ROOF ROCK:

FLOOR ROCK:

SAMPLE TYPE: channel

COMMENTS: Severnay is a mine at the Tash-Kumyr mining complex. Sample taken from lower part of seam.

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COAL SAMPLE DATA SHEET

SAMPLE NO: K 16 (Valakish 1)

NUMBER OF BAGS: 4

COLLECTOR: N. Bostick and D. Huber

COAL FIELD: South Fergana

LATITUDE: 40° 12' N

LONGITUDE: 72° 06' E

OBLAST: Osh

RAYON: Frunze

DRILL HOLE:

MINE NAME: Valakish

DATE SAMPLED: 10-27-94

FORMATION:

SERIES: Lower Jurassic

COAL SEAM:

ESTIMATED RANK: subbituminous

TOTAL SEAM THICKNESS: ft

15 m

THICKNESS SAMPLED: ft

3.4 m

DEPTH TO TOP OF COAL: ft

m

SURFACE ELEVATION: ft

m

ROOF ROCK:

FLOOR ROCK:

SAMPLE TYPE: channel

COMMENTS: Sampled at 110 m (east) horizon. Four bags collected intended to be mixed for one analysis.

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APPENDIX V. **HISTORY OF COAL EXPLORATION -- Kashirin**

Coal mining in Kygyzstan started more than 125 years ago in areas peripheral to the Fergana Valley in the southwestern part of the Republic. In 1988, F.T. Kashirin published a short history of coal geology studies conducted in the Kyrgyz Republic. Team member N.H. Bostick prepared a summary translation of Kashirin's report to provide background information for the assessment team. Bostick's report follows:

Kashirin, F. T., 1988, Ugol'naya geologiya v Kirgizii za 70 let Sovetskoy vlasti. <Coal geology in 'Kirghizia in the 70 years of Soviet power> Izvestiya Akademii nauk Kirgizskoy SSR <Kabarlary Kyrgyz SSR Ilimader Akademiyasynyn. No. 1, p.72-79.

Coal geology in Kyrgyzstan during 70 years of Soviet power

by F. T. Kashirin

^1 The coal industry is one of the oldest branches of the industrial economy in Kyrgyzstan. It originated in the south of Kyrgyzstan (in the present 'Oshsk _oblast') more than 100 years ago. Coal production began in 1866 in 'Sulyukta, in 1898 in 'Kyzyl>Kiya, in 1916 in 'Tash>Kumyr and 'Kok>Yangak. Mining was conducted by private enterprises using semi-primitive pits on a very small scale. The geologic basis for developing a coal industry was weak. Coal geologic studies were of a reconnaissance nature, and prospecting-exploration work was absent.

^2 The publications on coal geology in the territory of Kyrgyzstan were by the well-known Russian geologist I. V. 'Mushketov. It was he who first described exposures of coal seams in the Kyrgyzstan part of the hills surrounding the 'Fergana Valley: 'Sary>Biya ('Mayli>Say -- northern Fergana); 'Sulyukta, 'Kyzyl>Kiya (southern 'Fergana); 'Kumbel', 'Taldy>Su, 'Aldyyar (eastern 'Fergana) [1]. At the same time the geologist G. D. 'Romanovskiy studied exposures of coal beds in the 'Kokkinesayskay area in 'Sulyukta [2]. Later, more detailed studies of the coal geology of Southern - Kyrgyzstan were carried out by M. M. 'Bronnikov and A. P. 'Mikhailov in 1889-1913 under the auspices of the 'Geologic Committee. The famous geologist V. N. 'Veber also devoted some attention to coal geology during his survey on a ten-verst scale [4]. M. M. 'Bronnikov and V. N. 'Veber determined the reserves of several South-Fergana deposits to

total 157 million tons, including 19.5 m.t. in 'Kyzyl>Kiya, 19.0 m.t. in Shurab and 52.0 m.t. in Sulyukta.

^3 The first information about the presence of coal strata in Northern Kyrgyzstan (within the geographical boundaries of 'Soguty, 'Ak>Say, 'Dzhaman>Davan, 'Turugart, 'Kok>Maynak) was published by K. I. 'Argentov in 1911 [5] and V. N. 'Ryabinin in 1915 [6]. The most complete general work which summarized the results of pre-revolutionary studies on coal geology in Central Asia was by D. A. 'Nalivkin [7]. Already at that time it had been established that all the coal deposits discovered in Central Asia originated during the Jurassic time of coal accumulation. D. A. 'Nalivkin wrote that they are: "deposits of broad plains and wide valleys surrounded and cut off by strongly dissected mountain ranges. Numerous moderate-sized rivers flowing into the plain eroded huge masses of coarse clastic material, which was eroded and swept away for large distances during tumultuous floods. On these coarse sediments formed freshwater basins, only to vanish again under a cover of sands. Most often they had the appearance of extensive swamps which were surrounded and overgrown by a rich, luxurious growth of plants. In lakes and swamps the beds of coal were formed and also lived freshwater fish, pelecypods and insects."

^4 Within the first few five-year plans the Republic was considered to be the "stoke-box" of Central Asia. The development of a coal industry made necessary the creation of a reliable mineral resource base, for which, in turn, was needed expanded studies of coal geology. Somewhat arbitrarily, several periods in the development of coal mining and coal geology in Kyrgyzstan during the Soviet era can be recognized.

^5 **1918-1940** During 1918-1927, after nationalization of the coal mines began their reestablishment. By 1928 the coal production had reached a pre-war level (103 thousand tons). From this time began preparation of a geologic basis for expanding production of the reestablished operations and for construction of new mines. Large scale geologic mapping encompassed almost all of the main coal-bearing regions in the hills surrounding the Fergana Valley. Prospecting and exploration work included separate parts of the 'Sulyukta, 'Kyzyl>Kiya, 'Naryn ('Tash>Kumyr), 'Kok>Yangak and 'Shurab coal deposits. This work was done by a large collective of coal geologists, mainly from Leningrad and Tashkent. N. V. 'Shabarov provided the scientific leadership. The concept of formation of coal strata and coal seams in Central Asia which he proposed was as follows: The Jurassic coal-bearing deposits formed in lagunal-continental conditions. The main coal seams are concentrated in the lower parts of the coal-bearing sequence. The sporadic shifting of the coal-bearing areas and their interruption by Cretaceous deposits lying directly on the Paleozoic was caused by Alpine

mountain building and consequent erosion. On the basis of this concept, N. V. 'Shabarov postulated the possible discovery of coal-bearing deposits at greater depths under the cover of Cretaceous and younger deposits [8]. This conclusion was an important prospecting idea for discovery of new, concealed, areas of Jurassic deposits bearing industrially valuable coals.

^6 As a result of the studies mentioned, very significant results were obtained in coal geology. The main one was the creation of a reliable geological basis for development of coal-producing operations on the established deposits 'Sulyukta, 'Kyzyl>Kiya, 'Kok>Yangak, 'Tash-Kumyr and the discovery by N. V. 'Shabarov of the 'Uzgen ('East-Fergana) coal basin with workable seams having the whole range of bituminous coals from long-flame to anthracite [9].

^7 **1941-1945.** Before the beginning of World War Two the mining industry of Kyrgyzstan consisted of four relatively small coal producing operations which exploited the bituminous coal deposits 'Tash-Kumyr and 'Kok>Yangak and the lignite deposits 'Sulyukta and 'Kyzyl>Kiya. Production of other mineral resources, including petroleum and ores for non-ferrous metallurgy, were in a rudimentary condition. However, by that time Kyrgyzstan was completely covered by a mid-scale geological survey, which served as the scientific basis for planning and conducting exploration for mineral resources, including coal. In order to study coal deposits in Central Asia, 'Minugleprom-SSSR organized a special establishment, the 'Sredazuglerazvedka Trust in 'Tashkent. In Kyrgyzstan, since 1938 worked the Republic bureau of geology 'Mingeo-SSSR.

^8 From the beginning of the second world war all efforts of geologists were turned mainly to prospecting and exploration for strategic mineral ores, which included coal. Detailed exploration of new mine fields and coal-bearing sectors was carried out at the working deposits of 'Kok>Yangak (sectors 'Kok>Yangak, 'Sary>Bulak, 'Tyulek, 'Markay), 'Kyzyl>Kiya (field of Mine 6). The main volume of geologic work in coal geology during the war was concentrated in prospecting and exploration for deposits of technological coals (coking coals) in the area of the 'Uzgen ('East>Fergana) Basin. Here the 'Kyrgyzstan Bureau of Geology explored the 'Besh>Terek, 'Zindan and 'Kara>Tyube>Baybiche deposits and the 'Sredazuglegeoliya trust explored the 'Tuyuk and 'Kargasha deposits. The high pace of development of the coal industry during the war years and the heroic efforts of miners and geologists led to production of 4.0 million tons in the first post-war years. Of the large number of distinguished geologists working in the war years, professor N. V. 'Shabarov, discoverer of the 'Uzgen coal basin, can be listed first. In these years he studied the basin and consulted for the extensive prospecting and exploration by geologists of the

'Kyrgyzstan Geology Bureau (L. G. 'Bel'govskiy, Ye. I. 'Zubtsov, I. K. 'Yakovlev, F. T. 'Kashirin, Z. Ye. 'Kashirina, I. D. 'Rogozin, K. D. 'Musatov, B. I. 'Rybakov, A. I. 'Ivanova) and also geologists of the 'Sredazuglegeologiya trust (Ye. A. 'Kochnev, Yu. P. 'Barinkov, A. 'Gil'metdinova, R. S. 'Gaft, and others).

^9 Subsequently, N. V. 'Shabarov became one of the leading coal geologists of the country, and he worked many years as leader of the coal geology group in 'VSEGEI (Leningrad). For his discovery of the 'Uzgen ('East>Fergana) coal basin he war awarded the title of laureate of the USSR State Prize and Distinguished Scientist of the Kirgiz Republic.

^10 A large contribution in study of the geology of the 'Uzgen Basin was made by the Leningrad field geologist V. N. 'Ognev. Under his leadership and active work was completed the large scale geologic survey of the most favorable areas of the basin. Together with the famous paleobotanist M. I. 'Brik he worked out the stratigraphy of the coal-bearing strata of the basin determined the basic features of the paleogeography, which retains its significance to the present day [10].

^11 **1946 to present.** After the end of WW-II prospecting and exploration for coal was carried out at practically all deposits being exploited. However, the main effort was concentrated in the 'Uzgen coal basin since full industrialization of the basin was included in the fourth five-year economic plan (1946-1959) of the country. Accordingly, a plan of geologic exploration was laid out which included detailed exploration of 12 sectors in the deposits of coking coal 'Tuyuk and 'Kargasha for construction of shaft mines with production of 3 million tons as well as exploring a route for construction of a rail line to these deposits. The plan for a rail route extending from the 'Khanabad (Tashkent RR) station to the 'Sazy region (western part of the 'Kargasha deposit) was established in 1950. Unfortunately, exploration of the 'Tuyuk and 'Kargasha deposits went slowly, mainly because of complications in carrying out core drilling. In 1954 the assignment for detailed exploration of the 'Uzgen basin was decreased to six underground sectors with an output of 1.8 million tons, and the completion date was extended to 1953 {This and the previous date conflict; correct dates are unknown -- Translator} At the same time a new comprehensive project to develop the basin was set, including construction of a rail line to the basin. However, detailed exploration was not completed within schedule, and the final figure for reserves in the 'Tuyuk and 'Kargasha deposits was not approved by 'VKZ until the end of 1955. The development program for the basin was not carried out. In 1956 the institute 'Sredazgiproshakht worked out the basic provisions for development of the 'Tuyuk and 'Kargasha deposits. Approximately since this time

exploration at these and other 'Uzgen Basin deposits has ceased and the question of development of the deposits and continuation of the exploration efforts in the remaining deposits of the 'Uzgen basin remains for all intents and purposes open.

^12 The most substantial achievement of coal geology during this period was the opening of the 'Kavak brown coal basin in north Kyrgyzstan. Interestingly, this was done in conjunction with prospecting and exploration for ores of rare metals in the coal-bearing Jurassic strata of the 'Kavak mountains. The discovery was reported for the first time at the 'Second Coal Geology Congress in March, 1955, in Leningrad, by F. T. 'Kashirin, one of the discoverers of the basin [11].

^13 In subsequent years, from 1953 to 1980 (with interruptions) detailed exploration was conducted at the more favorable deposits of the basin. Up to the present, two coal sectors ('Kara>Keche and 'Agulak>Turakavak) have been prepared, with explored reserves adequate to supply two mine sections with 4-5 million tons combined capacity. Construction of a coal section has begun at the 'Kara>Keche deposit, which has now been reached by an electrical transmission line and a gravel road connecting with the 'Kochkorka>Chayek auto road. In the development plan for coal industry in Kyrgyzstan for 1986-1990 is projected expansion of the output of the 'Agulak>Turakavak section to 1 million tons.

^14 At the deposits opened in this period prospecting, exploration, and thematic studies have been carried out. In the 50's and early 60's at the 'Sulyukta deposit were conducted detailed exploration of the northern sectors (geologist B. Ye. 'Dimitruk), parcel No.8 (geologists V. A. 'Kramer and N. V. 'Il'chenko), No.12 (geologists V. A. 'Kramer and P. P. 'Konovalov), the field of mine No.16 (geologists Yu. S. 'Ler-Khodkevich and V. I. 'Utkin), parcel No.5 (M. I. 'Yaskovich and R. S. 'Mangel'din). This work provided reserves equal to the output of the active mines No.6/18 of the 'Sulyukta ('Kyzyl>Bulak) section and created a number of reserve parcels (field 11 and others).

^15 At the 'Kyzyl>Kiya deposit during these years practically the entire territory was explorated for coal sectors and parcels. This effort provided reserves to allow construction of the 'Dzhindzhigan mines and the coal sections 'Abshir and 'Almalyk, and allowed evaluation of the reserve Eastern Sector. This exploration was carried out by many geologists based in Frunze and Tashkent (A.A. 'Gavrilin, Sh. 'Tekenof, I. M. 'Mel'kovitskiy and others).

^16 Within the actual 'Tash>Kumyr deposit the inadequate reserves in one sector (section 'Kara->u, 'Severnaya mine) and

drastic worsening of mine/geological conditions in others ('Kapital'naya mine) led to basic prospecting and exploration to prepare for exploitation of the coal-bearing sectors and areas beyond 'Tash>Kumyr. With this aim the 'Tegenek deposit, 45(?) km north of 'Tash>Kumyr, was explored in detail. The proved reserves of this deposit provide initially for construction of a section, and after surface reserves are worked out -- shaft mines.

^17 At the 'Kok>Yangak deposit, in post-war years production has been mainly from drift horizons. At the present time at these horizons and in part lower (the region of shaft No.40) the reserves are worked out at coal sectors 'Kurgan>Tash, 'Kok>Yangak, and 'Sary>Bulak; the main front for exploitation work has shifted in a southern direction, encompassing the areas 'Tyulek and 'Markay (Southern 'Kok>Yangak). Preliminary exploration of these areas was carried out in 1941-1943, and detailed exploration of Southern 'Kok>Yangak in 1955. Calculation of reserves of the entire deposit (The Northern Area, shaft No. 40, 'Kapital'naya stsol'nya, shaft No.45, 'Kok>Yangak>Glubokiy and 'Sary>Bulak) was carried out by the 'Kyrgyzstan Geological Bureau in 1963.

^18 At deposits of the 'South>Issyk>Kul' coal region in the region of 'Dzhergalan and 'Soguty, small-scale exploration has been carried out from time to time to provide reserves for the two active shaft mines here. Their total yearly production does not exceed 200 thousand tons. Because of their reserves and size of output, the named deposits and mines have only local significance.

^19 In this short paper only certain aspects of development of coal geology in Kyrgyzstan during the Soviet era have been presented. I would say that the most striking is the creation of a large (for Central Asia) geologic base for the further development of the coal industry in Kyrgyzstan. While before the revolution (1913) the predicted coal reserves were reckoned at 157 million tons, at the present they amount to 33,000 million tons. That is, they have grown more than 200 times, including a reserve balance of 2,200 million tons.

