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United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VA 22092

In Reply Refer To:
Mail Stop 917

May 14, 1979

Mr. James B. Riley
Agency for International Development
American Embassy
FPO New York, N.Y. 09527

Letter May 23 Dec

Dear Jim:

Enclosed are three copies of the final version of the USGS team report including A. Fouda's sections on petroleum and water.

After our return from Egypt our international water resources group, which has had experience in Egypt, reviewed the water resources section of the report. Based on their observations, we should point out that if the proposed program goes forward, the water resources activities will require considerable more study including possible consultation with other Egyptian agencies that are involved in water resources. Therefore, the present recommendations, which were made without the benefit of a water resources specialist on our team, should be considered as preliminary.

The total budget, as the program now stands, is U.S. $20,000,000.

With best regards.

Sincerely yours,

Gene E. Tolbert, Chief,
Branch of Latin American
and African Geology
Office of International Geology

Enclosures - HSTD

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263-0105

(IR)EG-7

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PROJECT REPORT
Egypt Investigations
(IR)EG-7

EGYPTIAN MINERAL RESOURCES ASSESSMENT PROGRAM

Prepared in collaboration with the
Egyptian Geological Survey and Mining Authority,
The Egyptian General Petroleum Corporation, and
the Desert Research Institute, on behalf of the
Agency for International Development, U.S. Department of State.

1979

EGYPTIAN MINERAL RESOURCES ASSESSMENT PROGRAM

By

G. E. Tolbert, R. W. Fary, Jr., and A. Fouda
U.S. Geological Survey

and

H. Wedow
Mineral Resources Consultant to the U.S. Geological Survey

The project report series presents information resulting from various kinds of scientific, technical, or administrative studies, Reports may be preliminary in scope, provide interim results in advance of publication, or may be final documents.

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INTRODUCTION

At the request of the Agency for International Development (USAID), U.S. Department of State, Cairo, a team of three U.S. Geological Survey (USGS) geologists and a geophysicist were assigned to Cairo, under PASA IC/EGY-0026-11-78, for a period of one month to prepare a proposal for a mineral, petroleum, and water resources assessment program. This program would be executed by Egyptian government agencies with supplemental help from AID in the form of funding and technical assistance. The principal objective of this program would be to improve the capability of the Government of Egypt (GOE) to assess Egypt's metallic and nonmetallic mineral resources, including oil and water, and to speed identification and definition of those resources that can be utilized internally, or exported to support the economy and alleviate foreign-exchange problems. U.S. assistance would endeavor to strengthen GOE agencies responsible for mineral resources development by training personnel, providing new equipment, introducing additional techniques of mineral identification, and providing advice on pertinent subjects such as the collection and organization of mineral data and geophysical and geochemical exploration.

The following program is scheduled to be undertaken in three successive phases over a 6-year period. Each phase is to attain specific objectives and will be evaluated at termination in order to define more precisely the activities and goals of the succeeding phase. The scope of the program is designed in accord with the responsibilities of GOE agencies and with the number and capability of personnel, as well as with the availability of personnel and funds from the U.S. Government. Because the Egyptian Geological Survey and Mining Authority (GSE) is responsible for mineral resources development, this organization would be the lead GOE agency for the mineral resources assessment part of the program. The Egyptian General Petroleum Coporation (EGPC) is responsible for the assessment of petroleum resources, and the Desert Research Institute (DRI) addresses certain aspects of water resources. GOE agencies such as the Remote Sensing Center and other institutions dealing with earth sciences will provide additional support as required. Activities are defined below under three headings: mineral resources project, petroleum resources project, and water resources project.

MINERAL RESOURCES PROJECT (GSE)

Mineral data collection, organization, and analysis

Current status of GSE mineral information

Well organized and documented geologic data are fundamental to any mineral resource assessment program. Consequently, the modernization of procedures for cataloguing, indexing, and retrieving information from the accumulated documents of the GSE library is a major goal of the proposed program. The Geological Survey of Egypt has in its Library and Documentation Department a large amount of both published and unpublished data on the geology and mineral resources of Egypt. Its files include more than 5,000 published reports, 2,000 unpublished reports or manuscripts, 40,000 periodicals from 300 sources, and approximately 5,000 textbooks on earth sciences. Indexing of the published documents is not complete, although the file of unpublished manuscripts has recently been indexed and is currently being microfilmed. Microfilming is also planned for the published papers, particularly the older documents. The application of computer methods for retrieval of geologic information is now being considered.

Recommendations.--A scientific librarian should visit GSE's documentation center to make a detailed review of problems and needs with the Egyptian staff. (See schedule, Appendix I.) Subsequently, GSE library staff members will receive training in libraries abroad.

Read-Print microfilm units, duplicating equipment, and photocopy units are needed. Machine-readable copy of catalogues and indexes for computer input should be prepared.

Egyptian Mineral Data System (EMDS)

A national mineral resource assessment program requires the collection, storage, and analysis of geologic data. Such information includes not only the locations of important mineral deposits but also a large variety of descriptive geologic data. Each new step taken in mineral exploration should be based on the iterative assessment of all previously obtained geological data. Thus, ready availability of all reports, notes, maps, chemical analyses, and published material requires that they be placed in card files, summaries, abstracts, and computerized for rapid retrieval, sorting, duplication, arrangement, and graphic presentation.

To be effective, mineral location records should include such fundamental items as coordinates and other location information, relevant geologic data, and available statistics on mineral production, reserves, and potential resources. Although it is important for a mineral data system to include information on currently producing mines and quarries and on deposits about to be exploited, it is also imperative that the file be updated frequently as new information is acquired. New data may be added at any date through routine procedures.

Qualitative or descriptive geologic information including data shown on maps can be computerized. The merger of such data with mineral location information may show patterns that can help in the selection of new target areas for exploration. The preparation of a highly organized mineral data system is therefore the necessary first step in modern resource assessment. For convenience, this system will be refered to in this document as the Egyptian Mineral Data System or EMDS.

The computerized data bank would enable the rapid assembly of the numerous types of information needed periodically for mineral resource reporting, including mineral production tables, tabulations of reserves and resource estimates, and comparisons of geologic data from ore deposits. Furthermore, EMDS, together with a variety of already available computer graphics programs, can provide mineral locality maps, graphic illustration of production data (histograms, frequency polygons, pie diagrams, and 3-dimensional projections of geographically distributed data). Finally, selected mineral locality data printed in conjunction with special types of geologic maps can be used to compile metallogenic maps.