^20 In past years at many deposits worked for a long time ('Tash>Kumyr, 'Kok>Yangak, Kyzyl>Kiya) the reserves in certain sectors are worked out, whereas in others the mining/geological conditions have greatly worsened. However, as a whole, the coal industry of Kyrgyzstan has favorable perspectives not only for continued existence but for further large-scale development. The perspectives include the still untouched 'Uzgen and 'Kavak basins. The 'Kavak basin deserves special attention because of its uniquely thick coal seams, which with justice may be called the "cream" of solid fossil

fuel. In the 'Kavak basin even today is possible surface mining of coals on a large scale.

^21 In case of need, the 'Uzgen Basin may become the basic provider of high quality bituminous coals for the entire Central Asian region
and the base for technological coals -- the raw material for a coke-chemical industry.

^22 The results of prospecting and exploration for coal, the mining geology, and the scientific studies in coal geology which were carried out over many years by a large number of coal geologists have been published in monographs and numerous articles, but their greatest fruit is found in the book Coal Basins and Deposits of Central Asia [12]. This volume contains quite complete accounts of geology (stratigraphy, tectonics, depositional conditions), coal occurrence and perspectives for industrial development of nearly all coal basins and deposits of Central Asia, including those in Kyrgyzstan. It contains also description of petrography, chemistry and technological properties of the coals; special attention is devoted to evaluation of raw resources for coal-based industry.

^23 In a short article it is impossible to list all coal geologists of the old and young generations who have invested their work in creation of a raw material base of a coal industry of Kyrgyzstan and who continue their valued work toward further expansion of our knowledge of the coal riches of Kyrgyzstan.

^24 LITERATURE

1. 'Mushketov, I. V. *Turkestan. Geologic and geographic description according to information gathered during travels from 1871 to 1900.* St Petersburg, 1915, Part 1, Vol. 2.

2. 'Romanovskiy, G. D. *Materials on geology of the Turkestan Kray.* St. Petersburg, Izd. Akad. nauk. T.I, 1878; T.II, 1884; T.III, 1840.

3. 'Bronnikov, M. M. *Geologic studies in Syrdar'ya oblast' in 1904.* St. Petersburg, IGK, 1905. T.24, No.1.

4. 'Veber, V. N. *Natural resources of Turkestan.* Izvestiya Geol. Komiteta. St.Petersburg, 1913.

5. 'Argentov, K. I. *Preliminary account of geological explorations in the 'Przheval'sk uyezd of 'Semirech'ye oblast' in 1911.* Gornyy zhurnal, 1913, No.11-12.

6. 'Ryabinin, V. I. *Bituminous coal in 'Kok>Maynak urochishche on 'Dongurme river: Surface and subsurface.* 1917, T.2, No.4.

7. 'Nalivkin, D. I. *Outline of the geology of Turkestan.* Tashkent, 1926.

8. 'Shabarov, N. V. *Coal reserves and the perspectives for a coal industry in Central Asia and the Tashkent-Karatau region.* Tashkent, 1926.

9. 'Shabarov, N. V. *A new ('East-Fergana) coal basin in the Kirgiz SSR and its analogs in the Uzbek and Tadzhik SSR.* Sovyetskaya geologiya, 1939, No.6.

10. 'Ognev, V. K. *Structural-facies features of coal-bearing strata of the East-Fergana coal basin.* Izd. Kirgizskogo filiala, Akad nauk SSSR, Frunze, 1946.

11. 'Kashirin, F. T. *A new coal region in the Kirgiz SSR.* Trudy laboratorii uglya Akad. nauk SSSR, 1957, Vyp.7.

12. *Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR,* T. 6. *Ugol'nyye basseyny i mestorozhdeniya Srednyey Azii.* Moscow, Nedra, 1968.

Basic development stages in the coal-production industry and in coal geology of Kyrgyzstan from 1917 to 1987

1

Basic stages in development of the coal industry; growth of coal production

1918-1928----------

Nationalization of the coal pits. Reestablishment of them after the civil war and liquidation of Basmachism. Coal output reached the pre-war level (103 thousand tons).

1929-1940----------

First and second five-year plans. Growth of coal output from 103 to 1200 thousand tons.

1941-1945----------

Period of the Fatherland war. Growth of coal output from all coal-producing operations: In the five-year period about 7 million tons was attained, 1.5 million more than in the pre-war five-year period.

1946-1958----------

Re-establishment and development of the economy. "The law of five-year planned reconstruction and development of the economy of the USSR". Growth in coal output to 3.8 million tons. Development of surface mining. Geological reserves of explored coal in Kyrgyzstan reached 15,060 million tons in January, 1955.

1959-1987----------

Basic output of coal mainly from deposits established earlier. Output maintained at 4 million tons. Explored reserves of high-quality bituminous coal at Uzgen and of brown coal at 'Kavak basin practically not exploited.

Repeated recalculation of reserves. Depending on assumed conditions and depth for calculation, reserves in Kyrgyzstan evaluated as (thousand million tons): 1956 --33.0; 1979 --27.4. (In 1913 coal reserves of entire Central Asia amounted to 157 million tons.) Net conditional reserves amount to 2,200 million tons.

2

Directions in geological exploration work; important achievements; discoveries

1918-1928----------

In 1927 were begun large scale geological mapping and detailed studies of individual regions with coal deposits. in Kyrgyzstan (N. V. 'Shabarov). The first geological exploration for coal in Kyrgyzstan was conducted at 'Kok>Yangak in 1926-1928 under the leadership of the Leningrad geologist Ye. O. 'Pogrebitskiy.

1929-1940----------

Exploration was expanded to provide coal reserves for working operations and to support construction of new shafts at coal deposits in 'Kyzyl>Kiya, 'Sulyukta, 'Tash>Kumyr, and 'Kok>Yangak. A new (for Kyrgyzstan) coal basin was discovered -- the 'East Fergana basin, which includes the whole range of coals from long-flame bituminous to anthracite.

1941-1945----------

Extensive detailed work at all working deposits in order to increase their output (new sections, and shafts at surface mines) suitable for new or reconstructed active producing operations. Detailed exploration of coking coals in the 'Uzgen basin ('Tuyuk and 'Kargasha deposits) were begun.

1946-1958----------

Continuation of prospecting and detailed exploration for coal in the whole territory of the Republic. Discovery of the new 'Kavak coal basin, in which the coal-bearing sequence contains the basic Republic reserves of energy lignite available for surface mining. Detailed exploration of 'Kara>Kiche deposit, the most favorable for development in the 'Kavak coal basin.

1959-1987----------

In conjunction with development of reserves at many existing underground operations, the basic geological work was directed toward establishing new production units at existing underground and surface mines. Prospecting to evaluate possible rare-metal ore potential in coals and adjacent rocks was undertaken at all main coal operations.

3
Achievements in coal geology

1918-1928----------

The first general compilation of material on coal geology in Central Asia, including Kyrgyzstan (D. V> 'Nalivkin, 1926).

1929-1940----------

First publications about the geology and coal resources of 'Uzgen ('East>Fergana) bituminous coal basin (N. V. 'Shabarov, 1939).

1946-1958----------

News of discovery of the new 'Kavak coal basin released at the 'Second Coal Geology Conference (F. T. 'Kashirin, 1955). Publication about geological structure and coal resources of the 'Kavak coal basin (F. T. 'Kashirin, 1955). Monograph <<Geologiya SSSR>>, Vol. 20, Kirgiz Republic, part II, Natural resources, including coal (1954). Monograph by V. N. 'Ognev <<Structural-facies features of coal sequences of the 'Uzgen ('South>Fergana) coal basin>> (1946). Publication of the reserve calculations for coal of the USSR, including the Kirgiz Republic, as of January 1953 (N. V. 'Shabarov, A. V. 'Tyzhnov, 1956).

1959-1987----------

Publication of volume 6 of <<Geologiya mestorozhdeniy uglya i goryuchikh slantsev SSSR>>, titled Coal basins and deposits of Central Asia (collective of authors, 1968). Monographs on separate coal basins and deposits of Kyrgyzstan (F. T. 'Kashirin, 1964, 1975).

Coal conference in Frunze (1978), organized by the Bureau of Prospecting and Exploration for solid fuels, 'Mingeo SSSR (V. F. 'Cherepovskiy). The conference considered and adopted resolutions on problems of expanding solid fuel resources in Central Asia, exploiting the resources and further directions in geology of the solid fuels.

Translator's notes: (Neely Bostick, USGS)

1) This version does not solve some questions of terminology. An example from mining, _razrez is English "section" in many contexts, including some in mining. But here it could better have been called face or pit of a surface operation. And _urochishche has been defined in specialized geography work as a separable terrain or plant community unit, but in Kyrgyzstan it appears to be a vernacular term so could be well be given untranslated in English. like the political unit oblast' is given unchanged in English. This article has a half-dozen mining terms which would require careful inquiry to translate accurately into American English miner's terms. I did not do such inquiry.

2) I have given place names in noun form in Russian spelling, and I verified many (See the list appended to the article). Many names are hyphenated like Wheat-Ridge in the article but occur elsewhere as Wheatridge or WheatRidge, or sometimes Wheat Ridge. I have used the form in the text, with > as a connector instead of hyphen for reasons of word processing operation.

APPENDIX VI. MINING -- D. Huber

KRYGYZSTAN COAL MINING IN LATE 1994

IMPROVEMENT OPPORTUNITIES IN THE MINING SECTOR

Douglas W. Huber, PE
Mining Engineer
January 1995

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APPENDIX II

KRYGYZSTAN COAL MINING IN LATE 1994 - Improvement Opportunities
by Douglas W. Huber, P.E., Mining Engineer, January 1995

I. INTRODUCTION

This report records the condition in late 1994 of the Kyrgyzstan coal mining industry, based on impressions gained during an intensive visit as a member of a Coal Sector Assessment team led by The U. S. Geological Survey. The effort was funded by the United States Agency For International Development (USAID). The team consisted of five geologists and two consultants: a coal utilization engineer and the author, a coal mining engineer. The team spent five weeks during October/November 1994 in Kyrgyzstan studying coal industry conditions and status.

Due to the wide-spread distribution of coal deposits the team at times split into two groups, obtaining data and coal samples at thirteen sites. These sites (locations noted on an accompanying map) contain Krygyzstan's major coal producing, processing, or consuming facilities. The author personally visited six underground and seven surface mines. Two mines were selected for a more detailed study because of their potential for improvement. The two mines are a surface coal mine (Kara Keche) and an underground coal mine (Kok Yangak) and are considered to be examples of typical Kyrgyzstan coal mining operations.

This report centers on Kyrgyzstan's opportunities for improvement in coal mining operations as part of the larger subject of Coal Resource Assessment. The conclusions and suggestions stated herein refer to mining (production) aspects only and are those of the author. A daily personal journal of activities is attached for the record.

Other Studies

The complex problems faced by Kyrgyzstan in converting from a centrally-planned to a market-driven economy are clearly evident in the coal mining industry. A detailed investigation of the industry structure and future potential, currently underway, is being sponsored by the European Community (EC) TACIS Program. Although two informative field meetings were held with two members of the EC study team, no preliminary written results of their work were available. It is expected that the specific comments made herein in our analysis of current mining (as part of a Coal Sector Assessment) will provide useful inputs to the EC work in progress.

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II. KYRGYZSTAN'S COAL MINING INDUSTRY

Overview

Coal mining has been a positive factor in Kyrgyzstan's past development. The industry has been a significant source of both energy and employment, with the mining organization in several areas controlling the social as well as the economic aspects of community life. In early 1991, Kyrgyzstan's coal mining industry had a total reported annual production capacity of about 4 million tons and was operating at 93 percent of that capacity. During the Year 1991 coal production from seven underground mines and five surface mines fell to 2.5 million tons (63 percent of capacity). Total production for 1994 is forecast to reach less than one million tons (Less than 25 percent of capacity).

As a result of the 1991 changes, Kyrgyzstan became an independent republic faced with the difficult task of adjusting quickly to national independence and a market economy. Because of the impact of adjusting, the country's historic coal industry is in a crisis state and is floundering. The industry badly needs in-depth attention from the government, interim financial assistance, and a firm redevelopment policy. Short term operating money, training in western business objectives and practice, and technical assistance in profit-centered mining engineering project design and operation are desperately needed.

The magnitude of known and potential coal reserves mandates that a careful redevelopment program is carried out. Sufficient minable (ie: at a profit) coal reserves exist to warrant continued use of this fuel as a significant part of Kyrgyzstan's energy balance. Currently, coal resources are known to exist at 65 locations with less than 20 deposits mined and/or explored in detail. These coal resources (along with other prospective deposits) form part of Kyrgyzstan's natural treasure which should continue to be tapped and expanded as part of a national plan to build the Republic's capital, trading infrastructure, and expanded internal manufacturing industries. Energy from coal can and should contribute to the stabilization and growth of the Republic.

Mining or at least some mine development occurs in eight (8) widely distributed regions. A list of the regions, with mines identified can be found as Item I in the Annex.

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Recent and Current Production

There were seven underground mines and five surface mines, widely distributed, producing about four million tons prior to the dissolution of the Soviet Union. (These mines are listed, with comments, as Annex Item I.) The following table displays the total recent coal production from these mines.

ESTIMATED RECENT COAL PRODUCTION in million tons			
PERIOD	7 Underground Mines	5 SURFACE MINES	TOTAL
Pre 1990	* 2.5	1.5	4.00
1991	0.7	0.8	1.50
1992	1.6	0.6	2.20
1993	0.9	0.5	1.40
1994	** 0.6	** 0.2	0.80
* Estimated average of 10 year production ** Estimated			

The centralized control of the national economy prior to 1991 did not permit the development of Kyrgyzstan's widespread coal resources to the extent possible. As industrialization grew, indigenous coal production was not planned to expand to meet demand, rather deficiencies in supply were met by imports from the north, mainly from Kazakhstan. Due to Kyrgyzstan's mountainous terrain, railroad routing facilitated this situation. Coal has always been imported to some degree from Kazakhstan and Russia.

Steadily declining coal production since 1991 follows the decline of the general economy in Kyrgyzstan and its neighbors (all states of the former Soviet Union except China). A general realignment of all trade is to be expected, especially since no reliable medium of exchange has been established in Central Asia. The newly independent countries are currently back to bartering hard goods as a trade system. The lack of hard currency has had a strong negative impact on the coal mining industry.

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The following table illustrates the former coal supply and demand situation in Kyrgyzstan.

KYRGYZSTAN'S COAL INDUSTRY SUPPLY AND DEMAND in millions of tons			
SUPPLY		DEMAND	
Produced Internally	4.0	Used Internally	4.9
Imported	2.6	Exported	1.7
Supply Total	6.6	Demand Total	6.6

The fact that coal has always been both imported and exported can be explained by the wide distribution of the coal deposits, limited internal bulk transportation facilities of the nation, and inadequate rate of coal mining development. It should be noted that coal imports have always exceeded exports.

Institutions

The Republic of Kyrgzstan comprises a large number of Ministries with narrowly defined authorities and responsibilities. In the case of the coal industry, two different ministry-level government organizations have control. These are:

1. The Geology Committee
2. The Ministry of Industry, Trade, and Material Resources.

The progress of mine development appears to follow the following course:
The Geology Committee controls the assessment and exploration of coal resources. Both regional and detailed (mine planning) exploration are the Geology Committee's responsibility. It conducts mapping and drilling programs which are intended to prepare sufficient data to permit mine planning and mine development work to begin. Proven reserves are delineated (through development drilling) with geologic structure mapped (faults, folds, etc.) and coal quality details determined. Following this work, if reserves are sufficient, the property is declared ready for mine development and is turned over to the Ministry of Industry, Trade, and Material Resources (MITMR).

When deemed economically viable, (based on mining cost, market, and development funds availability) the Ministry (MITMR) assigns the coal property to Kyrgyzkomur (KOMUR), a government-held company responsible for coal mining. KOMUR, called the "Concern", uses the data to develop mine plans, sets a tentative schedule for

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development, obtains government funds, and eventually mines the coal. First, an appropriate market must be found.

Marketing of coal is the responsibility of the Kyrgyzstopsnab organization, also under MITMR. (However, it appears that in order to stay in operation, individual established mines have begun selling coal through local bartering agreements.)