Current status of activity.--In 1977 under a current GSE-USGS program, three GSE geologists began compiling data on selected mineral localities as a first step in establishing a data system. EMDS uses the same basic format as the CRIB (Computerized Resources Information Bank) file of the Mineral Data System developed by the U.S. Geological Survey (MDS/USGS). The latter is a storage and retrieval facility for mineral commodity information from a large variety of sources. The CRIB file uses GIPSY (General Information Processing System), a software system developed in the United States, for creating, storing, and processing resource records in the computer.

At this time data on localities, including past and present production and/or potential for production, of 29 mineral commodities have been collected. The relative completeness of CRIB-form preparation by GSE for each of the various commodities is shown below.

Complete (4)	Decreasing completeness (3)	(2)	(1)
Chromium	Asbestos	Fluorite	Beryl
Niobium	Iron	Gypsum	Feldspar
Molybdenum	Barite	Gold	Copper
Lead	Sulfur	Quartz	Kaolin
Tantalum	Mica	Nickel	Limestone
Tin	Talc		Potassium
Tungsten			Phosphate
Zinc			Precious stones
			Thorium
			Uranium

In all, about 300 CRIB-type records are reported to be completed and essentially ready for "key punching." Several hundred more are in varying degrees of readiness.

Recommendations.--Early in the proposed program copies of the completed Egyptian CRIB data forms would be sent abroad to be key-punched and entered in appropriate mineral data systems. Computer printouts would then be prepared and sent to Egypt to enable GSE geologists to review the records for completeness and to demonstrate the usability of the computerized data. Also, arrangements should be made with EGPC to enter in the EMDS certain selected data as well as mineral localities from available petroleum records.

Visits to Cairo by specialists in CRIB and related topics would provide assistance in setting up CRIB and GYPSY programs, including establishing a remote terminal in Cairo.

Geologic investigations

Geologic surveys consist of the collection of geologic information from the field by means of direct observation, sampling and identification of rocks and minerals, the measurement of rock structures, and the utilization of sophisticated methods for measuring and comparing the chemical and physical properties of rocks. The results of such surveys are employed in programs to locate and identify mineral deposits which do not crop out at the surface or have undergone changes that have made their identification difficult. Collation and interpretation of information gathered for large areas lead to the selection of successively smaller and increasingly promising areas in which to make detailed field investigations, ultimately resulting in the identification of concentrations of valuable minerals.

Geologic maps

Geologic maps show the distribution and structure of rock types and provide the basis for analyzing and portraying geologic data. The maps may be of various scales, depending on the objective. Generally, geologic mapping procedes from regional surveys and small-scale maps (1:500,000 to 1:50,000, for example), to successively smaller area surveys and larger-scale maps (1:50,000 to 1:5,000) as the requirements for detailed geologic information increases. The scales of maps of geophysical and geochemical work vary in the same manner as those of other geological surveys and make their own special contributions toward the identification of target areas.

Current geologic exploration and mapping by the GSE

Regional mapping.--Small-scale mapping is undertaken by the Regional Mapping Department. GSE has carried out geologic investigations and prepared maps at various scales in many parts of Egypt. For example, for the area south of lat. 25° N., the Aswan Regional Planning Project prepared

a map at 1:500,000 scale. More recently, the cooperative GSE-USGS program published the Aswan and Qena quadrangle maps of part of the Eastern Desert also at the scale of 1:500,000.

Currently, GSE geologists are completing a geologic map of quadrangle NH 36 in the northeastern part of Egypt as part of an ongoing project to publish a full series of maps for the entire country at a scale of 1:1,000,000. The series, based upon a pre-existing topographic map series, will consist of four complete and two partial sheets. About 40 GSE geologists are now assigned to the regional mapping program.

Detailed exploration and mapping.--Large-scale mapping is the responsibility of the Mineral Prospecting Department. The activities of this Department are directed toward detailed mapping of mineral deposits, usually at scales larger than 1:50,000 and, in many cases, include the use of geophysical and geochemical methods that are pertinent to mineral exploration. Current projects include: mapping in the area south and east of Idfu, which is known to contain geochemical anomalies of gold and arsenic; mapping and defining the reserves of glass sand in an area near the Gulf of Suez; and detailed mapping, in selected areas, of the basement rocks of the Eastern Desert.

About 23 geologists, geophysicists, and engineers are assigned to this Department.

Proposed exploration and mapping

Regional geologic mapping.--Continuation and completion of the series of maps at a scale of 1:1,000,000 would be achieved in phase I, as would the completion of a new geologic map of Egypt at the same scale. Landsat imagery would be used in extrapolating information from known areas to others in which little field work has been done. The Remote Sensing Center may contribute to these objectives by providing imagery, conducting special studies of certain areas, and making RSC equipment available to GSE geologists for training and research.

Utilization of the new GSE cartographic and photo laboratory facility will also increase the production and improve the quality of published maps and reports.

Regional geochemical exploration will play an important part in exploration and mapping, as will improved quantitative and qualitative laboratory analyses.

The mapping program will be reviewed with GSE early in phase I and at appropriate times in successive years to reassess priorities and to ensure its effectiveness during the 6-year program.

GSE is in the process of negotiating with the countries of Sudan, France, and Great Britain to undertake geologic mapping and mineral

investigations in several parts of southern Egypt and northern Sudan. Undoubtedly, information resulting from such projects will contribute substantially to the assessment of Egyptian resources and should be coordinated with the proposed program.

A senior geologic mapping specialist would be assigned to work full-time with GSE geologists on field mapping projects and would provide advice in planning and execution of the geologic exploration and mapping activities. Geologic mapping specialists on temporary duty would provide advice on selected regional mapping problems.

Detailed exploration and mapping.--In addition to providing assistance in the exploration and assessment of mineral deposits, analysis of resource data and regional mapping may identify new areas in which detailed work should be conducted. Two resident economic geologists would provide guidance on analysis of mineral-resource data and on applying new concepts of ore genesis and modeling to exploration. In addition, experts in special techniques of mineral exploration such as geochemistry and geophysics would be assigned, on a temporary basis, to help in studying specific mineral deposits. Known deposits currently being considered for special study and evaluation are: gold prospects and deposits in the Eastern Desert; zinc-lead and strontium-barium deposits in Miocene rocks in the Red Sea Hills; niobium-tantalum concentrations in the Eastern Desert; an ophiolite belt containing zinc-copper deposits in the southern part of the Eastern Desert; a sequence of evaporites containing potash and sulfur near the Red Sea; and ilmenite deposits associated with gabbroic rocks in the southern part of the Eastern Desert.

When it becomes possible to conduct field investigations in the Sinai peninsula, assistance would be provided for a regional exploration and mapping project. GSE plans to map this region at 1:100,000 scale, or larger. Deposits of coal, copper, and manganese are known in this region, which is considered as favorable for finding new mineral deposits. GSE has asked that three full-time U.S. geologists be assigned to the eventual Sinai project as field party chiefs. Funding for this activity will be estimated when final plans are formulated.

Economic studies of prospective ore deposits

Mineral deposits of various types have been found in the Eastern Desert and have been studied in considerable detail. Some of these are considered to have economic potential; however, all the economic parameters have not been determined. Special investigations of these deposits are needed to determine their economic viability prior to mine development. In addition to geologic information about the deposits, such as size, grade, and chemistry, it is necessary to study the economic factors, which include transportation, water and electric power supply, and availability of labor. Technical assistance would be provided through

government agencies such as the U.S. Geological Survey, the U.S. Bureau of Mines, or by consulting economic geologists, mining engineers, and mineral economists under contract. Projects recommended by GSE for such studies include gold in the Barramiya area; the Um Gheig zinc-lead deposits, the Abu Ghalaga titanium deposit; niobium-tantalum concentrations at Abu Dabbab and Noweiba; and tin at Igla.

Geophysical exploration

Geophysical instruments are used to measure the physical properties of rocks, e.g., magnetic properties, density, electrical conductivity, in order to provide information useful in mapping rocks at the surface of the earth and, in some cases, to determine the types of rocks and their configuration below the surface. These methods may also reveal structures that may be important in the location of mineral deposits. Geophysical surveys are conducted on the ground and from aircraft. Methods commonly used in mineral exploration are magnetic, electromagnetic, resistivity, induced polarization, gravimetric, shallow seismic, and borehole logging.

Current GSE activities.--Twenty-six geophysicists of the GSE are working on the following projects:

A joint project with the New Mexico State University is being undertaken to measure heat flow and microseismicity in a study of plate tectonics and the origin of the Red Sea rift.

Resistivity is being used in a study of underground water resources at Wadi Qena.

Drill holes at the Abu Tartur phosphate deposit are being logged by the gamma-ray method to determine more precisely the thickness of the phosphate beds.

Recommended projects.--The geophysical projects now being conducted by the GSE are only indirectly related to mineral exploration. The following program is recommended for the geophysical department:

Physical properties measurements: Prior to planning of geophysical surveys, a compilation of the physical properties of minerals and rocks of Egypt should be made; the data will be useful in selecting the geophysical tools to be used.

Airborne magnetic and radiometric surveys in the southern part of the Eastern Desert: The objectives of this survey are to obtain geophysical data to obtain structural information, locate deposits of magnetic minerals, and differentiate rock types by variation in radioactivity.

The area of the proposed survey is underlain by basement and sedimentary rocks and extends over 65,000 km^2. Line spacing should be 2 km, and orientation should be northeast. This work, including the interpretation, should be contracted with the provision that a GSE geophysicist participate as a trainee in the interpretative phase of the project.

An airborne electromagnetic survey estimated to total 5,000 km^2 will be made of areas to be selected after completion of the airborne magnetic survey.

Prospecting for iron ore: In the Western Desert iron ore is found in the form of hematite. Seismic, induced polarization, deep resistivity, and gravity methods should be useful in exploring this area. In the Eastern Desert iron occurs in the form of magnetite and titaniferous magnetite. Magnetic and induced polarization methods should be used here.

Metallic deposits in the eastern Desert: Magnetic, electromagnetic, induced polarization, and resistivity surveys should be conducted in search for metallic ore deposits in the Eastern Desert. Foreign advisors specializing in these geophysical methods would provide guidance and training in their use during temporary assignments in Egypt. GSE participants will also be trained in these methods in the U.S.

Geochemical exploration

Geochemical techniques are employed both in detailed and regional investigations. Sampling techniques include collection of stream-sediment, soil, rock, and other samples which are then analyzed in the laboratory by atomic absorption, spectrographic, and chemical methods. The results of these geochemical surveys are evaluated and areas selected which merit more detailed field examination. These surveys are normally carried out in conjunction with field mapping and other exploration activities.

Specialists in geochemical exploration would provide advice and participate in GSE field investigations for 6 months each year during the entire program. Training in field geochemical techniques as well as in analytical procedures would be provided to GSE participants for 4 months each year.

Subsurface investigations

As geologic exploration proceeds to increasingly detailed studies of smaller and smaller areas and as mineral deposits are located, subsurface information such as the grade, tonnage, and configuration of ore bodies becomes important. Pitting, trenching, and drilling would be undertaken in certain areas to help GSE obtain additional geologic information concerning potential ore deposits.

Systematic studies needed to outline ore bodies, prepare mine plans, construct ancillary facilities, and the study of transportation systems are usually left to the mining company or organization that proposes to mine the ore.

Other activities

Training will be provided in the U.S. on supervisory functions associated with drilling activities. During phase I, an objective should be to aid GSE in the publication of a brochure describing Egypt's mineral deposits. This publication would be aimed at prospective investors, both Egyptian and foreign.

Supporting services

Analytical laboratories

The central laboratories of GSE are located at El Dukki in Cairo, which is a considerable distance from the headquarters in Abassia. The three principal sections of the laboratories are: 1) instrumental, minor, and trace element analysis; 2) wet chemical, major element analysis; and 3) mineralogical. A small pilot plant for ore dressing studies, located in the same building, is not an integral part of laboratory operations.

The current annual capacity of the laboratory is as follows:

Analysis	No. of samples	No. of determinations
Chemical	3,570	33,530
Mineralogical and petrographic	325	
Spectrographic	6,050	80,000 to 110,000
Thermal	75	
Spectrochemical	850	

The laboratory undertakes work not only for GSE projects but from time to time also takes in work for other government and private agencies.

Present status of laboratories.--The technical capability of laboratory personnel is of a high caliber, but much of the equipment is either outdated or inoperable. Although laboratory space appears to be adequate, it is located so far from the rest of GSE as to hinder coordination between the geological and laboratory staffs.

Recommended program.--Some of the present laboratory equipment and supplies needs to be replaced. Acquisition of these replacements will result in more effective operation. Training abroad would be provided to chemists and other laboratory personnel in order to upgrade their capabilities in modern analytical procedures. A senior analytical laboratory specialist would be assigned to full-time service, and other specialists would have temporary assignments, as necessary, at the El Dukki laboratories during the program.