Since all steps in mine development and operation are government-controlled, no entrepreneurship occurs. Hence, under the current national system, no free market concepts, finance sources, or actions can be introduced and tried. Total dependence on institutional processes throttles development. A program for privatization of the coal mining process is needed. Meanwhile, a noteworthy step toward free market development has taken place.

The government, through KOMUR, has begun a worthy, small scale program to encourage local small-sized surface coal mining for humanitarian purposes, and to promote entrepreneurship. The effort is called "The Small Mining Enterprises Program" and is operated by KOMUR with assistance from the Geology Committee and other offices of the Ministry of Industry, Trade and Material Resources.

The Small Enterprises Mining Program

The Small Enterprises Mining Program began operations in early 1994. The government budgeted 6 million Som (about US$ 600,000) for credit assistance for up to 20 small coal mining enterprises. About 1/4 of this amount has been issued for start-up costs (mostly used for diesel fuel) for 6 small surface mines to open under private organizations. The purpose is to start small surface coal mines for humanitarian purposes and to encourage local entrepreneurship. Each small surface mine plan is required to have the following:

- A minimum of 100,000 tons of reserves (reserves are assigned and verified by the Geology Committee),
- The capability to produce a target maximum annual production of 10,000 tons,
- A mining plan approved by KOMUR,
- Members must agree to KOMUR supervision, in exchange for the right to mine and receive financial assistance. The credits for funds are controlled by the Ministry of Industry, Trade and Material Resources.

Although complicated, this system produced 20,000 tons from January to May 1994 (there is virtually no local market during the summer). Production reached 10,000 tons in September and the expected total 1994 production from the program is about 100,000 tons. Mining costs are said to be 60 Som (US$ 6) per ton, which is about one-half the cost typically claimed at large surface mines.

It appears that no funds are set aside for surface reclamation or mine closing costs.

Markets

Other than coal sold locally near the mines for home heating/cooking purposes, coal is sold to larger individual consumers and industry through the Kyrgyzstopsnab organization, a government-owned company under the Ministry of Industry, Trade and Material Resources.

The primary market for Kyrgyzstan's coal is local heating and power plants, which use fine-sized coal particles. The majority of these markets were recently lost due to customer non-payment for deliveries, increases in rail transportation charges and rising coal prices. Meanwhile the market for coarse coal is firm. The large amount of coal fines normally produced (60 percent or more on a national basis) suggests that efforts to reduce the production of fines in the mining process may be worthwhile. In addition, the recapture and subsequent expansion of the market for fine coal through mining cost reductions, coal quality improvement, and briquetting of fines are necessary.

An untapped market for fines exists in the production of coal briquettes which can be used in light industry and some home heating and cooking. A serious expansion into the production of coal briquettes at selected mines needs to be implemented. Development of smokeless varieties can be accomplished. Further discussion of coal briquetting can be found in Appendix IV of the report.

Coarse coal is sold for use by light industry and for home heating and cooking fuel. Coarse coal, over 30 percent of coal production, is currently in short supply. In addition to improving mining techniques to produce more coarse coal, coal briquettes could supplement coarse coal in the market.

Transportation of coal is either by rail or public highway trucking. The rail routes involve what are now foreign countries which have increased tariffs to uneconomic levels. An expansion of the internal rail network as part of economic reform will assist regeneration of the coal industry and promote improvement in the general economy.

Further discussion of marketing can be found in Appendix III of the report.

Coal Resources

Kyrgyzstan's coal deposits occur in a tectonically active, mountainous area. As can be expected in such a geologic setting, considerable variation exists in coal seam position, thickness, continuity and quality. This situation does not lead to hugh coal

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deposits found in some parts of the world, but rather to a widely spread distribution of varying size coal deposits. The coal resource has been developed as demand and necessity warranted. The remaining considerable reserves should continue to be exploited. Coal is a national treasure which should be employed in assisting the development of the nation's new market economy.

Coal deposits are distributed throughout Krygyzstan, with a total of 65 known occurrences. Of these, 35 deposits have been identified and 15 prospected and developed to a varying degree. About 2 billion tons of reserves have been identified, and estimates of geologic reserves have been stated to be 30 billion tons. There is reason to believe that this number may be conservative and more exploration is warranted to identify potentially lowest cost future mining areas. Details regarding coal resources are contained in the main report.

Socio-Economic Factors

Coal has been a significant source of both energy and employment in Kyrgyzstan. Under the former system, the mining organization traditionally controlled much of the social as well as the economic aspects of life in its area. Some of this has carried over. Currently, most mines continue to provide, operate, and maintain municipal vehicles and bus services.

Consequently, the collapse of the industry is having a disastrous effect on associated mining communities and its market areas with respect to lack of, or reduction in, availability of heat and electricity and/or loss of employment in local coal-dependent industries. Short term solutions are needed to alleviate the immediate problems followed by longer term strategies for the coal industry. "Improvement Opportunities" are discussed later in this report.

Coal mined in the southwest areas was formerly transported through parts of Tajikistan, Uzbekistan and Kazakhstan to reach central Kyrgyzstan (for example, to the Bishkek heating plant). Tariff for such shipments through these now foreign countries has risen to US$800 per 65 ton car. Such costs (especially in foreign exchange) are prohibitive and since the heating plant could not pay for the coal anyway, shipments were halted last year (when the unpaid account rose to US$ 2 million). (We were told that Karaganda coal with much rock dilution is being obtained through a government barter agreement with Kazakhistan.)

Pricing

Kyrgyzstan's change to a free market economy during the past four years has disrupted many aspects of business activity. The condition of the general economy of the country can be characterized as in turmoil and the pricing of commodities is unstable. The information obtained for the purposes of this report

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in regard to coal pricing reflects these uncertainties. The coal price is certainly being affected by supply (with factors of quality and location) and by regional demand. However, the overall market can be categorized as being in turmoil because of the following.

The primary cause of the coal industry's current problem is the decline in sales of the fine coal product. The loss of this market is due to foreign price competition, government negotiation for foreign coal supplies in barter agreements, lack of internal transportation capability, and the inability of most consumers to pay for the coal delivered. This lack of cash currency payments to the mines by heating, electricity generating, and industrial plant customers for coal delivered has forced reduction in tonnage mined. Examples of large market loss for fine coal are demonstrated by the national government's barter agreements across borders, primarily with Kazakhistan, neglecting indigenous sources. In these cases, transportation costs are a factor. Also basic to the problem is the instability of the new currencies of the newly established central Asian countries and hence, the lack of established exchange rates.

As a direct result, the nation's coal production has declined over a four year period from about 4 million tons in 1990 to less than a million tons in 1994. Simply stated, the steady loss of market for the fine sizes and non-payment in cash for coal delivered to bulk consumers has forced mines to reduce or cease fine coal shipments and, therefore, maximum production. This decline in availability of funds caused mines to reduce maintenance of equipment, number of miners, support personnel, and staff.

Pricing of coal generally is made up of two main parts: (1) its price at the mine and (2) the price of transportation to its point of use. Kyrgyzstan is no exception. While a complete coal pricing analysis is beyond the scope of this study, inquiries were made and these centered on the current coal price at the mine, resulting in the following information.

<u>The Price of Coal As Mined:</u> Historically, coal price was affected by the size of coal particles available for sale. The major portion of the market was formerly coal fines defined as 5 mm or less. (One mine classified fines as 0 to 13 mm.) Coal particle sizes over 5 mm are generally considered to be coarse coal, which is used in some industries and for home heating/cooking in less urban areas. Coarse coal is currently in short supply, due to the overall decline in coal mining, while most of the fine coal fraction produced along with the coarse coal is being stockpiled due to loss of viable market. There are indications that sizes greater than 20 mm (3/4 inch) bring a premium price and are also in short supply nationwide.

In 1992, the government officially allowed KYRGYZKOMUR to set its own prices under the "Self-Financing Rule". This rule requires industry to obtain funds for future capital improvements (such as

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equipment replacement) along with recovering current production costs in the price of currently mined coal. Although we discussed coal prices with the mine personnel, we were unable to obtain details of the composition of the price. Such details require a prior disclosure agreement which we expect the current EC study has arranged for.

The coal prices listed below do not appear to be based on direct and indirect costs plus profit, but mainly on direct costs alone. The table below illustrates the range and roughly weighted average of fine and coarse coal from the answers we obtained.

COAL PRICES PER METRIC TON FOB MINES AND CLEANING-SIZING PLANTS in US$ at 10 Som per 1 US$			
COAL TYPE	RESPONSES	RANGE/TON	AVE/TON
FINE: generally, particle size 5mm or less	6	$8-$10	$ 8.70
	2	$4 & $12	n/a
NOTE: Price range is affected by quality and availability (all are high ash: 20-35%. Fines are being stockpiled at several mines.			
COARSE: Generally, particle size more than 5 mm to 20 mm	6	$9-$13	$9.70
	1	$14.60	n/a
NOTE: Quality is about the same as fine coal.			
COARSE: generally, particle size greater than 20 mm, called Lump Coal	3	$18, $20 & $22.50	n/a

Although the pricing in the table above does not appear to include all indirect costs, such as amortization charges for development, equipment and facility depreciation, and interest plus profit, this is a moot question. Production levels are so that none of the mines visited are on a sound business basis. The mine that stated a $20/ton price claimed that 18% is profit (the only mine to declare that their price included a profit) and the rest are direct costs of production. This means that true coal prices are understated, as all costs are not recovered. In order to compete in a free unsubsidized market as a self-supporting, private sector enterprise, improvements in overall production, individual miner productivity, coal quality,and cost control will have to be made. These can be accomplished through reorganization, refinancing and training.

Additional Related Notes:

- We were told, in the town of Kyzyl Kiva, that premium lump coal sells for $40 - $50/ton delivered. The supply of this coal is very limited and some of the price paid by the

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consumer will be non-monetized in the form of bartered vegetables, fuel wood or traded labor.

- The BBC television news, aired in Bishkek, interviewed people in the street willing to pay $48/ton (in Kyrgyz Soms) for lump coal delivered for winter heating, but even at such a price little coal is available.

Coal Transportation Prices: The buyer pays directly for transporting coal from mine to market. It is not uncommon for transportation charges to equal and even exceed the mine price of coal. In Kyrgyzstan, we were quoted prices of $8 and $10/ton for transporting coal in 7 to 20 ton truckloads. The transport distances applicable to such transport costs are too vague and these prices should be considered to be nothing but general indicators. We estimate that the current price for coal transportation by truck ranges from a surprisingly low $0.10 to as much as $1.00/ton-mile. (These prices currently include bartered food stuffs and other agricultural products along with some currency.) No estimate could be made on the current price of transporting coal by rail.

Finally, Kyrgystan will have to decide what its national policy will be in regard to coal self-sufficiency. Coal is available outside its borders, at probably competitive prices, but this is a matter related to national objectives and is beyond the scope of this report.

The World Bank statements in regard to the Kyrgystan coal sector as stated in an Aide Memoire, 22 October to 4 November 1994 Mission are quoted as follows.

"V. Coal,

a. Institutional Reform and Restructuring:

i. Production, Paragraph 40:The coal industry of Kyrgystan is undergoing a major crisis on account of declining demand, the inability of consumers to pay, and the high cost and low profitability of the mines. As a result, four mines have been designated for closure, and will be taken care of by the Enterprise Reform and Resolution Agency (ERRA) under the PESAC. The mission recommends that the remaining mines be slated for privatization at the earliest opportunity.

ii. Marketing, Paragraph 41:
Until recently, Kyrgyztopsnab had a monopoly on the import and distribution of domestic and imported coal. This monopoly has been gradually eroded with: (i) KNEKC importing coal directly from Kazakhstan; (ii) two depots under the Kyrgyztopsnab having declared themselves privatized (with the consent of the local authorities); (iii) Kyrgyzkomur marketing its coal directly at the pithead; and (iv) the depots having initiated programs to

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store other goods, under such circumstances the justification for Kyrgyztopsnab, as a State enterprise becomes questionable. The Mission thus recommends that: (i) the depots be converted into independent enterprises concerned with storage of coal and other goods - they should not be allowed to trade in coal (Footnote: Were the depots to trade in coal, there is a danger that they would behave as local monopolies. By providing exclusively storage services for a fee, access to the depots would be equal to all, thus creating minimum conditions for competition at the local level.); (ii) the trading arm of Kyrgyztopsnab be privatized; and (iii) entry of the private sector to coal trading be facilitated.

b. Coal Prices

42. These have been increased very sharply in real terms for both local and imported coal since early 1993. They have tripled in nominal terms over the past 12 months, thus keeping up with inflation. Demand has collapsed and may still fall further as more residential users switch to electricity for heating. KNEHC no longer buys Kyrgyz coal for power generation in Bishkek as the rises in freight rates means that coal from south Kyrgyzstan cannot compete with imported Kazakh coal in this important coal market. There is little justification for further increases in coal prices in real terms as they are about $2/GJ, close to the value of internationally traded coal in Western European markets.

c. Financial Management and Arrears

43. Similarly to other energy enterprises, the coal enterprises should introduce modern cost accounting, budgeting and budget control systems. In line with the Government's policy, coal should only be sold to consumers having the ability to pay for the product, so that the practices of prepayment/downpayment should be encouraged."

MAJOR MINING ENTERPRISES

Our assessment of coal mining capabilities of planners is that the basic concepts of mechanized, modern coal mining are well understood. It seems, however, that a rigid systems approach has been applied which lacks flexibility for adaptation to the variations inherent in individual coal deposits. For example, in the producing underground coal mines, only the mechanized longwall system (which usually produces a high proportion of fines) is being used. Missing are the lower capital-intensive "conventional" and "continuous" mining systems which often produce a greater proportion of coarse coal, but at a lower rate of extraction.

In surface mines visited, only the "open-pit" truck-shovel haul system (where trucks haul waste rock to dump areas) is in use. Innovations in the use of direct blast (explosives) casting or conveyor haulage of waste rock have apparently not been attempted. Also, limited attention is paid to control of mine water drainage. Insufficient diesel fuel and lack of spare parts are blamed for not dewatering the coal loading areas, maintaining haul roads, or uniform cyclic overburden removal operations, and doing surface reclamation work. Overburden to coal ratios appear to be high and limited highwall safety benches are being installed. The high voltage electricity distribution system (6,000 V.) feeding the shovels and two small draglines seen seemed rudimentary. We could not confirm positively the use of ground-fault protection because of a translation problem.

We were surprised to learn that equipment, such as the 10 cubic meter capacity draglines, are assigned only a 10-year life. Western practice is to depreciate draglines over 20-25 years and continue to operate them in some capacity for another 10-15 years.

Surface (Open Cast) Mining

Mechanized surface coal mining has been practiced for many years using an open pit approach common to metal mining practice. In the steeply dipping or near vertical thick coal deposits, waste rock is excavated and loaded into diesel powered, rear-dump haul trucks and hauled to a dump area. As waste rock is carried away, bench by bench, the coal is exposed and mined. Open pit mines are usually higher cost than conventional surface open cast or strip mines, but the coal deposit configuration usually dictates the mining system required to be used.

The cost advantage of open cast mining is that large excavators remove and place the waste rock overburden directly (or possibly place it on conveyors) with limited rehandle. In principle, waste rock should be moved only once, with some exception for surface reclamation which must proceed as close to mining as possible. It appears that no surface reclamation work has ever been done and the current emergency financial conditions do not permit the start of such work at this time.

The following description is intended to illustrate the mining conditions which are typical of Kyrgystan surface coal mining.

Kara Keche Surface Mine Details

Background: The Kara Keche surface coal mine is located about 80 km by road northeast of the Agulak/Kara Keche Mining Headquarters Complex at Min Kush. Of this distance, 30 km is secondary road south of the village of Chaek. This mine, currently considered to be under development, has potential for expanded production assuming that the so-called "basic" seam being mined maintains its thickness (said to range from 45 to 90 meters including partings)

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and lateral extent. The decision on the amount of cubic meters of overburden to be removed for each ton of coal exposed is controlled by costs of mining the overburden (the economic stripping ratio).