Geochronology studies

Knowledge of ages of rocks and minerals is important for correlation of rocks units, the determination of the sequence of geologic events, and the establishment of the geologic framework in which mineral deposits may occur. A specialist should review GSE requirements concerning radiogenic age determinations and advise on what steps are necessary to provide this critical information. Assistance may be rendered in the form of participant training in the U.S., providing for radiogenic age determinations abroad, and, if warranted, the procurement of laboratory equipment.

Cartography and publication

A principal objective of the program is to publish and disseminate geologic information in the form of maps and reports. The current GSE-USGS technical assistance program has had as a main objective the establishment of a small cartographic office and photographic laboratory capable of producing geologic maps ready to be printed in color. This goal has been partially achieved but additional support is needed. Furthermore, this capability should be augmented to insure that an increased cartographic load can be handled effectively. Assistance would be given by acquiring additional equipment, providing participant training in the U.S., and by assigning specialists for temporary assignments in Egypt. Participant training in the editing of manuscripts and in new techniques in printing should also be given to enable GSE to produce reports of high quality in a timely manner.

Other studies

Participant training will be given as required in special fields such as palynology and sedimentology. Specialists in the preparation of various types of exhibits will have short-term assignments at GSE's Geological Museum in Cairo during the early phases of the program.

Management studies

GSE has requested that its organizational structure be reviewed, and that, in collaboration with GSE management, recommendations be made for changes through which GSE might become more effective in meeting its goals. The Project Manager aided by whatever specialized personnel on temporary duty that may be required could collaborate with GSE management in fulfilling this request.

PETROLEUM RESOURCES PROJECT (EGPC)

The appraisal of Egypt's petroleum resources is a continuing long-term responsibility. Efforts to improve appraisal methods and data collecion, together with the results of continuing exploration, will result in better forecasting of the remaining undiscovered oil and gas resources in Egypt.

Estimation of the petroleum resources potential and estimation of the undiscovered petroleum in the Western Desert and the Nile Delta require additional information on the following subjects: regional geology, tectonic evolution, depositional history, thickness of sedimentary rocks, quality of source rock, thermal history, maturation of organic matter, reservoir rock, migration of petroleum, trapping mechanisms, and timing of petroleum generation and migration in relation to the development of traps.

After reviewing parts of the tremendous volume of data and reports in the files of the Egyptian General Petroleum Corporation (EGPC), it is evident that these data, will, together with additional data to be collected after detailed analysis and interpretation, contribute toward the compilation of the following products: 1) a magnetic map, 2) a gravity map, 3) a basement tectonic map, and 4) a Paleozoic thickness map together with a map showing the sedimentary basins. Additional activities, useful in an analysis of the petroleum potential include: 1) seismic stratigraphy and seismic modeling, 2) source-rock quality evaluation, thermal history, and hydrocarbon maturation, and 3) standardization of stratigraphic nomenclature.

The petroleum resources estimate is scheduled to be carried out in three successive phases of 2 years each.

Phase I

Basement tectonic map and standard well sections.

The objectives of this study are the construction of basement tectonic maps and preparation of composite standard well sections.

Review of existing data and reports

In order to reduce time and effort, all data and reports should be compiled and made accessible. Geophysical and geological data and published and unpublished reports should be microfilmed.

Basement tectonic and sedimentary thickness maps

The structural development of Egypt is governed, to a large extent, by the basement tectonics. The outline, shape, size, and disposition of the deep sedimentary basin are controlled entirely by the pre-existing topography and structure. Block faulting in the basement is commonly accompanied by basin subsidence. Many anticlines have resulted from the movement of basement blocks. Block faulting commonly controls facies, oil-bearing structures oil shows, and graben basins; therefore it is essential to have reliable tectonic maps of the basement. It is recommended that these maps be constructed by the combined interpretation of magnetic data, gravity data, and regional seismic sections. The results of this interpretation can then be integrated with deep well information, outcrop data, and the results of refraction surveys. Sedimentary thickness maps should be constructed for each basin.

Refraction surveys

Previous exploration work in the Western Desert consisted of widespread gravity and magnetic surveys, scattered holes drilled for structural data, and some conventional reflection-seismic surveys. Results concerning the evaluation of the Paleozoic basin and the deeper structures, especially the Paleozoic uplift, have been inconclusive.

The refraction survey will be supplemented by existing gravity, magnetic, and deep-well data. The object of the refraction survey is to determine: 1) the major subsurface geologic features with special emphasis on the existence and shape of the Paleozoic uplift and Paleozoic basin; 2) the depth and dip of the refractions from all competent beds, especially the basement; 3) the effective refraction velocity for identification of gross lithology and correlation of reflection seismic records; and 4) the displacement of basement formations by faults.

Two continuous in-line-reverse refraction profiles are recommended: one along the strike of the general trend, and a second profile perpendicular to the first. ach profile should be about 100 miles long. Inasmuch as the immediate objective of the survey is to determine major subsurface geologic features at estimated depths of about 10 km, the shot points may be offset 30-40 km from the main spread. A cable 20 km long is recommended and the shot-point spacing should be 4 km.

Composite standard well section

Standard type sections for subsurface formations that have been assigned formal nomenclature and ages are necessary for the coordination of geological and geophysical data. This could best be done by first studying samples, cores, and electric logs and preparing composite sample logs of the stratigraphically deepest wells in each basin or province. These standard logs would include not only lithology and electrical characteristics, but also fossil, oil, gas, and water information. The logs could then be used to extend correlations along cross sections (at a vertical scale of 1"=100'), designed to outline the regional stratigraphy and facies changes. It may suffice to prepare one composite standard well section for each province. In addition, two perpendicular stratigraphic cross sections (vertical scale of 1"=200') should be compiled and published for each region.

Phase II: Basin analysis and evaluation

The objective of this study is to assess the petroleum potential for each basin or province of the Western Desert and the Nile Delta. The following subjects will be addressed: (1) Determination of the general structural framework of each province or basin; (2) delineation of each basin (Paleozoic, Mesozoic, and Cenozoic); (3) basinal tectonic histories; (4) depositional environments and stratigraphy; (5) reservoirs and seal rocks; (6) source rock evaluation and thermal maturation; and (7) migration and trapping mechanisms of hydrocarbons.

Basin delineation (Paleozoic, Mesozoic, and Cenozoic basins)

The purpose is to determine the shape, length, width, and axis of each basin. This work will also determine the ridge or ridges which bound each basin, the generalized structure, stratigraphy, and the geologic history of each basin. A composite stratigraphic sequence will be established.

Stratigraphic analysis of sedimentary basins

Regional stratigraphic analysis is an important method of petroleum exploration in frontier areas. It offers a relatively inexpensive means of comparing the petroleum potential of different rocks in different basins so that priorities can be established. It requires analysis and synthesis of data and interpretation of each basin's petroleum potential. It does not ordinarily provide the detail needed for selecting well sites, but aids in selecting the most promising areas, from a stratigraphic point of view, for further investigations using seismic stratigraphy.

Stratigraphic analysis can provide evaluations of potential reservoir rocks, sealing rocks, source rocks, potential facies and unconformity traps, and the possibilities for maturation of hydrocarbons and entrapment of petroleum in each basin. Such studies require reconstruction of the geologic history including tectonics, environment, and mode of deposition. Necessary information includes the depth of burial of rocks at successive stages of basin development as well as their present structure, thickness, and distribution. Paleontological maps, maps showing regional unconformities, paleogeographic maps showing environmental interpretations, and thickness maps with lithofacies distribution are effective tools in exploration and should be published for the major sedimentary basins in Egypt.

Source-rock evaluation and crude oil correlation

The productivity of an oil basin is determined by the quality, extent, and thickness of its source bed. To assess the petroleum potential of Egypt, especially the Western Desert and Nile Delta, and to select the optimum prospect areas, a hydrocarbon source-rock evaluation of well cuttings and surface samples is needed. Such studies include the determination of (1) the hydrocarbon-source quality (richness), (2) the source type (gas versus oil), (3) the degree of thermal maturation, and finally (4) the identification of specific organic facies that are of interest in exploration.

Correlations for crude oil and gas from different oil and gas fields in the Western Desert and the Nile Delta can readily be made to relate the hydrocarbons to their subsurface source. This knowledge, in conjunction with source-rock data, could aid in exploration for favorable stratigraphic units.

Seismic structure and seismic stratigraphy

In Egypt seismic reflections have been used in the traditional way-to identify events and to study structural deformations with the objective of locating structural features that might entrap hydrocarbons. However, seismic data can provide a great deal of information for stratigraphic interpretation by relating seismic data to stratigraphy. Seismic stratigraphy is recommended for all parts of Egypt but especially for the Nile Delta and the Western Desert. It includes (1) seismic-sequence analysis to identify the stratigraphic units, their succession, and the sequence boundaries and lateral extent of strata, (2) seismic-facies analyses to interpret the sedimentary processes and environmental settings and to help predict the facies lithology, (3) cycle-sequence analysis to recognize cycles of rise-and-fall of sea level. This analysis yields a variety of predictable depositional patterns and helps in constructing the regional stratigraphic framework necessary for interpreting paleogeography, geologic history, the geologic setting for petroleum-prospect analyses, and (4) true-amplitude analysis (Bright Spot) will help in detecting petroleum in place, especially gas.

Seismic modeling and true amplitude (Bright Spot) analysis

Two major interpretative classes of seismic modeling are needed in Egypt--structural and stratigraphic. Structural modeling relates to interpretive problems where structural identification is the primary objective such as the deep structures or in structurally complicated areas. Stratigraphic modeling concerns interpretive problems where identification of lithologic changes is the primary objective, that is, the trapping mechanism is primarily stratigraphic. Many such problems exist in the Western Desert and the Nile Delta. Obviously, many problems concern both types of modeling.

Phase III: Petroleum potential and estimate of undiscovered oil and gas

The estimates of undiscovered oil and gas resources in the Western Desert and the Nile Delta can be made by (1) utilizing the geological and engineering information gathered in Phases I and II of this project; and (2) applying suitable resource appraisal techniques to each potential petroleum province or basin. Each method requires a certain amount of information and has limitations which must be considered in choosing the method or methods to be used in making the estimate of petroleum potential. When estimating unknown quantities, it is essential to make estimates in a probability range using subjective probability procedures which may be characterized as low, high, and most likely for the various provinces or basins. The recommended procedure includes: (1) basin evaluation studies, (2) play analysis techniques which include quantified geologic parameters

such as area, thickness, trap type, reservoir, lithology, source, and (3) statistical analysis and development of models, petroleum province analog and risk analysis.

Northern Sinai petroleum province

Northern Sinai, a part of the unstable shelf tectonic province, is defined by EGPC as the area of the Sinai Peninsula north of the latitude of Cairo (about 30°N), extending to the edge of the continental shelf in the Mediterranean. This sparsely drilled area has geology and petroleum prospects similar, in many ways, to those of the Western Desert.

Because of political problems since 1967, the region has not been open for active exploration. Recently, leasing and exploration have been resumed in the westernmost part of the area, but further activity in most of the region awaits resolution of political problems.

EGPC has requested that a project be undertaken similar to that proposed for the Western Desert when the Sinai Peninsula becomes accessible.

GROUND WATER RESOURCES PROJECT (DRI)

Estimates of the ground water resource potential in the Western Desert, North and Central Sinai, and Nile Delta require determination of the surface hydrographic conditions, preparation of hydrogeological maps, and delineation of ground-water provinces of basins. The study also requires criteria for delineating and describing the provinces or basins including the hydrographical structure, water occurrences, water origin, chemical quality of water, and aquifer parameters.

The study of ground-water resources would be carried out in three successive phases of 2 years each. Emphasis would be placed on coordinating the petroleum project with the ground-water study, especially correlating information and maps developed in Phases I and II.

Phase I: Surface hydrography and basement relief maps

During the initial phase, two types of maps of the Western Desert, the Sinai Peninsula, and the Nile Delta would be prepared--surface hydrographic maps and basement relief maps.

Conducted in close cooperation with the petroleum project, this study would review the available data and reports from previous studies as well as data from the Egyptian General Petroleum Corporation (EGPC), the Egyptian Geological Survey and Mining Authority (GSE), and the Remote Sensing Center (RSC).

Surface hydrographic maps would be constructed from work carried out by the DRI and from available maps, reports, and publications (emphasis on charging and discharging areas).

The basement tectonic maps, which will be constructed in Phase I of the petroleum project, will provide the main base for constructing basement relief maps.

Phase II: Basin analysis and evaluation of ground-water potential

This phase would be based largely on information available from the ground-water investigations made by DRI, information from other organizations including the United Nations (UN), and from phase II of the petroleum project.