Coal Seams:

Mining began in 1940 in small mines at coal outcrops of two seams, the upper "Compound" (1 to 10 meters) and the lower "Basic" (average 45 to 90 meters). The "Basic" seam of which about eight meters is currently being mined at Kara Keche apparently lies in a northern limb of a synclinal structure which dips in a southerly direction at a low angle. Where observed, the coal is overlain by several meters of a ceramic quality clay (which has been produced in the past) and a thick (10 to 20 meters) of claystone/mudstone. Lying above this is a varying thickness (over 10 meters) of sandy gravel containing small boulders. The coal seam lies over a consistent underclay of about a half meter thickness.

Coal Quality: A sample obtained at the coal mining pit face will confirm (See analyses in main report) the following information. The coal is said to be sub-bituminous with 15% moisture, 13% ash, less than 1% sulphur and 6,900 to 7,350 Kcal/Kg.

Mining: Overburden Removal: A truck/shovel system, common to metal mining, is used to remove overburden. Two diesel-powered shovels of 5 cubic meter capacity are used on typical benches loading overburden into two 45 ton diesel rock trucks which haul the overburden varying distances to rock dumps. Bench height in the gravel portion is 7 to 10 meters and in the sedimentary rock, 15 to 20 meters. Some of the sedimentary rock can be dug by the shovels directly, but drilling and blasting is required occasionally disrupting the loading cycle.

The current ratio of overburden to coal (cubic meters/ton) is about seven to one. Indications are that this ratio will increase significantly (possibly to 20 to 1) as mining continues in the present location. A detailed re-engineered mine plan may provide a lower cost, long-life mine for the Kara Keche coal reserves.

Coal Mining: Coal is mined by one 1.5 cubic meter diesel "back-hoe" excavator. Since the mine does not own coal haul trucks, private or other agency highway trucks of 5 to 20 ton capacity are loaded by the excavator on the excavator bench. Although ground water was said not to be a problem, in spite of some attempts at pumping, about a meter of water was present down along the bottom of the coal face. Coal trucks are forced to negotiate this deep water during the loading process. The upper part of the coal seam was said to generally produce 35 per cent fines (sizes less than about 5mm) but is currently producing 65 per cent fines. The lower part of the seam contains broken coal ranging from five mm to eight cm. The loader (back-hoe) operator is said to be able to distinguish between coarse and fine coal and loads the trucks accordingly. A stockpile of fine coal (for

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which there is no current market) estimated to be at least 3,000 tons, is located adjacent to the current mining pit.

Production and Coal Price: Coal production is expected to reach only about 50,000 tons during 1994, a significant decline from the over 100,000 tons said to have been produced previously. The coal is sold FOB mine pit, in local currency, for $8 to $9 a ton for coarse coal. The fine coal brings only $4 per ton and, as stated before, the market has declined for this product. Coal haulage costs are said to be about $10 per ton which is paid by the consumer to the trucker. We were told that some coal is hauled 150 km to the power and heating plant at Balykchy at this price.

Workforce: Fifty miners are currently employed at Kara Keche Mine. (When judged in comparison to other similar mines in Kyrgyzstan, 50 miners may not include all support staff required and the number may be as high as 200 workers.) Since most of the miners do not live near this remote operation, two crews of miners work 12 hour shifts for 15 days and are then given time off to return home while another two crews replace them for 15 days. Miners are supposed to be paid the equivalent of US$ 25 per month and lodging at the mine but instead receive bartered foodstuffs when available. At the time of our visit, miners had not been paid in currency for two months.

Underground Mining

The underground coal mines visited employed similar equipment and methods for mechanized longwall mining. Single entries on either side of the panel being mined had been driven instead of the minimum of two usually required. This was probably done as an expediency to get the panel into operation quickly or to save costs by eliminating the additional airway passages. A consequence of only having one entry is a reduction in safety.

Mechanized longwalls with shearers generally cut hard, compact coal into small pieces. Selection of this system is usually based on the potential for high production of fine coal which can be achieved with fewer miners, where subsidence of the overlying surface can be tolerated. In spite of the relatively high capital investment, longwalls usually produce lower cost coal due to high productivity. Where coarser coal is desired, a "conventional" room and pillar system, with pillar recovery, may be more appropriate. In this method the coal face is usually undercut, drilled, and either lightly blasted with low flame (permissible) explosives or high pressure compressed air cartridges. Although more labor intensive, this system does not require as high a capital investment as longwalls and produces coarser coal. Coarse coal is currently in short supply due to the fact that fine coal cannot be sold and is being stockpiled. It is likely that the "conventional" system described may have

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been used in the past but was supplanted by the potentially more productive longwall mining systems.

Surprisingly. no typical drum-type "continuous" miners were seen. "Continuous" miners are widely used, electric powered machines operated by one man. These machines cut and load the broken coal onto shuttle coal carriers or extendable conveyor belts. A similar machine called a "road header" was being properly used for driving entries for passageways. Since "continuous" miners may produce less fines than longwall systems, in a situation where the previously described "conventional" system is not applicable, a test program using a "continuous" miner is warranted.

Health and Safety: All miners wear safety helmets with cap lamps and carry self-rescuers (emergency oxygen units). No steel-toed shoes or boots, or safety glasses are worn. Also, probably because the mines do not appear to produce much dust, no individual miner dust protection or air sampling devices are provided. No rock dusting is done to reduce airborne coal dust and flame propagation. Air flow quantity does not reach western mining requirements, but appears to be adequate. Most conveyors are equipped with safety stop-wire devices and off-center stop switches, but limited guarding of pinch-points exists. General housekeeping needs improvement and discarded or broken equipment should be removed at least from manways and airways in the mines.

Kok Yangak Underground Mine Details

Background: The Kok Yangak mine is located near the city of Kok Yangak (which is about 20 km northeast of Oblast headquarters city of Dzhalal Abad). The mine is near the paved highway which is sited southwest to northeast through this part of Kyrgzstan. A railroad connects the mine with the international (Uzbekistan) route and, southwest, to Osh at Kara Soo.

Although the Kok Yangak underground mine began as a small surface mine as early as 1932, sufficient reserves remain to warrant continued operation utilizing the existing infrastructure and experienced mining personnel. The mine will require an investment to devise a new mining plan, to refurbish facilities, and to re-equip it. Kok Yangak's is a large mine with internal and adjacent reserves, good access to markets, and sufficient experienced mining personnel to continue as a profitable operation once investment is made in its future.

Coal Seams and Reserves: The mine has produced coal from three seams, the upper #5, the middle #6, and the lower "M" (Moshchnyy). Most of the coal mined came from the #5 and #6 seams. These two coal seams are close together in places or actually combine and are mined as one seam. The structure is a monocline in the mine area, dipping 17 to 21 degrees to the west. Much faulting with unpredictable direction and size of offsets complicates mining. Coal thickness of the combined #5 and #6 seams ranges from 3 to 5.7 meters which includes a varying thickness of easy cutting claystone partings. (We were told the thick section was mined in two separate cuts.) The rock partings usually occur in three layers of varying thickness but where the central parting increases to a maximum of 4 meters, only one 3 meter segment is recovered in the upper #5 seam.

Total reserves are said to be 32 million tons with nine million tons minable in the existing mine. This would allow about a 13 year mine life at a production level of 500,000 tons/year at the claimed recovery of 72% with the existing longwall mining system. A possible extension of the mine exists eastward across a deep ravine where there are another 9 million tons of indicated reserves in the Markay sector. An unknown percentage of these reserves are considered recoverable.

Coal Quality: The coal is high volatile bituminous long flame (D) rank with 8-12% moisture, 7,750 Kcal/Kg (dry, ash free) calorific value. Ash ranges from 9-16%, averaging about 12% on hand picked product, but about 23% as mined. Sulphur content is only 0.7-0.9%, which makes this coal an excellent boiler fuel.

Mining: Underground mining began in 1937 through a vertical shaft which is now used as part of the ventilation system. Other shallow shafts were installed and later, entries sited in hillsides called the 72 South and the 72 North entries at the 1,600 meter elevation level were driven on the coal seam's buried outcrop. We were told that some old clinker from surface burning of the coal seams extended as far as 80 meters in from the

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outcrop. Later, entries at the 1,370 meter elevation level were driven. These portals are called Kapital-North and Kapital-South and are entries for the extensive 9.7 km underground electrified rail haulage system. Later, an entry at the 1,200 meter elevation level was driven, with connections to the 1,370 m level, as an airway and gravity water drain. We entered the mine through the 1,200 m level. An entry from the 1,000 meter elevation level is about half complete, requiring the construction of a slope of about 400 m to the 1,200 m level. The new portal will provide gravity drainage and access between the 1,000 m and 1,370 m levels. Work ceased on this tunnel 6 months before our visit due to the lack of funds and materials.

We were told that room and pillar mining was tried with indifferent success (probably due to difficulty in holding the weak roof). A longwall system was applied, which resulted in better coal recovery. Support at the face was provided by post jacks and beams. Hand mining at the longwall face was done with pneumatic picks. Coal broken from the face was hand shoveled onto a chain conveyor. Coal production varied due to difficulty in removing the jacks and beams to allow the mined-out area to cave. Insufficient conveyor and rail haulage in removing cut coal also contributed to unpredictable production rates. The currently used hydraulic longwall face shields and face chain conveyor were put in place in 1971. Also, a new conveyor system and a 150 ton underground surge bin for loading underground rail cars were installed on the 1,370 m level. As the underground haul distances grew, a heavy duty rail system (appears to be at least 90 #/yard rail) evolved on the main haulage level. This main underground haulage line is 9.7 km long and in a normal situation is an important factor limiting coal production.

Normally, twelve electric trolley locomotives were employed in trains of what appear to be about 12 ton cars. These trains were loaded at the 150 ton underground surge bin and hauled the coal to either the Kapital North or South portals. When the two longwall faces were in full production, several trains were required to keep the surge bunker from filling (which would cause production stoppages at the longwall faces). Such longwalls are usually high volume producers routinely cutting and delivering via the face chain and outbound conveyor system in excess of 1,000 tons per eight hour shift. Removing the coal from the mine is, typically, the bottleneck and is the reason a total belt conveyor system has replaced rail train coal haulage in western mines. Such mines currently only use rail (if not replaced by rubber-tired vehicles) for bringing supplies and the workforce into the mine.

The depth of the mine in the production area averages about 250 meters, which represents a typical rock load. The broken nature of the rock due to tectonic forces, as evidenced by extensive faulting and some folding in the area, presents a challenging support problem for development openings. The weak roof, however, aids in the desired caving of the mined out area as the longwall advances.

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The longwall faces are planned at 100 meter width, with a varying length of up to a maximum of 1,000 meters limited by deposit conditions. Achievement of such length is rare due to faulting and the rolling nature of the seam. Much rock is necessarily mined along with the coal due to the partings and other seam conditions. Rock dilution is a clearly visible problem requiring, at least, rock picking and, preferably, coal cleaning at a surface plant.

Currently, two adjustable double drum shearer longwall systems (called complexes) are in use, complete with hydraulic face shields and chain conveyors. A wire rope conveyor system (the conveyor is hung from the roof) about one meter wide carries the coal to the surge bin.

Longwall panel entries are driven with an electric powered "road header" cutting and loading machine. The cut coal is loaded into a shuttle car or extendable belt which carries it to a temporary conveyor belt. Supporting the newly excavated entry in weak roof conditions appears to be a problem, as yieldable steel arches with complete lagging are installed at approximately one meter centers. Roof control is obviously a problem, as no roof bolts or other fast, low cost methods of support were seen (posts and beams, etc). This is unfortunate, as yieldable arches are relatively more costly to purchase and install. Also, the face advance is delayed longer due to installation of arches, reducing the development coal tonnage produced and lengthening the time for panel development.

Only single entries on each side of the longwall panel were seen although we were told that dual entries are usually driven. We were unable to determine why and surmise that the use of single entries was a cost and time saving expedient, however, at the price of safety for longwall access and ventilation.

In normal western practice three development headings on each side of the longwall panel are required. One heading contains the development conveyor belt, another the ventilation air inlet and the third, an air return. Conveyor entries are not allowed to be used as airways. A drum type electric continuous miner (cutting and loading machine) similar to the "road header" cuts the coal and removes it from the face. The machine advances two to five meters, depending on roof conditions, with the operator required to be always positioned under supported roof. The continuous miner is withdrawn and trammed to one of the two adjacent faces through a cross cut, which are installed at ten to thirty meter intervals depending on roof conditions. The newly cut roof is immediately supported by temporary jacks and is roof bolted, or otherwise supported, before the jacks are removed. The face is then ready for another cut by the continuous miner which follows a systematic cycle.

<u>Production:</u> The mine grew to a maximum production of 720,000 tons in 1976 and had been producing at about the 500,000 TPY rate until 1990. Recent mine production is listed below:

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KOK YANGAK UNDERGROUND MINE PRODUCTION		
YEAR	TONS/YEAR	COMMENTS
1986-1990	507,000	5 Year Plan Average
1990	488,000	Estimate
1991	380,000	
1992	280,000	
1993	212,000	
1994	70,000	Official Estimate

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Workforce: The following table displays the distribution of workers when the mine was producing coal during the last five year plan (1985-1990) average rate in comparison to the 1994 production rate.

KOK YANGAK UNDERGROUND COAL MINE WORKFORCE		
WORKER LOCATION & JOB TYPE	NUMBER OF WORKERS AT 500,000 TONS/YR	NUMBER OF WORKERS AT 70,000 TONS/YR
Underground workers: Miners, roof support, transport,	1,000	480
Surface workers: Shops, maintenance, coal cleaning & handling, office, hostel, food service, municipal, utility,	1,000	400
Total Workers	2,000	880
Productivity, tons/manday: Underground production workers	about 2	about 0.5

The rapid decline in production, due chiefly to loss of market, has reduced the mine (and apparently all others in Kyrgyzstan) to emergency conditions in order to stay in operation. Assuming that the market can be regained and a meaningful cash flow established, the former production of two tons per man day is far too low. Such production is below modern western practice by a factor of 5 to 10 or better, thus illustrating a need to improve reliability in cyclic mining operations while reducing workers where practical. (Current productivity, at about 0.5 tons/manday, reflects the decline into an emergency condition.)

A note of caution is necessary when comparing worldwide statistics on productivity rates. The real criterion that should be used is the actual total cost of labor per unit of production. Recognizing the difficult nature of underground mining work, the target labor portion of the coal sale price (total cost plus profit and taxes) can and should eventually range from 40 to 60 percent. Mining requires skilled labor, and when recognized as such, standards for workers can be raised along with expected increases in productivity.

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As an interesting part of its workforce history, we were told that the mine was operated almost totally by women during the Great Patriotic War (World War II). Currently, women only work in surface jobs.

Coal Pricing: The mine price of coal is US$ 14.60 per ton, which appears to cover only direct production costs. There is no special price for the fine coal fraction, which is 65% of production. Most of the fines produced are being stockpiled, although some fine coal has been be sold to nearby heating plants in Uzbekistan under local barter agreements. The mine stopped supplying coal to the Bishkek heating plant due to not being paid. We were told that after US$ 2 million worth of coal was shipped and not paid for, the mine simply quit shipping it. The Bishkek plant now uses Kazakhstan coal from Karaganda under a government-level barter agreement. One factor in this change in market was the rise in railroad shipping cost, reported to be US$ 800 per 65 ton car.

A final comment regarding the Kok Yankak underground mine: The reserves left to be mined and the socio/economic factors in the area affected by the mine warrant keeping the mine open in the future. This mine has the potential to be operated at a profit, but will require an investment in funds and skilled effort do so.

IV. IMPROVEMENT OPPORTUNITIES

Kyrgyzstan's coal industry faces many challenges in adapting to a market-driven economy. Opportunities which will assist in meeting the challenge exist in both the institutional and technical aspects of the industry. These opportunities could attract International as well as national interest.

International Sector

Opportunities exist for international trading institutions, development banks and foreign donor agencies to benefit from free market growth in Kyrgyzstan's energy sector. Such opportunities worthy of attention are:

- Expansion and modernization of national coal resource assessment,
- Technical assistance in coal briquetting activities,
- Training by demonstration through formation of western-style coal mining corporations.
- Technical coal mining improvements.