In addition to these activities, the following studies would be conducted:

(1) Delineation of the main ground-water basins.
(2) Delineation of the aquifer (clastics and carbonates) in each basin.
(3) Determination of aquifer parameters (petrophysical properties, storativity, transmissivity, and piezo conductivity).
(4) Determination of water quality and chemical regime.
(5) Determination of age and origin of water.
(6) Preparation of piezometry and hydrogeochemistry maps.

Phase III: Estimation of ground-water potential

Estimates of ground-water potential in the Western Desert, Sinai, and Nile Delta can be made by:

(1) Reviewing carefully the geological, chemical, and engineering information and maps gathered and prepared in phases I and II of this project and the petroleum project.

(2) Applying suitable resource appraisal techniques to each groundwater basin.

(3) Mathematical models to determine the amount of exploitable ground water for periods of 25 and 50 years.

IMPLEMENTATION OF PROGRAM

Management

The overall assessment program should be headed by a senior Egyptian geologist with a broad knowledge of mineral, petroleum, and water resources. A counterpart senior geologist with similar qualifications would be designated as Project Manager and would be responsible for all program activities of the advisory group.

A geologist would serve as Senior Mineral Resources Advisor and would be responsible for all activities involving the GSE. Professionally, he should be a specialist in mineral-resources assessment. GSE would appoint an Egyptian counterpart to this position.

A petroleum geologist or geophysicist would be designated as Senior Petroleum Resources Advisor and would be responsible for all activities involving the EGPC. EGPC would appoint an Egyptian counterpart to this position.

A ground water specialist would serve as Senior Water Resources Advisor. DRI would appoint a counterpart to be responsible for all activities in this field.

Technical personnel

Mineral resources project (GSE)

A senior economic geologist would work with GSE geologists on resource assessment as well as on problems and techniques of exploration.

A senior geologist specializing in field mapping would work with GSE in regional and detailed geologic mapping activities.

An analytical laboratories specialist would be assigned to the Director of Laboratories, El Dukki, to organize and upgrade analytical procedures, implement new techniques, install new equipment, and coordinate training for Egyptian personnel.

A cartographer would be assigned to work with the cartographic and publications offices to advise on and coordinate map-making activites, to assist in the installation of equipment, and to train personnel.

Petroleum resources project (EGPC)

A senior petroleum geologist/geophysicist would work with EGPC to organize and interpret petroleum data, and coordinate the preparation of subsurface maps, sections, and other information.

Ground-water resources project (DRI)

In Phase I, a senior hydrologist will be assigned to DRI for one year.

In Phase II, one hydrologist, one geologist specializing in log interpretation, and one hydrogeochemist will each work with DRI for 6 months.

In Phase III, two hydrologists will be on duty for 6 months each.

Support personnel abroad (USA)

A project coordinator would recruit, schedule, and supervise all foreign personnel and contractors assigned to the Egyptian project. A participant training coordinator is needed to schedule and coordinate the training program. The U.S.-based work on the petroleum resources project would require three petroleum geologists/geophysicists assisted by a cartographer and three clerk-typists.

Administrative Office--Cairo

A small staff of Egyptian personnel would be required to support the foreign advisors in Cairo. Most of this staff would be concerned with the mineral resources group. Office space would be provided by the counterpart GOE agencies: GSE, EGPC, and DRI. This will insure a close and convenient working relation between counterpart organizations. Staff personnel would be funded by the program and would consist of the following:

Administrative Officer

Assistant Administrative Officer

Bookkeeper

Secretaries and Typists (6)

Expeditors (2)

Drivers (4)

Messengers (2)

Vehicles and certain items of equipment and supplies would also be funded by the program.

Appendix I -- SCHEDULE OF PROPOSED ACTIVITIES

Item \ Phase / Year	I				II				III			
	1		2		3		4		5		6	
Mineral resources project (GSE)												
Mineral data collection												
Current status of GSE mineral information												
U.S. specialists - TDY 1/	1	2/							1			
Participant training		6				6						
Egyptian mineral data system												
U.S. specialists - TDY	1		2		1					1		
Participant training		3				3						
Geologic investigations												
Geologic maps												
Regional mapping												
U.S. specialists - TDY	2	4	2	4	2		2		2		2	
Participant training		4		4		4		4		4		4

1/ TDY = Temporary duty

2/ Months

Appendix I -- SCHEDULE OF PROPOSED ACTIVITIES (Continued)

Item \ Phase	I				II				III			
Year	1		2		3		4		5		6	
Detailed exploration and mapping												
U.S. specialists - TDY	2		2		2		2		2		2	
Participant training		4		4		4		4		4		4
Economic studies of prospective ore deposits												
Feasibility/mining studies	2				2				2		2	
Participant training		4	4	3				3				
Geophysical exploration												
U.S. specialists - TDY	3	3		3		3						
Participant training	3	3	3	3	3	3		3		3		
Geochemical exploration												
U.S. specialists - TDY		6	6		6		6		6		6	
Participant training	4		4		4		4		4		4	
Subsurface investigations												
Participant training		3				3						
Supporting services												
Analytical laboratories												
Recommended program												

Appendix I -- SCHEDULE OF PROPOSED ACTIVITIES (Continued)

Item \ Phase / Year	I		II		III	
	1	2	3	4	5	6
U.S. specialists - TDY	2	2	2	2	2	2
Participant training						
Analytical chemists	6	6	6	6		
Spectrographers	6	6	6	6	6	6
Research chemist			12			
Data processor		6				
X-ray mineralogist	6					
Cartography and publications						
U.S. specialists - TDY						
Publication specialist	2	2	2	2	2	2
Photo-lab technician		3		3		3
Printing technician	2	2	2	2	2	2
Technical editor		3		3		3
Participant training						
Cartographer	3	3	3	3	3	3

Appendix I -- SCHEDULE OF PROPOSED ACTIVITIES (Continued)

Item \ Phase / Year	I			II			III					
	1			2			3			4			5			6		
Photo-Lab technician		4						4										
Senior publication specialist	2													2				
Technical editor					4						4						4	
Geochronology																		
U.S. specialist - TDY		2																
Participant training									9						9			
Other studies (palynology, sedimentology, museum exhibits, etc.)																		
U.S. specialist - TDY	2				2													
Participant training		2		3		2					3							
Management studies																		
Participant training	3			3			3						3					
Management																		
Program manager	12			12			12			12			12			12		
Senior mineral resources advisor		6		12			12			12			12			12		
Senior petroleum resources advisor	12			12			12			12			12			12		
Senior water resources advisor	12			12			12			12			12			12		

Appendix 1 -- SCHEDULE OF PROPOSED ACTIVITIES (Continued)

Phase	I		II		III	
Item / Year	1	2	3	4	5	6
Mineral resources project (GSE)						
Exploration geochemist or geophysicist	6	12	12	12	12	12
Geologist (field mapping specialist)	6	12	12	12	12	12
Analytical laboratories specialist	6	12	12	12	12	12
Cartographer	12	12	12	12	12	12
Petroleum resources project (EGPC)						
Petroleum geologist or geophysicist	6	12	12	12	12	12
Petroleum engineer		12	12	12	12	12
Participant training	3	3	3	3	3	3
Water resources project (DRI)						
Hydrologist		12				
Hydrologist			6			
Geologist			6			
Hydrogeochemist				6		
Hydrologists (2)					6	6

Appendix I -- SCHEDULE OF PROPOSED ACTIVITIES (Continued)

Phase	I		II		III	
Year / Item	1	2	3	4	5	6
Petroleum geologist or geophysicist	12	12	12	12	12	12
Cartographer	12	12	12	12	12	12
Clerk-typist	12	12	12	12	12	12
Participant training						
Structural geologist		6				
Geomorphologist		6				
Hydrologist		6				
Hydrologists (2)			6	6		
Hydrogeophysicist				6		
Hydrochemist				6		
Senior hydrologist					6	
Senior hydrogeologist						6
Support personnel in U.S.						
Program coordinator	12	12	12	12	12	12
Participant training coordinator	12	12	12	12	12	12

Appendix I -- SCHEDULE OF PROPOSED ACTIVITIES (Continued)

Item \ Phase / Year	I		II		III	
	1	2	3	4	5	6
Petroleum geologist	12	12	12	12	12	12
Petroleum geophysicist	12	12	12	12	12	12
Petroleum geologist or geophysicist	12	12	12	12	12	12
Cartographer	12	12	12	12	12	12
Clerk-typist	12	12	12	12	12	12
Clerk-typist	12	12	12	12	12	12
Clerk-typist	12	12	12	12	12	12

Appendix I -- SCHEDULE OF PROPOSED ACTIVITIES (Continued)

Item	Phase I		Phase II		Phase III	
Year	1	2	3	4	5	6
Administrative Office (Cairo)						
Administrative Officer	12	12	12	12	12	12
Assistant Admin. Officer	12	12	12	12	12	12
Bookkeeper	12	12	12	12	12	12
Secretary						
-1	12	12	12	12	12	12
-2	12	12	12	12	12	12
-3	6	12	12	12	12	12
Typist						
-1	12	12	12	12	12	12
-2	6	12	12	12	12	12
-3	6	12	12	12	12	12
Expediter						
-1	12	12	12	12	12	12
-2	6	12	12	12	12	12

Appendix I -- SCHEDULE OF PROPOSED ACTIVITIES (Continued)

Item \ Phase / Year	I		II		III	
	1	2	3	4	5	6
Messenger						
-1	12	12	12	12	12	12
-2	6	12	12	12	12	12
Driver/mechanic						
-1	12	12	12	12	12	12
-2	12	12	12	12	12	12
-3	12	12	12	12	12	12
-4	6	12	12	12	12	12
-5	6	12	12	12	12	12
-6	6	12	12	12	12	12

Appendix II -- BUDGET ESTIMATE
(Thousands of U.S. Dollars)

Item	Phase I		Phase II		Phase III		Total
Year	1	2	3	4	5	6	
Mineral resources project (GSE)							
Mineral data collection							
Current status of GSE mineral information							
U.S. specialists - TDY	9	-	-	-	9	-	18
Participant training	26	-	26	-	-	-	52
Equipment	10	10	5	5	5	5	40
Library acquisitions	10	10	10	10	10	10	60
Shipping	3	1	2	1	2	1	10
Egyptian mineral data system							
U.S. specialists - TDY	9	16	9	-	9	-	43
Participant training	14	-	14	-	-	-	28
Equipment	15	10	15	10	10	5	65
Computer time and software	15	15	15	15	15	15	90
Shipping	1	1	2	1	2	1	8

Appendix II -- BUDGET ESTIMATE (Continued)
(Thousands of U.S. Dollars)

Item	Phase I		Phase II		Phase III		Total
Year	1	2	3	4	5	6	
Geologic investigations							
Field equipment	5	5	5	5	5	5	30
Remote sensing data	20	20	20	20	20	20	120
Miscellaneous supplies	2	2	2	2	2	2	12
Vehicles (28 jeeps, 8 tanker trucks, 5 4-ton trucks, 2 microbuses)	720	-	-	360	-	-	1080
Drill rigs, truck-mounted w/spare parts and shipping	125	-	125	-	-	-	250
Geologic maps							
Current geologic mapping and exploration (GSE)							
Regional mapping							
U.S. specialists - TDY	46	46	16	16	16	16	156
Participant training	18	18	18	18	18	18	108
Detailed exploration and mapping							
U.S. specialists - TDY	16	16	16	16	16	16	96
Participant training	18	18	18	18	18	18	108

Appendix II -- BUDGET ESTIMATE (Continued)
(Thousands of U.S. Dollars)

Item	Phase I		Phase II		Phase III		Total
Year	1	2	3	4	5	6	
Economic studies of prospective ore deposits							
Feasibility/mining studies	16	-	16	-	16	16	64
Participant training	18	32	-	14	-	-	64
Geophysical exploration							
U.S. specialists - TDY (in seismic, magnetic, gravimetric, and electrical methods)	46	23	23	-	-	-	92
Participant training							
- (for techniques in mineral prospecting, ground water studies, and paleomagnetism in ore genesis)	20	20	20	-	-	-	60
- (for techniques in seismic prospecting, deep resistivity and rock magnetism, and instrumentation and maintenance)	14	14	14	14	14	-	70
Airborne magnetic/radiometric surveys	-	-	200	250	-	-	450

Appendix II -- BUDGET ESTIMATE (Continued)
(Thousands of U.S. Dollars)