- Technical assistance to the newly begun private sector coal mining enterprises.

National Institutional Improvement Opportunities

Since a successful market economy depends a great deal on price competition as a major component, it is necessary to create competition in the production and marketing of coal. Experience has shown that profit-motivated enterprises obtain these results at lowest cost. It follows that entrepreneurship and special management talent is required to increase production while reducing costs and improving both quality and reliability of supply.

There are indications that private ownership of business is being encouraged. The Public Enterprise Sector Adjustment Credit (PESAC) rules favor industrial privatization. Coal mining needs special government attention and future government incentives need to encourage private ownership of mines, funded by private capital. This is consistent with the World Bank views cited above.

Examples of successful conversion of industries from government to private ownership are dramatically demonstrated by recent actions taken by the West/East German governments. While most of the investment funds originated in West Germany, a large amount of money and vital industrial knowledge came from the international community. A similar transformation of the Kyrgyzstan coal industry can occur through an infusion of leveraged private investment, coupled with profit-centered management and improved technology.

The design and implementation of a national strategy for energy industry privatization is necessary. The privatization program must be expansive; it must include international participation for all aspects of the coal industry. The new ideas and technology brought to Kyrgyzstan will cover method of assignment of coal property leases, mining operations, transportation, utilization and the marketing of coal. Fortunately, a beginning has been made in the Small Enterprises Coal Production program recently begun under the control of Kyrgyzkomur (KOMUR) and the Geology Committee. Specific institutional suggestions are listed below.

- Expansion and adoption of the most modern methods of coal resource assessment for the entire country, including studies of utilization, mining and marketing.

- The "Small Enterprises" coal mining program for encouraging local small surface mines (humanitarian coal production for local needs with a limit of 10,000 tons per year) is a commendable step needing a greatly expanded program of scope and financial assistance.

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- The Kyrgyz government needs to quickly solve the complicated problems associated with cross-border (international) trade. Although this subject is beyond the scope of this study, it is clear that foreign currency exchange problems have negatively affected coal mining and all other industry as well. (The lack of funds in the internal economy has reduced the industry to paying miners with bartered farm goods and bread.) Generally, local industries and in most cases the coal-consuming population have limited money for buying coal. (An associated technical problem with coal particle size is addressed in the technical section below.)

- Individual mines cannot continue to carry the social burdens imposed on them under the former system. Improvement opportunities exist at each mine as ones with potential are reorganized as potential profit-making business activities. In the short term, subsidies to individual mines serving internal markets may be required during a sorting-out and learning period. This is considered reasonable, given the extreme importance of an indigenous coal industry to the country. (Kyrgyzstan has only seven percent arable land, and needs to develop all other resources to prosper.)

- Considerable opportunity exists in improving the internal transportation system as a national program. The current railroad is inadequate for movement of coal and general freight within the country. Owing to the mountainous terrain, the past construction of rail lines followed easier but much longer routes regardless of borders. The result has been segmentation of the railway system within Kyrgyzstan. New and improved highways are needed.

- A coal briquetting industry needs to be developed for the fine coal produced. Further discussion on briquetting opportunities can be found in Appendix III to the main report.

Technical Improvement Opportunities

While Kyrgyzstan coal mining has evolved along mechanized mining concepts, many technical improvements are not in evidence. These improvements were developed in the west because of the economic necessity to produce coal at the lowest possible cost in order to stay in business. Technical innovation coupled with a production-oriented work attitude (both of which can be achieved through some capital investment, training and increased worker financial reward) will produce improvement.

Several specific technical improvement possibilities noted during the field visits are listed below according to type of mining, surface or underground.

<u>Improvement Opportunities in Surface Coal Mines:</u> Mining coal at low unit cost from the surface has prompted development of

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massive equipment and highly technical operating systems. Large capital investment and a well-trained and highly-motivated workforce are required. The ability and range of management must match the scale of the project as well. The potential is large. Some examples of improvement opportunities in surface coal mining follow.

- Limited innovation in moving overburden is evident in the surface mines visited. (Only the truck-shovel method was used, except that two small electric draglines of 10 cubic meter capacity were digging, probably in waste rock rehandle work.) To lower costs, comparisons between conveyor systems, blast-casting of rock, or direct excavator placement (as with large draglines or bucket-wheel excavators) may be productive.

- Prevention of water accumulations in coal loading pits will lower equipment (loader and haul truck) costs, and improve coal recovery. Also, control of surface runoff water (and water pumped from pit sumps) by use of retention/settling ponds will reduce future reclamation costs. In very wet areas, dewatering by pumping from water wells in advance of mining can be assessed for cost effectiveness.

- Maintenance of coal haul roads reduces haul truck costs. Roads in the mines are in poor condition. It is assumed that the shortage of diesel fuel results in a low priority on road maintenance.

- Strict cyclic operating and maintenance schedules with individual equipment records will lower costs and provide data for making informed decisions. Such records will assist in lowering repair and replacement costs.

- Lighting for night operations will improve production rates and safety.

- To provide equal operating conditions for the day and night shifts, adjustments in the work shift start times to equalize daylight for the two main production shifts is successful in some western mines.

<u>Surface Mine Health and Safety Improvement Opportunities:</u> Strict attention to health and safety matters, while humanitarian in principle, in fact reduces mining costs. This double benefit is generated when all employees do their work with a conscious attitude about safety. The following are several opportunities noted.

- In future surface mining, highwall safety benches need to be installed in an approved sequence to intercept dislodged rock which may tumble down the face, causing injury and damaging equipment.

- Electrical distribution facilities, especially high voltage, need to be designed, built and maintained at high standards. Positive ground fault protection, cable handling and repair and electrical hazards training will reduce costs.

Improvement Opportunities in Underground Mining: The limit for technical improvements which assist high production in underground coal mining ultimately depends on roof rock strength and the support system required. The weaker the rock, the more costly and time consuming the support system becomes, which in turn usually reduces the potential for fast, reliable coal production.

Worker ability and attitude toward innovative technical systems and teamwork requires consistent training and attention. Management's objective should be high production at lowest cost without compromising safety. Workers' objectives are high, stable pay and benefits (which can be linked to safety records). Other significant cost improvement opportunities follow.

- Reduce rock dilution in the mined coal by simply not cutting rock and mixing it with the coal. If rock must be mined along with the coal, the rock should be removed from the coal stream as close to the mine portal as possible to reduce dilution rock transportation costs.

- Provide "scalping" screens to eliminate cut rock which had to be cut at the coal face. Also, adding rock "picking" tables could be considered.

- Improve ventilation systems through use of more effective technology.

- Add dust and gas detection apparatus along with suppression and elimination systems.

- Install multiple access entry ways in all development workings.

- Improve roof support system design and use. (Specifically, roof bolting along with tension cable systems and sprayed concrete or "guniting".)

- Add machine pinch-point guarding, particularly at conveyor transfer locations.

- Replace rail coal haul with belt conveyor systems where possible.

- Review electrical distribution systems for adequacy and safety features such as ground fault protection.

- Provide formal training and retraining for employees. Seek and use technical production and safety ideas obtained from employees during training discussions.

Underground Mine Health and Safety Improvement Opportunities: In most cases it is difficult to separate benefits to safety from production improvement items. Improvements in safety aspects of mining operations usually yield increased production and lower costs. Underground coal mining operations need dependable roof support, good ventilation, reliable access and miner personal protection against job hazards. Diligent attention to worker health and safety pays in reduced costs, higher production and a stable work force.

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ANNEX

Item I: KYRGYZSTAN'S COAL REGIONS AND COAL MINES

(1) **Issyk-Kul region in the northeast:**

Dzhergalan underground mine (bituminous; an old mine; high cost mining; supplied power plant at Kara Kol).

Suguty underground mine (sub-bituminous; formerly mined for uranium content, now local use only; will probably close).

(2) **Kavak region in central Kyrgyzstan:**

Agulak surface mine (sub-bituminous; an old mine; high cost mining and truck transportation).

Kara Keche surface mine (sub-bituminous; can be further developed; truck transportation). A detailed description of this mine appears in the report.

(3) **North Fergana region in west-central Kyrgyzstan (Tash Kumyr area):**

Severnay underground mine (bituminous; an old mine; high cost mining; truck and railroad transportation; lost fine coal market).

Kara Soo surface mine (bituminous; an old mine; truck transportation to cleaning plant at railhead).

Kara Tut Central and Kara Tut West surface mines (bituminous; old mines; truck transportation to cleaning plant at railhead).

Tegenek underground mine (bituminous; new mine: development halted due to lack of funds; near existing infrastructure; has 35 million tons reserve, coal dips 16 degrees, incomplete 2.6 km horizontal entry; needs new reassessment).

(4) **South Fergana region in west central Krygyzstan (Kyzyl Kiva area):**

Lenin-Komsomol underground mine (bituminous; very old mine; screening plant; rail and truck transportation; lost market for fines in Uzbekistan and Kazakhstan; has a problem with a fire; essentially shut down).

Almalyk surface mine (sub-bituminous; an old mine with high overburden to coal ratio; production low due to 40-50% fines; has large reserves of cement-grade limestone; truck transportation).

Almalyk underground mine (sub-bituminous; experimental mine being driven into highwall; will use a caving system in thick coal; expect 5 year life; truck transportation).

Abshir surface mine (sub-bituminous; an old mine-almost closed- with high overburden to coal ratio; production low due to almost all fines; truck transportation; has reserve of weathered coal being mined as humic soil conditioner and drilling fluid additive; has large reserve of minable plaster-grade gypsum):

Yetan surface mine (sub-bituminous; small mine being developed).

Valakish underground mine (bituminous; experimental; thick vertical coal seam; an innovative adaptation of sub-level caving

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from metal mining; produces 50% fines, mainly being stored at mine; low mining costs expected; truck transportation).

(5) **East Fergana region in east central Krygyzstan (SE of Kok Yangak area):**

Contains 17 named coal localities in a belt of Jurassic coal bearing, folded and faulted rocks which extend from near Dzhalal Abad southeasterly to the China border. The coal ranges from bituminous to anthracitic.

Small Enterprises Mining Operations (bituminous; several small surface mines serving local market; remote locations; difficult truck transportation in most cases; controlled by KOMYR).

Kumbel area small surface mines: Tashim, Jabad, Malik, Alty Bai, and Nichke (bituminous; 53 seams reported; tragic recent mudslides in area; difficult access; some historic local mining; Tashim: 3 years production; Malic: begins next year; others working this year; difficult truck transportation).

Kara-Tyube area (bituminous to anthracite; coking reported; known and lightly prospected; no reported production; needs assessment).

Kok Yangak underground mine (bituminous; drift-type mine with horizontal openings; extensive workings over 9.5 km length; screening plant; rail transportation; structural problems; reserves indicate potential; needs refurbishment). A detailed description of this mine appears in the report.

(6) **Alay region (including the mountains north and south of it) in the southwest:**

Small Enterprises surface mine (probably bituminous; difficult access; new operation; lack of roads; local market). (Note; seven named coal localities exist; area needs assessment.)

Kzyl-Bulak area Small Enterprise surface mine (bituminous; being developed while exploration continues; local high demand market; truck transportation).

(7) **South central region (the Ak-say, Uselek-Turugart, and others) occurrences isolated east of the Fergana range in the south central part of the country.** (Note: Region was not visited; coal reported by Geology Committee; needs assessment).

(8) **Chui region (near Kazakhstan border north of Bishkek:** (Note: Region was not visited; coal reported by Geology Committee; needs assessment).

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SUMMARY

Background

Following World War II the Kyrgyzstan coal mining industry was modernized and expanded to eventually provide over four million tons of fuel for domestic heating plants, industrial heating and processing and electricity generation. Such facilities used the fine sized (less than 5mm) coal particles produced, about 2/3 of total production. The remaining larger sizes (about 1/3 of production) was used industrially, and in local heating and cooking fuel.
Coal has been a significant source of both energy and employment, with the mining organization in several areas controlling the social as well as the economic aspects of life.

Since the dissolution of the Soviet Union in 1991, coal production has declined steadily from about four million tons per year to less than one fourth of its former capacity. A number of reasons can be identified for this decline, the major ones being loss of market for fine-sized coal, not being paid for coal produced and delivered, and high transportation costs. The collapse of the industry is having a disastrous effect on mining communities and their market areas in both humanitarian aspects (lack or reduction of heat and electricity) and loss of employment in other local coal-dependent industry.

Similar to the rest of the economy, a barter system has evolved also at the mining level which does not provide the flexibility inherent in monetary transactions. A chain reaction follows with obvious results once the mining units have no funds to pay for repair parts and supplies (when available) or mining labor. (Most of the "employed" miners have not been paid fully in currency for several months but accept bread, potatoes, flour, and cabbages which the mining unit has obtained by bartering coal.)

Other problems include an impractical burden on almost all mines such as providing municipal and other social services, and the inability of the local consumer to pay for coarse coal with cash. The departure through emigration of seventy percent of the technicians and experienced mine staff, aging mines with little past innovation attempted, and production of too much fine-sized coal for the current market to absorb are additional problems.

Improvement Opportunities

In spite of the existing dismal situation, realistic improvement opportunities exist for both surface and underground coal mining which can assist in rejuvenating the industry. Such opportunities can be divided into "Institutional" and "Technical" actions.

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Institutional: Improvement opportunities include government actions which lead to privatization of the coal industry. Mechanisms for investment of internal and international funds need to be established. The government, businesses, and education systems need to actively promote the understanding and adoption of free market concepts which have been successful in the West. Such improvements will affect all industry in a positive manner.

Technical: Improvement opportunities exist in both surface and underground mining. Basically these involve innovative adaptation of proven Western practices. All are aimed at reducing the cost of mining, improving worker productivity, or raising the quality of the coal produced. Selected mines and coal reserve areas need to be assessed for "new life" mining potential. A priority plan for private sector participation in rejuvenation of existing mines and the development of new mines needs to be implemented quickly. These private sector projects will seek specific markets with price and tonnage targets. Increasing transportation efficiency of coal is an obvious part of the process.

Training of all personnel in safety improvement and equipment operation and maintenance will improve individual miner productivity. A teamwork approach to achieving the goal of raising coal production while improving coal quality through reduction of dilution rock will lower costs and improve coal demand.

Surface mines: Revamped mining plans aimed at reducing overburden amount are a priority for surface mines. To lower costs, comparisons between conveyor systems, blast-casting of rock or direct excavator placement (as with large draglines or bucket-wheel excavators) should be attempted. The key is innovation in removing overburden at lower cost, coupled with improving the efficiency of truck loading operations and haul road design and upkeep. When carefully pursued, such innovations will provide higher production at lower cost.

Improved lighting for night operations will increase safety and lower haulage costs. Control of mine water and diversion of surface water away from the mining area will reduce mine water problems. A general improvement is personal safety items such as hard hats, steel-toed shoes, safety glasses, and protective gloves will reduce costly accidents and promote miner well-being.

At Kara Keche surface mine, the thickness, extent and quality of the coal resources make it worthwhile to re-engineer this mine to meet Western practice. Overburden to coal ratio can be decreased and lower cost methods of overburden removal can be found. Improved coal loading, upgraded haul roads, and strict maintenance schedules will lower costs. Training of miners to improve equipment operation efficiency and safety practices will increase productivity. Upgrading the miners' living and working

conditions will contribute to lower costs and improved productivity.

Underground mines: Revision of support systems in access entries is required to obtain maximum production from existing longwall equipment. Adaptation of multiple access entries driven by existing "road-header" continuous miners is needed. Roof support using variations of the roof bolting techniques available should be attempted.

Continuous belt conveyor coal transport to the surface, eliminating underground rail haulage, will prevent costly work stoppages in the production area. In addition to the longwall systems in use, alternate methods such as room and pillar "conventional" and "continuous" mining should be considered as a means to reduce the production of fine coal sizes.

Although miners wear safety helmets with cap lamps and carry self-rescuers (emergency oxygen units), no steel-toed shoes or boots, or safety glasses are worn. Also, no individual miner dust protection or air sampling devices are provided. A program initiating additional health and safety requirements will reduce costs and improve production. Other operational safety aspects which need attention are rock dusting to reduce airborne coal dust and flame propagation, increased ventilation air flow quantity. Although most conveyors are equipped with safety stop-wire devices and off-center stop switches, increased attention to these details and guarding of pinch-points is needed. General housekeeping should be improved.

At Kok Yangak underground mine, the existing and adjacent reserves, infrastructure, and experienced mine personnel warrant efforts to improve its operation. Although a large older mine, Kok Yangak mine's positive aspects and ready access to market make it a good candidate for operation as a profitable demonstration and training project. This mine would certainly benefit from the above mentioned continuous conveyor coal transport system and improved roof support system.

APPENDIX VII. UTILIZATION -- C. Harrison

Coal Utilization Specialist

Final Report

INTRODUCTION

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INTRODUCTION

Objectives

The Kyrgyz Republic, a part of the former USSR, lies in the south of central Asia. Its territory of 198,500 square kilometers borders on Kazakhstan, Uzbekistan, Tajikistan, and, mainly to the south, with China. The population of the Republic is about 4.4 million people.

The Republic is rich in hydroelectric resources and in coal. There are also occurrences of oil and natural gas. Coal deposits are reported to include 620 million tons of industrially-explored coals and an estimate of at least 1,360 million tons as reserves. The deposits appear to comprise about 65 percent brown coal (subbituminous in American usage) and the remainder largely high volatile bituminous coal.

In 1991 coal was produced from seven underground mines and five open pits, the total having a capability of producing about six million tonnes annually. In 1991, the total coal output is reported to have been 3.5 million tonnes, 1.7 million tonnes from open-cast mining and 1.8 million tonnes from underground mining.

Worsening geological exploitation conditions and lowered expenditures for reconstruction and building have brought about significant technological, economic, and social problems in the coal industry.

The Kyrgyz Republic possesses prospectively attractive but undeveloped coal deposits. The largest is the remote Kavak brown coal deposit at 3,200 meters above sea level showing 763 million tonnes. Here, two basic coal deposits could be developed--Kara Keche with indication of 482 million tonnes and Min-Kush with indication of 123 million tonnes. However, their full development is hindered by lack of railroads and by local consumers for the by-product coal fines. The Kavak coals have a low percentage of impurities (the ash content is 10-15 percent).

The Uzgen coal deposit is the largest coking-coal deposit in central Asia, showing almost 800 million tonnes. The Uzgen coals, compared with Kuzbass coals, contain lower sulfur, phosphorus, and ash. They are suited to producing high quality metallurgical coke.

In order to meet the Republic's demands for solid fuel, it is estimated that coal output should grow to reach an output about five million tonnes by 2000, with current coal imports then coming to a halt. Further development in the coal industry will require considerable investment during the period 1994 to 2010.

Growth of coal consumption obviously depends on the domestic markets for coal and the ability of the Kyrgyz coal mining industry to produce competitively with imports. Growth also depends on the ability of the coal industry to compete with other sources of supply and to overcome transportation obstacles. The more promising export opportunity could come from the development of the metallurgical coal deposits. Competitively-priced coal production is a separate subject which will be addressed by a coal-mining consultant under a separate scope of work. One concern in market development is markets for the fine coal portions of the coal output.

The European Community (EC) is sponsoring on-going work in the coal sector of the Kyrgyz Republic. However, their work does not include technical and economic study of briquetting the finely-particled coal for sale. The work described in this report presents the investigation of coal utilization options investigated for IDEA, Inc. which will also support the EC briquette marketing study.

Coordination with Work by Others

Prior to visiting Kyrgyzstan, IDEA Inc. advised the coal utilization specialist that others from the European Community were interested in this topic. Contacts were made with Mr. William Pemberton and the information he provided indicates that their evaluation of utilization alternatives is being withheld, pending the results of work sponsored by US AID through IDEA.

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Consequently, they provided no information or guidance to the utilization specialist.

During the visit, IDEA's coal utilization specialist (Mr. Harrison) met with Mr. Ned Popovich of Burns and Roe who was on assignment to evaluate potential reconstruction of the Bishkek Heat Electric Central Station. Mr. Harrison had several conversations with Mr. Popovich to gain an understanding of the Burns and Roe effort and to coordinate pertinent coal-related issues.

Mr. Harrison accompanied the USGS personnel of the coal resource assessment team and the coal mining specialist on several visits to mines and power stations, and maintained close contact with their work in progress. Following the visit, USGS provided splits of coal samples, copies of coal quality analyses, and field information related to coal utilization to Mr. Harrison.

During the visit, Mr. Harrison also had meetings with Mr. Manfred of IDEA to review preliminary plans and results and to discuss preliminary recommendations.

Integration of Work and Report

A preliminary field report was provided to USGS and IDEA at the conclusion of the visit. This report served as preliminary input to the integrated assessment report prepared by the USGS team. Moreover, Mr. Harrison worked closely with Hal Gluskoter of USGS in preparing sections of the final report related to coal utilization and transportation, and he reviewed sections of the report and conclusions prepared by others.

Working with splits of USGS coal samples, CQ Inc. also conducted empirical briquetting tests to evaluate the potential for low-cost technology to improve Kyrgyz coal utilization. Using splits of the coal samples collected by USGS, CQ Inc. engineers experimented with animal fat as a binder, since it is readily available in Kyrgyzstan. The pellets made from fine coal and animal fat did not maintain their shape integrity with minimal handling, leading to the conclusion that a better binder is needed. Experiments are on-going with lime and/or high-carbon fly ash to determine if the pozzolonic properties of ash are sufficient for it to serve as a binder.

Overview

In Kyrgyzstan, coal is produced from 7 underground mines with a total capacity of about 2 million tonnes and 5 opencast mines with a total capacity of almost 2 million tonnes. Actual production has fallen from about 4 million tonnes in 1990 to about 1.7 million tonnes in 1993, and 1994 production is expected to be less than 1 million tonne. Recent industry statistics show the following

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Kyrgyzstan Coal Production

	1990	1991	1992
Production Capacity (Mtonnes)			
-Underground	4.1	4.1	4.1
-Opencast	2.2	2.2	2.2
Actual Production (Mtonnes)	3.7	3.5	2.3
-Underground	1.9	1.8	1.1
-Opencast	1.8	1.7	1.2
Percent Lump Coal*	32	31	31
Percent Fine Coal*	68	69	69

* Industry definition is about 5mm marginal size between lump and fine coal. Source: Amanaliev, N. A., Muraliev, A. M., and Tuleberdiev, Zh. T., 1993, "The Energy Program Of Kyrgyzstan"

About 50% of the coal produced in Kyrgyzstan is used in the country and the balance is sold or bartered to other republics. As part of its barter system with other republics, Kyrgyzstan also imports some of its coal needs in situations where domestic coal is more expensive than imports. Following are the available statistics on coal imports and exports.

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Kyrgyzstan Coal Imports (in thousands of tonnes)

	1990	1991	1992
1. Kazakhstan - total	916.5	812	547
"including high quality"	-	-	5.7
2 .Uzbekistan - total	756.2	703	394
"high quality"	220.2	134.0	83.7
3. Tajikistan - total	198.1	162.0	34.0
"high quality"	148.2	87.0	23.8
4. Turkmenistan - total	83.8	43.0	19.2
"high quality"	63.2	29.0	15.0
Total	1954.6	1720	994.4
Percent of total mine production	52.2	49.4	46.3

Large Consumers of Coals Exported from Kyrgyzstan (in thousands of tonnes)

	1990	1991	1992 (est)	1994 (est)
In Kazakhstan				
Chimkent heat and power station	-	-	1.6	10 10
Kentansky h & ps no. 5	305.0	282.5	192.6	100
Kezel-Ordinsky h & ps no. 6	514.0	445.5	342.5	200
In Uzbekestan				
Ferganskaya h & ps	234.5	308.0	188.6	15
Kuvasjskaja Metropolitan Regional Electric Station	84.0	40.4	28.4	20
In Tajikistan				
General Population	NA	NA	NA	40
In Uzbekistan				
General Population	NA	NA	NA	10

Source: Personal Communication; Ministry of Industry and Trade

Imports and exports have declined over the last 4 years, indicating a declining coal demand throughout the potential market area for Kyrgyz coal. The energy production in the region is increasingly shifting from coal to hydro; the demand from the population for residential heating is declining because electricity is more convenient and it can be purchased on credit; and heating plant consumption is declining because these plants are not generating enough revenue to pay their fuel expenses and they are being taken out of service when steam production is not essential. Moreover, the cost of rail transportation from southwest Kyrgyzstan to the population centers in the north and east regions and the deterioration of highways and local roads discourage the use of coal outside the mining regions. Some projections of coal demand indicate an increase in the total Kyrgyz consumption and exports to a total of 8 million tonnes by 2010, but this requires a significant increase in demand for industrial and regional boiler plants, and there is no evidence that the infrastructure will support such growth.

The current users of coal in Kyrgyzstan are shown below:

Major Coal Users in Krygyzstan

Customers	1994 (in Thousand Tonnes)
Bishkek Heat Electrical Central	365
Issyk Kul Electrical Enterprises (Kara Kol)	130
Kyzyl Kiya Boiler Station	20
Kara Balta Boiler Station	40
Balykchy Boiler Station	50
Kormenty Cement	50
Kant Cement	20
Bishkek Block Plants	20
Kinda Cable Plant - near Kara Balta	10
Kyrgyz residential fuel supply	400
Kyrgyz Carbon Sales (commercial and institutional)	125
TOTAL	1230

The Kyrgyz coal industry attributes much of its market constraints to the problem with using fine (smaller than 5 mm) coal, and there is a groundswell of interest in briquetting/pelletizing. Laboratory experiments are being conducted by the Kyrgyz Academy of Science, the State Committee of Science, and the Department of Science of

the Ministry of Industry and Trade to assess the briquetting characteristics of Kyrgyz coals and to evaluate additives/binders for coal briquetting. There are currently no funds to support pilot- or demonstration-scale facilities in the Republic, although there are some test facilities set up for experimenting in a facility near Osh. While the research projects continue to pursue technical objectives, there does not appear to be a corresponding effort to assess the potential markets for briquettes and the sensitivity of those markets to the price of briquettes. Since all energy sources--coal. gas, oil, electricity, hot water, and steam--are currently subsidized in different ways, the task of evaluating the economics of an alternative energy form is formidable.

US AID-sponsored field work to evaluate coal utilization alternatives included visits to selected power plants, steam heat plants and mines is described in the following sections.

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PRICING STRUCTURE AND COAL DEMAND FORECASTS

Although coal is mined, transported, sold, and used in Kyrgyzstan, there is little semblance of an actual coal market. From interviews and observations, Mr. Harrison concludes that the price paid by the electric utility, heat and industrial plants for coal has little to do with the value of the coal for its intended purpose or the actual costs of delivering the coal to the user.

For example, the price of heat, hot water, or electricity delivered to the consumer is set by a government agency on the basis of the amount the consumer can afford to pay in the local economy. In fact, if the consumer cannot afford to pay for the energy received, the energy provider receives no revenue but still provides the energy. From the revenues actually received by the energy provider and subsidies provided by the government, the energy producer pays labor costs and other direct costs and the remainder, if any, is paid to the coal provider and transporter. The coal provider and transporter deduct their labor and other direct costs and the government subsidizes any shortfall. It appears that neither the coal provider nor the energy producer are recovering depreciation which would provide capital for reconstruction, mine development, and replacement of aging equipment.

Pricing Structure

Coals that are imported and exported are frequently exchanged in a barter arrangement for goods or services. Although it is the intention of both parties to make the barter at "world energy prices" the actual prices of the energy and other goods exchanged in the barter are adjusted based on the amounts of goods and services exchanged so that no hard currency needs to change hands. Although these arrangements provide the immediate means to satisfy consumer demands and maintain the survival of local economies, they discourage industrial investment, development, and maintenance or reconstruction because prices do not include recovery of depreciation or return on investment.

Another difficulty with international barter arrangements is that quality or value is not linked to actual price paid. This situation has led to the delivery of high-ash coal to the Bishkek heat power station and the Kara Balta electrical enterprise and the plant operators have no choice but to burn the poor quality coal, thereby causing inefficient operations and higher-than-necessary emissions so that electricity can be produced and exported back to Kazakstan in exchange for the coal. The logical solution of converting these stations to Kyrgyz coal is not presently feasible because the Kyrgyz railroads and highways are inadequate to transport Kyrgyz coal from the mines where it could be produced to the power stations where it could be burned.

The domestic use of coal for home heating is closer to a traditional market. The home owner that uses coal pays a retailer a market price based on the availability of coal from the retailer and the demand for coal in the local community. As a result, price fluctuations sometimes prevent poor families from being able to afford coal for home heating and supply shortages can result in rapid price increases for consumers that can

afford them. Recent publications indicate this situation exists in Kyrgyzstan at the present time.

Consumers who cannot afford market coal prices have a choice of living without heat or using portable electric heaters, some of which are homemade. Since electricity is subsidized (and in some cases free if the homeowner cannot afford to pay the bill), converting a home from coal to electricity is perceived to be less costly than a free market would dictate.

Since the prices and subsidies of electricity and coal are so tightly controlled by the government, any predictions of future energy prices are likely to be inaccurate because the basis for such predictions would be speculative. Similarly, projections of future coal demand must be based on expected changes in population, the economy, and industrialization rather than a free market based on the expected value of energy.

Coal Demand Forecast

In 1992 the Kyrgyzstan Ministry of Economy and Finance and the State Power Company engaged a group of energy specialists and scientists in the task of developing a proposed energy program for the Republic. Their report includes an assessment of the prospects for coal supplies to the economy of the Republic and this assessment appears to be the most reliable and current demand forecast. It suggests a modest increase in coal demand, coupled with a rise in the price of coal and continued replacement of coal-fired home heating systems with electrical systems. Modest growth in industrial and central heating plants is also projected, as shown in the following table.

	1993		1994		1995		2000		2005		2010	
	t.t.	%	t.t.	%	t.t	%	t.t.	%	t.t.	%	t.t.	%
Requirement total	4300	81.1	4500	80.4	4700	80.2	5300	90.4	5700	79.7	6400	85.3
Including												
Thermal power stations	1080	25.1	1250	27.6	1300	27.7	1100	20.8	1000	17.5	1000	15.6
Industrial & regional boiler units	840	19.5	850	18.9	1000	21.3	1750	33.0	1100	38.6	2900	45.3
Population	2240	52.1	2250	50.2	2250	47.8	2300	43.4	2300	40.3	2300	35.9
Other needs	140	3.3	150	3.3	150	3.2	150	2.8	200	3.6	200	3.2

The projection also anticipates the reconstruction of the Bishkek Heat Power Station by the year 2000 which is currently being studied by the complementary US AID project. The result of this reconstruction and the planned gradual replacement of coal-fired power stations with new hydroelectric facilities results in an increase in coal demand for power generation in the mid-90s, followed by a decrease in demand, finally leveled off at approximately one million tons per year early in the next century. Since the financing has not been secured for major construction efforts on hydroelectric projects, the projected coal demand for thermal power stations in this report may be too low in the first decade of the

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next century. If the construction of the hydroelectric facilities and associated transmission and distribution lines is not dramatically accelerated, the demand for coal to generate electricity could remain at 1.3 million tons well into the next century, about 30 percent more than is currently projected.

The projected demand for industrial and regional boiler units shows significant growth from 840,000 tons in 1993 to 2.9 million tons by 2010. Such dramatic growth is logical since coal is likely the most economical and reliable source of energy for industrial development in the Republic. Oil and gas supplies are primarily imported from other countries, electrical supply will the limited until the hydroelectric plants are completed and significant improvements are made to the transmission and distribution infrastructure. A growth of the industrial economy in Kyrgyzstan must be fueled by coal.

The demands by the domestic population and other needs are expected to remain relatively constant at about 2.5 million tons through the turn of the century. A potential cause for alarm is that although current coal demand is estimated at 4.3 million tons per year, the actual production in 1992 was approximately 2.3 million tons, representing a continued decline in production in the 90s. Without depreciation recovery and return on investment, the productive capability of the Kyrgyz mines will continue to decline, although the 1992 projections call for coal production to be twice as much as current levels within the decade. If the productive capability of existing mines is not maintained, and preferably increased, increasing demand for imported coal will place further strains on the Kyrgyz economy and may limit industrial development due to a lack of domestic energy.