Item \ Phase / Year	I		II		III		Total
	1	2	3	4	5	6	
Airborne electromagnetic surveys	-	-	150	150	-	-	300
Equipment for ground geophysical surveys	75	-	-	-	-	-	75
Geochemical exploration							
U.S. specialists - TDY	44	44	44	44	44	44	264
Participant training	18	18	18	18	18	18	108
Subsurface exploration							
Participant training	15	15	-	-	-	-	30
Geologic drilling	-	100	100	100	100	100	500
Pitting and trenching	-	5	10	15	10	5	45
Supporting services							
Analytical laboratories							
Recommended program							
U.S. specialists - TDY	16	16	16	16	16	16	96
Participant training	78	78	102	52	26	26	362
Equipment	50	100	50	25	25	50	300
Shipping	5	10	5	3	3	5	31

Appendix II -- BUDGET ESTIMATE (Continued)
(Thousands of U.S. Dollars)

Item	Phase I		Phase II		Phase III		Total
Year	1	2	3	4	5	6	
Cartography and publications							
U.S. specialists - TDY (publications, photolabs, printing, technical editing)	32	78	32	78	32	78	330
Participant training	42	32	32	32	24	32	194
Equipment	120	-	-	-	-	-	120
Shipping	12	-	-	-	-	-	12
Geochronology							
U.S./Contract - TDY	16	-	-	-	-	-	16
Participant training	-	-	38	-	38		76
Analyses (in USA)	25	25	25	10	10	10	105
Equipment*	-	-	200	-	-	-	200
Shipping	-	-	20	-	-	-	20
Other studies (palynology, sedimentology, msueum exhibits, etc.)							
U.S. specialists - TDY	16	16	-	-	-	-	32
Participant training	10	25	-	14	-	-	49

Appendix II -- BUDGET ESTIMATE (Continued)
(Thousands of U.S. Dollars)

Item \ Phase / Year	I		II		III		Total
	1	2	3	4	5	6	
Management studies							
Participant training	-	14	14	-	14	-	42
Petroleum resources project (EGPC)							
Microfilm selected at EGPC (contract)	150	-	-	-	-	-	150
Core analysis (contract)	-	-	200	-	-	-	200
Refraction survey (contract) *	2000	-	-	-	-	-	2000
Compilation and interpretation of gravity and aeromagnetic maps	150	-	-	-	-	-	150
Modeling, stratigraphic interpretation, bright spot analyses	-	-	-	-	150	-	150
Geochemical analyses for hydrocarbons	-	75	75	-	-	-	150
Computer time and special software	-	-	-	-	50	50	100
Participant training	15	10	15	10	15	10	75

Appendix II -- BUDGET ESTIMATE (Continued)
(Thousands of U.S. Dollars)

Item	Phase I		Phase II		Phase III		Total
Year	1	2	3	4	5	6	
Continuing education							
Special lectures, short courses, or workshops for advanced petroleum geoscientists in Egypt	-	-	15	15	15	15	60
Ground water resources project (DRI)							
Chemical analysis	-	-	5	5	-	-	10
Radio-isotope analysis	-	-	50	25	-	-	75
Drill rig, truck-mounted	-	-	100	-	-	-	100
Vehicles (3 jeeps, 2 station wagons)	-	75	-	-	-	-	75
Geophysical equipment	-	75	-	-	-	-	75
Computer time and special software	-	-	-	-	20	20	40
Participant training	36	18	36	36	36	36	198

Appendix II -- BUDGET ESTIMATE (Continued)
(Thousands of U.S. Dollars)

Item \ Phase / Year	I		II		III		Total
	1	2	3	4	5	6	
Implementation of program							
Management							
Program manager	120	120	120	120	120	120	720
Senior mineral resources advisor	95	120	120	120	120	120	695
Senior petroleum resources advisor	120	120	120	120	120	120	720
Senior water resources advisor	120	120	120	120	120	120	720
Mineral resources project (GSE)							
Exploration geochemist or geophysicist	95	120	120	120	120	120	695
Geologist (field mapping specialist)	95	120	120	120	120	120	695
Analytical laboratories specialist	95	120	120	120	120	120	695
Cartographer	95	95	95	95	95	95	570
Petroleum resources project (EGPC)							
Petroleum geologist or geophysicist	120	120	120	120	120	120	720
Petroleum engineer	-	120	120	120	120	120	600

Appendix II -- BUDGET ESTIMATE (Continued)
(Thousands of U.S. Dollars)

Item	Phase I		Phase II		Phase III		Total
Year	1	2	3	4	5	6	
Water resources project (DRI)							
Hydrogeologist/hydrologist hydrochemist	-	120	60	60	60	60	360
Support personnel in U.S.							
Program coordinator	57	57	57	57	57	57	342
Participant training coordinator	30	30	30	30	30	30	180
Petroleum geologist	50	50	50	50	50	50	300
Petroleum geophysicist	50	50	50	50	50	50	300
Petroleum geologist or geophysicist	50	50	50	50	50	50	300
Cartographer	30	30	30	30	30	30	180
Clerk-typist	15	15	15	15	15	15	90
Clerk-typist	15	15	15	15	15	15	90
Clerk-typist	15	15	15	15	15	15	90
Administrative office (Cairo)							
Administrative officer	10	10	10	10	10	10	60
Assistant administrative officer	6	6	6	6	6	6	36

(Thousands of U.S. Dollars)

Item \ Phase / Year	I		II		III		Total
	1	2	3	4	5	6	
Bookkeeper	5	5	5	5	5	5	30
Secretary	3	3	3	3	3	3	[illegible]
Secretary	3	3	3	3	3	3	18
Secretary	2	3	3	3	3	3	17
Typist	2	2	2	2	2	2	12
Typist	1	2	2	2	2	2	11
Typist	1	2	2	2	2	2	11
Expeditor	2	2	2	2	2	2	12
Expeditor	1	2	2	2	2	2	11
Messenger	1	1	1	1	1	1	[illegible]
Messenger	1	1	1	1	1	1	6

Appendix II -- BUDGET ESTIMATE (Continued)
(Thousands of U.S. Dollars)

Item	Phase I		Phase II		Phase III		Total
Year	1	2	3	4	5	6	
Driver/mechanic							
-1	2	2	2	2	2	2	12
-2	2	2	2	2	2	2	12
-3	2	2	2	2	2	2	12
-4	2	2	2	2	2	2	12
-5	1	2	2	2	2	2	11
-6	1	2	2	2	2	2	11
Office equipment supplies	15	5	15	5	15	5	60
Field equipment (personnel in Cairo)	2	2	2	2	2	2	12
In-country travel and per diem for field work (personnel in Cairo)	36	36	36	36	36	36	216
Vehicles for Cairo office and maintenance	100	70	25	85	25	25	330

Budget, grand total $20,057,000