FIELD VISIT TO KYRGYZSTAN

Mr. Harrison traveled to Kyrgyzstan from October 8 to October 22. During much of that time, he visited industrial coal-using facilities with Mr. Gluskoter from USGS and various representatives from the Kyrgyz Ministry of Industry and Trade. By visiting coal mines and coal-fired industrial facilities, a more complete assessment of the coal utilization infrastructure was possible.

Bishkek Heat Electric Central

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Hal Gluskoter and Clark Harrison visited the Bishkek Heat Electric Central on October 12. They met with Mr. Vladimir Prokophevich Zhuchenko, chief of Industrial Technical Department of the Electric Holding Company.

The station receives bituminous (black) coal by 50-52 car trains from Karaganda in Kazakhstan. The coal is about 18% moisture, 40% ash and its delivered price is reported to be about $36/tonne ($18 for coal and $18 for transportation). The station's 24 boilers were commissioned in 1961-1985.

There are 2 types of units at the station :
11 boilers at 220t/h of steam with electrostatic precipitators
13 boilers at 160t/h of steam with wet venturi particulate scrubbers

Five of the boilers (manufactured in Russia) were in operation in October and the remainder will go into service this winter to meet peak demands. About 413,000 tons (90 days supply) of coal was in inventory for winter use, and the coal mills are double-roll and table design which must be overhauled monthly. Gas and oil co-firing is frequently required due to the ash content of the coal. Boiler efficiency was quoted as 85-86% gross, 82-83% net. These boilers burn about 1.5 million tonnes of coal per year to produce 70-80MW of electricity in the summer and up to 500 MW in the winter peak in addition to supplying heat and hot water to the city of Bishkek. The power is sold in northern Kyrgyzstan and southern Kazakhstan.

When the electricity is "sold" to Kazakhstan, oil and coal are purchased from Kazakhstan and the payments essentially "balance out". (Gas is purchased from Uzbekistan at world price.)

Ash from the Bishkek station is disposed in ponds and less than 10% is used in construction products. Coal handling and ash disposal are done as 3-shift operations and maintenance is done on daylight shift only. A total of 1200 workers are employed at the station.

During the tour, Mr. Gluskoter photographed a statistics bulletin board. Some of the figures for 1993 were:
176 Thousand Gigacalories
2828 Gigacalories/KWH
9.73% Auxiliary Power
200 MW Working Capacity

Mr. Zhuchenko suggested that we should also visit smaller power and heat stations at Kara Balta and Karakol. He also provided us with copies of the 30th anniversary brochure for the station..

Kara Keche Mine

On October 13 Hal Gluskoter and Clark Harrison accompanied USGS representatives Landis, Bostick, and Johnson and mining consultant Huber to the Min Kush area to visit

two active coal mines--Kara Keche and AK-ULAK--and an inactive heat plant at Sector No. 16.

Mr. Kamchybekov travelled with the group to the Kara Keche Mine. En route, we saw the Kant cement plant.

The Kara Keche Mine employs 50 people to surface mine about 50,000 tonnes/year, although the production rate is limited by markets rather than production capacity. Mr. Kadazki, mine manager for Kara Keche and AK-ULAK said that Kara Keche produces about 35% fines (smaller than 3-5mm) and 65% lump coal. Fines are shipped to Balykchy Heat Plant and similar plants at Naryn and Chaek. These markets are as much as 235 Km from the mine and all coal shipments go by truck over a long gravel haul road.

There is no preparation of the as-mined coal. The mining equipment operator visually determines the distinction between lump and fines, and trucks are segregated accordingly. Most of the fines are found in the top of the coal seam and lump coal is taken from the bottom. The trucks from customers are loaded directly from the pit, although a small stockpile is maintained to load larger trucks or to handle higher demands. Trucking is contracted by coal purchasers and the average trucking cost is $10+/tonne according to Mr. Kamchybekov.

Inspection by USGS personnel indicates that Kara Keche coal is subbituminous and analyses provided by the mine operators indicate the sulfur content is less than 1%, moisture is about 15%, and ash is about 13%. The mine analyses show heating value is about 6902-7344 KCAL/Kg on a dry, ash-free basis. The coal is friable, giving a further indication that it easily degrades into fines.

Mr. Kadazki said the coal from Kara Keche is sold for about 129 COM (about $12) per tonne of lump coal and 120 COM (about $11) per tonne of fines. Initial observation--with a premium of only 9 COM ($1) for lump coal, it will be difficult to recover any investment in briquetting.

Ak-ulak Mine

Hal Gluskoter and Clark Harrison also accompanied the USGS team (Landis, Bostick, and Johnson) and mining consultant Huber to AK-ULAK Mine on October 14. Mr. Kamchybekov met the group at the mine.

The AK-ULAK Mine employs 250 people to produce 50,000 tonne per year, but is productive capacity is about 250,000 t/y according to manager Kadazki. AK-ULAK coal is about 20% fines which is less than the "average" or "typical" Kyrgyz coal (35% fines), also according to Mr. Kadazki. Fines and lump coal from AK-ULAK are shipped to the same markets as the products from Kara Keche. These markets are as much as 250 km from the mine, and all product is shipped by truck over an unimproved local road.

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Although there is currently no preparation of coal products from AK-ULAK, there is a portable screen on site that was used for removing fines and rock from lump coal sometime in the past. At AK-ULAK, the large mine trucks (about 40+ tonne capacity) are used to haul overburden and coal from the mining area. The coal is segregated in stockpiles (lump or fines) to dry out before shipment in smaller (8 to 20+ tonne) trucks. Trucking is contracted by the coal purchasers at an average cost of $10/t, according to Mr. Kadazki.

The AK-ULAK coal is similar in appearance to the Kara Keche coal, and in this mine the fines are also removed from the upper part of the coal seam. Mr. Bostick obtained the following analyses from the mine geologist:

Ash Content 5.1-31.8 % (Dry Basis)
Moisture Content 9.1-21.2 %
Sulfur Content 0.41-3.02 % (Dry Basis)
Heating Value 6438-7446 KCAL/Kg (Dry, Ash-free Basis)

Mr. Kadazki also provided some information on mining costs. He said that the sales price of 120 COM provides some profit to the mines, but does not allow them to recover any depreciation on equipment. The price also includes 16-20 % VAT tax.

To further evaluate briquetting potential, Harrison collected a small (about 10-pound) sample of the AK-ULAK fines.

Additional Observation--Rail transportation from AK-ULAK and Kara Keche is impractical due to mountainous terrain and the cost of new rail facilities that would be needed for the rather small production rates of these mines.

Sector No. 16 Heat Plant

On October 14, Hal Gluskoter and Clark Harrison, accompanied by the USGS team of Landis, Bostick, and Johnson and consultant Huber, visited the Sector No. 16 Heat Plant which operated from 1954-1993. The plant is about 6 km (25 minutes drive) from AK-ULAK Mine and it was investigated as a possible market for AK-ULAK mine coal.

The heat plant has 3 pulverized-coal boilers and 2 steam turbines rated at a total power output of 10MW. Three ball mills (one per boiler) pulverized the coal that was used to fuel the wall-fired boilers to produce 35 t/h of steam for electricity generation and local domestic heating.

Our inspection showed the plant to have no remaining life due to the age of equipment, its present state of repair, and the presence of asbestos throughout the plant for boiler and steam pipe insulation. Any effort to utilize this plant would likely conclude that it should be decommissioned and replaced rather than repaired.

The former plant engineer told us that when the plant shutdown, local people resorted to the use of coal and homemade electrical resistance heaters. There are current plans to build centralized electric boilers for domestic heat.

Observation--when faced with the option of purchasing coal for home heating or using electricity that would not have to be paid for until the future (if ever), local people chose to use the electricity. Although logical, this decision does not help the coal industry or the economy.

Issyk Kul Enterprises of Electrical Network (Kara Kol)

On October 17, Clark Harrison met with Mr. Meder Bartzkovich Baitkov, Chief of Electric Network Enterprises and Mr. Victor Ivanovich Lemesch, Deputy of Main Heat Supply Engineer. The Karakol station produces steam and hot water for 100 houses, 4000 apartments, and a few industrial customers from approximately October 15 to April 15 each year. They do not supply hot water in summer months because it is not economical to operate the plant for such a small heat demand.

The Russian-designed plant of 6 boilers has been in operation since 1961. These boilers have a design capacity of 25t/h of steam at an efficiency of 0.7 GCal/t of coal. In the past, they were stoker-fired with a mixture of Dzhergalan and Soguty (from the Kaja Sye mine) coals (blended by front-end loader) about 20mm size. The mine at Soguty is essentially closed now and coal is presumably not being shipped to Kara Kol. Mechanical dust collectors (cyclones) collect about 50% of the fly ash from each boiler, but very fine fly ash is emitted with the flue gas. Total coal consumption is about 100,000 tonnes per year, but based on a 6-month operating schedule, the 1994 coal burn is expected to be 54000-55000 tonnes, having the approximate qualities shown below.

Analyses of Coals Burned at the Kara Kol Heat Station

	Dzhergalan (Black Coal-"long Flame)	Soguty (Brown Coal-"short flame")
Ash (dry basis)	7-9%	13-16%
Moisture	9%	11-17%
Heat Value (KCal/KGram A.R.)	5000	3800
Size (approx)	20mm	20mm
Cost (FOB mine) (as of 10/1/94)	197com	150com
Transportation Cost	65com	60com*
Distance	70km	130km*

* Distance is further, but the roads from Soguty are better. For comparison purposes, one tonne of coal from the southern region to Kara Kol costs 320com.

To accommodate the differences in quality between current coal supplies, to increase boiler efficiency (carbon in ash was as high as 40%) and to extend plant life, the plant staff (under Mr. Lemesch's leadership) has reconstructed one of the plant's boilers to incline the bed, increase residence time by lowering the stoker in the furnace, and increase slag removal capacity. The reconstructed boiler was tested in August and performed very well--carbon content of the fly ash between 10 and 15 percent and noticeably lighter fly ash color. Moreover, the steam production capacity has been increased to 40 tonnes per hour, and the air heater has been eliminated. Reconstruction of a second boiler using this design is planned in 1995.

A cost reduction program has been implemented in all facets of plant operation to generate the budget for the boiler reconstruction. By going to a 6-month operating schedule, the plant staff was placed on temporary layoff (no salary) and fuel costs were reduced. These savings are significant because 65% of the plant operating costs are fuel and 11% are salaries (labor). Heat rate (Kg/Cal in fuel versus GCal of heat output) was also improved from 350 to 213 and employees were asked for their help in reducing plant power consumption and minimizing/reusing their scrap metal and waste.

The 1994 budget for the plant was approved by the Energy Company and the plant's cost reduction program was then implemented to fund the boiler reconstruction. Coal and coal transportation costs were negotiated to save money, in addition to the 6-month shutdown, staff was reduced by about 5% by attrition and overall, a total of 9 million COM was saved through September 30. The reconstruction budget was 3 million COM and 6

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million COM was passed on to the Energy Company. Recent cost escalation for coal and materials necessitated quarterly budget reviews. Some of the impediments to further savings are the shortage of coal in summer months and a shortage of coal transportation equipment (maintenance is particularly a problem from Dzhergalan to Karakol due to the poor condition of the road and asphalt costs about 700,000 COM per km). In the past, 50,000 tons of coal was moved from south Kyrgyzstan by rail to Balykchy, by barge across Lake Issyk and then by truck to Karakol, but the cost of this coal is now unaffordable because of rail tariffs in other countries.

Steam from the station is sold for residential use (homes and apartments) for 15 COM per GCal and to industry for 165 COM, although production costs are 200 COM per GCal. Costs not covered by revenues are funded by the Energy Company. Since this operation is not profitable for the long term, there is consideration of conversion to electric boilers for residential and industrial steam and hot water supply . However, the power supply to Karakol is presently inadequate to handle these new boilers and local load growth which was 35% last year.

There are 4 100-KV transmission lines leaving Balykchy to the east; two lines are on the north side of Lake Issyk and two are on the south side. Two of the lines go about halfway to Karakol and two lines (one north and one south) go to Karakol. Mr. Baitkov said that during peak load periods, the lines are 112 kv in Balykchy and only 85 kv in Karakol. In the future (1997), the European Reconstruction Bank may provide a loan to install a 220-km line on the south side of Lake Issyk, about halfway to Karakol to serve a planned gold mine. This line will cost about $34 million and another $18 million is needed to extend the line to Karakol. Another 220-km line is being planned on the north side of the lake for 2000.

Observation--The plant is emitting 50% of its fly ash production because they have no money to install baghouses or other particulate control equipment. If the boiler fly ash is pozzolonic (like most U.S. subbituminous coals), it may be economical to collect more of it and use it to repair/rebuild the road to Dzhergalan. Coal production and road maintenance are two means of employing local people and developing infrastructure to attract new investments.

Kara Balta Heat Electrical Central

On October 20, Hal Gluskoter and Clark Harrison met with Director Kokofkin and Main Engineer Aleksander Pavlovich Kolperkoff of the Kara Balta station. This station was constructed in the late 1950's to provide electricity, steam and hot water to a uranium processing plant, a gold processing plant and the local settlement of plant workers for all 3 plants. It also serves a few other nearby industries and residences and it can sell electricity to the Energy Company. The station employs 220 operating, service, maintenance and administrative staff. In essence, it is a coal-fired cogeneration plant.

A gas-fired heat station serves a carpet factory in Kara Balta and an oil-fired heat station serves a sugar plant there. Another gas-fired heat station between Bishkek and Kara Balta

was being converted to coal firing, but the construction was halted due to a lack of capital funds.

The Kara Balta station historically used 200,000 tonnes of coal per year, but its current use is only 150,000-160,000 tonnes because gold and uranium are no longer being imported for processing at the local plants. The current stockpile is 80,000 tonnes from Karaganda and Ekibustuz in Kazakhstan.

The plant was designed to burn Kazakhstan coal with ash content of about 26%, but current shipments are approximately 36% ash, which increases plant operations and maintenance costs and cause the plant to continuously co-fire oil with the coal to control flame stability. Current energy production costs are not competitive with hydroelectric power, but the conversion to electric boilers would cost too much. The characteristics of Kazakhstan coals that make them attractive to the plant owners are volatile matter (20-27%) and ash melting temperature (over 1300° C). The plant staff is concerned that other coals (specifically Kyrgyz coals) will cause problems with dust fires/explosions (due to volatile matter of over 30%) and/or boiler slagging (due to ash melting temperature less than 1300° C). The other characteristics of the Kazakhstan coal are maximum sulfur content of 0.7%, dry basis, and heat content of 3800-4600 KCal/Kg, as received.

There are 7 pulverized-coal boilers of two general sizes: 4 boilers at 35 tonnes of steam per hour for each boiler and 3 at 75 tonnes of steam per hour for each boiler. Two of the smaller boilers are in cold reserve because they were being converted to gas, but gas prices escalated during the reconstruction and the project was left unfinished. In the summer months, only 1 boiler is needed to meet customer energy demands and 2 or 3 are needed in the winter. Since hydroelectric power rates are cheaper, the plant produces only 1.5 MW using 150 tonnes of coal per day in the summer and 10-11 MW using 800 tonnes of coal per day in the winter.

Fly ash is collected by dry cyclones and is sluiced with water to nearby landfills. Bottom ash is also disposed in landfills. Some local block plants tried to use the plant's ash, but the blocks did not maintain their integrity in the winter (probably due to the high carbon content of the ash).

The station has 4 turbines that can be served by any of the boilers to meet these capacities: No. 1 Turbine 4.6 MW; No. 2 Turbine 6.0 MW; No. 3 Turbine 10.5 MW; No. 4 Turbine 12 MW.

Around the station there are acres of flat, unoccupied land that could be developed for industrial use. Observation--the resources are in place in Kara Balta to develop a major industrial center that is ready to be served with heat, steam and electric power from an existing on-site facility.

GENERAL OBSERVATIONS

Briquetting

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Representatives of each subbituminous coal mine stressed to the field team the importance of developing briquetting or other fine coal utilization technology because Kyrgyz coal may contain as much as 80 percent fines (smaller than five millimeter topsize) when it is ultimately used by the coal consumer. Some of the coals are found in the seam as a conglomeration of fine particles, some breakup during the mining and transportation activities and others degrade into fines as they weather and oxidize in storage at the point of consumption. In any event, the fines content of Kyrgyz coals limit their utilization potential.

During the visit, team member Bostick visited a laboratory of physical and chemical analysis of the Southern Filial of the Kyrgyz Academy of Sciences in Osh. During his brief visit, he observed a large hydraulic, cylinder press that was previously used for coal briquetting research and demonstration. At that site, he also saw two large hydraulic presses, one of which is steam jacketed to run as hot as 200°C. These presses have been used to make briquettes of Kyrgyz coal with various binders, including limestone slurry, residue from cotton seed processing and grape harvesting, bentonitic clay, and other materials. Mr. Bostick's visit to the lab and discussions of the team with mine operators, confirm that the Kyrgyz approach to briquetting is to develop technology for large, centralized facilities to be located at the mines to transform coal fines into briquettes which would be shipped separately from the coarser coal to stoker-fired facilities and the general population for home heating. Work by others in Germany, Pakistan, Indonesia, and elsewhere confirms the technical and economic feasibility of this approach in economies with strong currency and fuel markets that are traditional supply and demand based. With the current price controls and subsidies in the Kyrgyz coal market, no capital investment or increase in domestic coal price can be afforded, so the centralized briquetting operation would have to be government-sponsored and the briquetted product would have to be sold at a subsidized price.

Alternatively, if a simple, low-cost briquetting technology were developed for use by home owners or their retail fuel providers, the marginal cost for using briquetted coal could be minimized, current production and delivery systems would remain intact, and the coal user would be responsible for briquetting the unusable fines after they are delivered to the point of use. The home-based or "community-based" briquetting approach is premised on the abundance of low-cost local labor with a high work ethic (in the home-based approach, responsibilities for briquetting would likely rest with women and children in the Kyrgyz culture.)

From a technical standpoint, just-in-time briquetting in the community or in the home permits the use of lower-cost, locally-available binders which may have a limited life in use. For example, empirical tests by CQ Inc. indicate the possible use of corn starch, farming residues, or fly ash as binders and a hand-operated hydraulic press as the briquetting tool. Further development of the briquetting tool to simplify its operation, minimize the number of working parts and production cost, and confirm its effectiveness on all Kyrgyz coals is appropriate.

The empirical tests conducted by CQ Inc. used crushed splits of the field samples collected by the USGS team during the visit. To assemble a large enough sample for the

briquetting tests, some of the USGS splits were combined based on coal type and quality analyses, but the tests are not sufficient to conclude that their results are applicable to the entire population of Kyrgyz coals or that the binders used represent the most abundant, lowest-cost material available to domestic coal users in Kyrgyzstan.

By-product (Ash) Utilization

To complement the coal utilization assessment for the Republic, a corresponding assessment of by-product utilization is also appropriate. During the visit, the field team discussed ash utilization with heat power station and district heating plant personnel. Although they reported some previous unsuccessful efforts to use coal combustion by-products, there are no existing industrial uses for such by-products and little attention focused on developing a market for them.

Technical representatives of the plants visited indicate that the carbon content of fly ash from existing combustion facilities is generally 15 to 40 percent and most facilities use cyclones or mechanical dust collectors to capture about 50 percent of the fly ash that is produced during combustion. Since cyclones and mechanical collectors tend to collect only the coarsest-size ash and since the carbon content of the collected ash is much higher than U.S. utilization technologies allow (typically, a maximum of five percent), fly ash utilization is unlikely until the combustion performance of existing power stations is improved, resulting in lower carbon content of the ash, and fly ash collection systems are improved (with the addition of precipitators or baghouses which would collect finer-size ash).

Bottom ash from pulverized coal-fired boilers and slag from stoker units may be useable as road base and aggregate, pending further sampling and analysis to confirm particle size analyses and quality characteristics.

Ash from home furnaces and stoves is land-disposed which provides a soil conditioner and some mineral supplement that is not harmful in the quantities disposed.

R&D ORGANIZATIONS IN THE REPUBLIC

The technology used in Kryghyz mines and power plants is roughly equivalent to US technology of the 1940s. Industrial facilities are structurally competent, technically sound, and durable, but the processes employed are labor intensive, thermally inefficient and environmentally problematic, not because of a lack of technical know-how or experience, but rather because of a lack of capital for replacement, reconstruction, or modernization.

When the Republic was part of the Soviet Union, most of the coal research and development was performed in Moscow and directed by the central government.

Within Kyrgyzstan, some research and development activities were carried out by the Central Laboratory of the Committee of Geology, although this work did not focus on coal utilization.

Some coal briquetting research and testing was conducted in Osh in the Southern Filial of the Kyrgyz Academy Sciences and the equipment is still in place. However, funds, personnel, and other resources are needed if the briquetting work were to be resumed.

Due to the remote locations of Kyrgyz coal mines, power stations, and heating plants and the limitations of their transportation infrastructure, technology transfer opportunities are limited to mail, telephone, and occasional faxes and visits. (Note: Fax machines and computers are uncommon and the costs of electronic communication are still prohibitive in the Republic.)
Consequently, implementation of research results and training are slow, evolutionary efforts.

TRANSPORTATION SECTOR ASSESSMENT

Coal is delivered to its users by truck or rail in Kyrgyzstan. Although barges were used in the past to transport coal over Lake Issyk Kul, they are no longer in service.

In the northern part of Kyrgyzstan, a major rail line runs from Lake Issyk Kul (Balykchy) through Bishkek to Kara Balta. Although some small spurlines operate from the main line, its main connecting lines are to the north, entering Kazakhstan. The mines in central and northern Kyrgyzstan do not have rail access so their shipments to customers are by truck and the northern coal users import coal by rail from Kazakhstan. The roads for truck transportation were paved under the government of the Soviet Union, but there is little funding available for maintenance, repairs, or upgrading and the heavy truck traffic causes significant deterioration in the road surface.

In the southern and western coal producing region of Kyrgyzstan, coal can be transported by rail or truck to local power stations and it is exported by rail to the west. The roads in the southern region are equal or worse than the roads in the north. Moreover, the roughness of the terrain makes the roads in central and southern Kyrgyzstan more dangerous.

A major new rail line has been proposed from northeastern Kyrgyzstan, near Balykchy to the southwest Osh region. This rail line is critical to the intra-Republic use of coal. It would allow coal from central and southern Kyrgyzstan to be transported by rail to large coal-burning facilities in the north, it would provide increased supplies of coal to the population along the route, and it would reduce road deterioration caused by heavy truck traffic. Moreover, construction of the rail line would provide substantial employment and a means of transporting other goods and people within the Republic.

METALLURGICAL COAL MARKET

There is currently no metallurgical coal production in Kryghyzstan. The outcrop of one reserve was sampled by USGS representatives, but because the coal was weathered the free swelling index did not confirm its usefulness for metallurgical purposes.

Further sampling and analyses are necessary to confirm Kryghyzstan resources of metallurgical coal and to assess prospective markets. Such markets will be limited until international markets are established among the former Soviet republics.

UTILIZATION PLAN

The objective of the utilization plan is to increase the market for Kyrgyz coal without adversely affecting the environment or disrupting the local economy. Implementation of the plan should be prioritized based on the time frame in which favorable results can be delivered. For example, improving coal utilization at existing coal-fired facilities should be the first order of business and longer-term, higher-capital cost measures should be pursued later.

Large, Existing Plants

While in Kyrgyzstan, Mr. Harrison toured power plants in Kara Kol, Bishkek, and Kara Balta. He found that the plants are well run and there is abundant, experienced, competent labor. However, because of a lack of funds for maintenance and modern instrumentation, the plants are running at efficiencies well less than can be attained with the present equipment.

Potential Savings From Boiler Efficiency Improvement at Bishkek Heat Electric Central

Carbon in Fly Ash (%)	Potential Annual Savings per Boiler (1994 U.S. Dollars)	Boiler Efficiency (%)
40	0	0
30	412,454	5
20	744,884	10
10	1,018,518	15

The low efficiency of the power plants is evidenced by their particulate emissions and the high levels of unburned carbon in the fly ash produced. In some instances there are carbon contents around 40 percent. Both the low efficiency and the high unburned carbon levels, though symptoms of the same problem, have separate adverse impacts on the quality of life and the Kyrgyz economy.

- Currently, power generated at these stations is bartered for coal and oil with Kazakhstan to the north of Kyrgyzstan. Because of the low plant efficiency, an unnecessarily high proportion of these fuels is used for producing electricity rather than for heating and transportation.

- Because of the inefficiency of the power plants, the cost of hot water or steam for district heating is high. One Kyrgyz health care facility, for example, spends half its budget on heat.

- High carbon in the coal ash limits the ability of pollution control equipment to collect the ash. As a result, airborne emissions from coal-fired power plants are greater than necessary.

- Because of the high carbon content of the ash, it cannot be used for beneficial purposes such as in paving materials and must be landfilled.

CQ Inc. recommends a project to assist power plant engineers in Kyrgyzstan to increase the overall efficiency of Kyrgyzstan's power plants.

The project would have two primary objectives:

- To increase boiler efficiency by two percent.

- To achieve a ten percent carbon content in the fly ash of pulverized coal-fired boilers (15 percent for the stoker boilers).

CQ Inc. will design and conduct a comprehensive boiler testing program on four boilers at two selected power plants. As part of this process, CQ Inc. will involve Kyrgyz engineers and technicians heavily in the boiler testing program so that they can learn the testing techniques and continue the testing of other boilers on their own.

Increasing boiler efficiencies in Kyrgyzstan will:

- Lower the overall cost of electricity, which in turn will lower the cost of production in existing basic industries. The lower cost of electricity will also make Kyrgyzstan more attractive to foreign investment in other basic industries such as steel and aluminum manufacturing.

- Lower the cost of home heating in the areas where electricity is the primary means of home heating as well as in the areas where steam or hot water is used for heating.

- Decrease the cost of providing heat to public institutions. The resulting savings can be rerouted to improve or support other programs to improve overall public health, education, and living conditions.

- Reduce the carbon content in power plant fly ash, making existing pollution control equipment more effective and permitting alternative uses (such as road building) for the fly ash. This turns an environmental liability into an infrastructure resource.

Use of Dzhergalan Coal at Bishkek Heat Power Central Station

Continued development of the Dzhergalan coal deposit is essential to supply the existing heat station at Kara Kol. By developing a second mine entry, the Dzhergalan mine operators could increase coal production to 300,000 t/y. Further increases in production are also possible with the development of new mines in the Dzhergalan reserve.

Additionally, the existing highway from Dzhergalan to Kara Kol needs to be repaired and upgraded to accommodate increased truck traffic. After upgrading, this highway can also provide access to Lake Issyk Kul so that Dzhergalan coal could be moved by water to Balykchy and then by rail to Bishkek. By supplying the total fuel burn for Kara Kol and Bishkek, the Dzhergalan reserve would greatly reduce coal imports and also improve power plant performance and reduce emissions at Bishkek because the ash content and other quality characteristics of the Dzhergalan coal are consistent with the design specifications for the Bishkek plant, but its current fuel supply from Kazakhstan has significantly higher ash content.

Reducing Coal Imports

The key to reducing coal imports is the construction of a rail line between northeastern and southwestern Kyrgyzstan. Construction of this rail line will provide near-term employment for a significant portion of the population and it will ensure a domestic supply of fuel for existing coal-fired power and heat plants during the next decade while hydroelectric capacity is built in the southwest and transmission facilities are reinforced throughout the Republic.

The rail line will also provide a means of transporting construction workers and materials for the hydroelectric plants, transmission facilities and other industrial development projects within the Republic.

Fuel Specifications and Sources

Following the construction of rail facilities, each power station will have several fuel supply alternatives from domestic and imported fuel providers. At that time, specifications should be developed for each station based on its thermal efficiency and operating and maintenance costs. By selecting coals that provide electricity at the lowest possible production cost, each power station will also be minimizing its emissions per megawatt hour of electricity produced.

Other Industrial Uses

Even at its current production rates and prices, coal is the most effective energy source for any prospective industrial facility in Kyrgyzstan. The primary limitations on coal use are availability due to transportation infrastructure limitations and location since most mines are in rural areas of the Republic. To solve the availability problems, transportation needs to be improved as outlined above and a free market must be developed so that coal can be sold at a price that allows coal producers to recover equipment depreciation and a return on investment that motivates them to invest in equipment replacement and new mine

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development. Such investments will also insure industrial customers of long-term, reasonably-priced energy that should insure their investments in new facilities.

Fine Coal Briquetting for Domestic Use

In an effort to promote the use of indigenous coal in Kyrgyzstan, we investigated ways to manufacture coal briquettes for home heating and cooking. Before working on the formulations for these briquettes, we decided that to be applicable to the situation in Kyrgyzstan, the briquettes had to have the following features:

- The briquettes would be made by individuals for their own use, thus avoiding a high-capital-investment project requiring foreign funding.
- The briquettes had to be made from run-of-mine coal. This would preclude the need for the average person to pulverize coal for making the briquettes.
- Binder for the briquettes had to be from materials, preferably waste materials, that were commonly available in Kyrgyzstan.
- The briquettes would be made either as-needed or shortly in advance of use, therefor the storage and handling properties of the briquettes would not be critical.
- The pressure used to make the briquettes had to be within the range that the average individual could achieve with a small amount of mechanical advantage.

Initially, binders that were considered were animal by-products, because of the agrarian nature of Kyrgyzstan and because some of these products were already used as fuels. The two binders initially considered were animal fat and dung. Dried dung has been used as fuel in many areas; animal fat had an advantage in that it would make the coal briquettes more ignitable.

Coal samples from Kyrgyzstan were received at CQ Inc. in the second week of January, 1995. Initial test were performed using the Kara Keche coal, because it was one of the largest samples. Coal and animal fat were mixed together at 5%, 10%, 20%, and 40% animal fat by volume. Volume measurements were used rather than weight, because the average Kyrgyz would most likely not have access to weighing equipment. Coal briquettes were made from the above mixtures and compressed in a small hydraulic pellet press, but using only enough pressure to keep excess animal fat from being squeezed from the briquette. Briquettes with 5% and 10% animal fat did not adhere together well enough to be removed from the briquette form. Briquettes made with 20% and 40% animal fat held together, but were still rather fragile. These higher concentrations of animal fat are probably uneconomical for use in Kyrgyzstan.

Future tests will focus on other binders, specifically ash. Kyrgyz coal ashes are potentially good binders. Since most of the fly ash produced in Kyrgyzstan comes from subbituminous coal and therefore should have good pozzolonic characteristics, further tests are planned with fly ash. Note that Kyrgyz fly ash is higher in carbon than typical U.S.

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subbituminous coal ash and this may affect the prospective briquettes in two ways. The carbon in the ash would add to the heating value of the briquette, but is may also lower the pozzolonic quality of the ash and reduce its binding potential. If the ash from burning prior briquettes is mixed in with new briquettes, the ash may provide enough adhesion to make stable briquettes. Animal fat will probably remain a component of the mixture, but at the 5% to 10% level, mainly to provide ignitability. These tests will be conducted by CQ Inc. in February 1995 to address these issues.

Clean Coal Technologies

In the future, Kyrgyzstan is a prospective candidate for the use of U.S. clean coal technologies. As the economy strengthens, post-combustion control systems will be affordable. For example, high-efficiency, pulse-jet baghouses may be considered for particulate controls, some coal cleaning technologies may be used to reduce the sulfur content of Kyrgyz coals (although many of them are low in sulfur content), dry scrubbing technologies may be deployed to reduce SO_2 emissions, and possibly most promising, integrated gasification combined cycle could be critical to Kyrgyzstan in the future. IGCC could provide a source of energy and raw materials to support other industrial development within the country without substantial deterioration of the environment. Electricity, hot water, steam, gas, chemical feedstocks, and other materials could be derived from coal in a single integrated facility and distributed to existing industrial complexes and new greenfield sites and to the population to replace their use of coal or briquettes and higher-priced electricity.