FERROMANGANESE PLANT
ABU ZENEIMA, SINAI

STAGE I
PREFEASIBILITY
WORK REPORT

APPENDIX 1 AND 2

The Sinai Manganese Company

SIMANG

PREPARED BY

KAISER ENGINEERS AND CONSTRUCTORS, INC.

in association with

ARAB CONSULTING BUREAU

REPORT NO. 80-57-RE
SEPTEMBER 1980

APPENDIX 1

General Information

TABLE OF CONTENTS

- Project Organization and References
- Documentation
- Inventory Reports
- Meteorological Data

Project Organization and References

PROJECT TEAM ORGANIZATION

KECI Personnel

J. F. Sulzbach	Project Manager
G. G. Aiken	Mining Engineer
C. J. Templain	Mining Engineer
G. F. Coope	Infrastructure Engineer
R. B. Greenwalt	Metallurgical Engineer
D. A. Neumann	Economist
D. F. Boyd	Process Engineer
T. Johannesson	Geologist
R. F. Lufkin	Administration - Oakland
G. Sukaya	Administration - Cairo
J. S. Lagarias	Environmental Engineer
G. Fenity	Schedules and Implementation

ACB Personnel

Fayez A. Awadalla	Chief Mining Engineer
Nabih S. Farag	Senior Mining Engineer
Nabil H. Moussa	Senior Mining Engineer
Mohamed L. Radi	Chief Mining Geologist
Ahmed Hashem	Mining Geologist
Mamdouh El Arabi	Mining Geologist
M. Youssri	Mining Geologist
Dr. Gamil S. Salib	Chief Geologist
Amani A. Zafer	Geologist
Tawfik M. Tawfik	Geologist
Wagih Abdel Halim	Geologist
Hemaya A. Hemaya	Chief Mechanical Engineer
Mohamed M. Mahfouz	Mechanical Engineer
Mahmoud Z. El Hifnawi	Senior Civil Engineer
Edward A. Awadalla	Senior Civil Engineer
Dr. Adel Fareed	Senior Civil Engineer
Omar N. Fawzy	Architectural Engineer
Robert F. Awadalla	Architectural Engineer
Suzane M. El Kholy	Architectural Engineer
Samir H. Motawe	Chief Economist
Mahmoud I. El Kholy	Senior Economist
Ahmad H. Mahfouz	Chief Financial
Hassanein H. El Kholy	Chief Administrator
Yehia I. El Kholy	Logistic Support - Abu Zeneima

KECI/ACB Consultants

John Winterhaller	Satra (Macalloy) Corporation
Geologist Monir El Kholy	President, ACB
Professor Dr. Geologist El Shazly M. El Shazly	Chairman, Nuclear Materials Corporation
Geologist Galal A. Moustafa	Chairman, General Authority for Geological Survey and Mining Projects
Mining Engineer Ibrahim A. Kamel	Chairman, El Nasr Phosphate Company
Dr. Civil Engineer Fouad H. El Kholy	Vice President, ACB
Geologist Abd El Hadi Attia	Consultant, ACB
Engineer Hassan H. El Kholy	Consultant, ACB
Economist Moustafa A. Mahfouz	Consultant, ACB

CONTACTED AUTHORITIES, ORGANIZATIONS, COMPANIES & INDIVIDUALS

1. Ministry of Industry & Mineral Wealth
   Directorate General for Mines & Quarries

   Geologist M. Sami, General Manager Mines & Quarries,
   Eng. G. Attwa, Manager Mines Department.
   Eng. Ibrahim Ratib, Manager Quarries Department.

2. Ministry of Reconstruction & New Communities

   Eng. H. El Kafrawi, Minister
   Eng. S. Shaheen, Vice Minister
   Dr. Eng. A. Abu Zeid, Deputy Minister, Chairman, Executive Organization for Reconstruction of Sinai
   Acct. S. Hedayah, First Deputy Minister
   Eng. S. El Beheri.
   Eng. M. A. Mahran, Office of the Minister.
   Eng. A. Mansour, Deputy Minister for Research & Studies.

3. Ministry of Planning

   Acct. M. Khodeir, Project Manager.

4. Ministry of Social Affairs & Insurance.

5. Ministry of Electricity & Power
   Egyptian Electricity Authority

   Eng. Dr. Kamel El-Desouki, Chairman
   Eng. Dr. M. Swidan, General Manager, Planning & Projects.
   H. Abdullah, Manager of Commercial Affairs.

6. Ministry of Housing

7. Ministry of Transport

Ports & Lighthouse Administration

Eng. M.R. Abdel Malek, General Manager, Civil Engineering.

General Egyptian Authority for Roads & Bridges.

8. General Authority for Geological Survey Projects.

Prof. G. Moustafa, Chairman

Geologist M. Zaatout, General Manager,

Geologist M. F. El Ramly, Director

Eng. Anwar Bishai, Director.

Geol. Sameeh Affia.

9. General Organization for Industrialization

Chemist M.A. Ghoneim, Director Mineral Wealth Dep.

Eng. Kamel Saad, Manager, Industrial Site Selection.

Acct. M. El Fergany, Project Manager.

Geol. A. Hathout, Mineral Wealth Dep.

Eng. Janette

10. General Egyptian Surveying Authority

Eng. K. El Sharabasi.

11. General Egyptian Astromineral Authority

M.A. Badran

12. General Egyptian Authority for Sea Transportation

13. General Egyptian Authority for Nile Transportation

14. National Research Center.

1-	Prof. Mohey Eldin Attia	Head of Fine Analysis Lab (Deputy principle Investigator).
2-	Dr. Mechael D. Samoail	Assistant Research Professor in the Earth Science Lab.
3-	Dr. Mohamed Abdel Maksoud	Assistant Research Professor in the Refractories Lab.
4-	Dr. Abdel Hady El Geaes	Assistant Research Professor in the Lab of Metallurgy.
5-	Dr. Nagy N. Yany	Assistant Research Professor in the Earth Science Lab.
6-	Dr. Khairv M. Amer	Researcher in the Earth Science Lab.
7-	Dr. Abdel Karim A. Salem	Researcher in the Earch Science Lab.
8-	Dr. Makram H. Gergeous	Researcher in the Earth Science Lab.
9-	Dr. Nabil Feliks	Researcher in the Lab of Metallurgy.
10-	Dr. Nabil Ghoneim	Researcher in the Refractories lab.
11-	Dr. Ibrahim Sayed A. Farag	Researcher in the Central Lab.
12.	Dr. Saad M. Ahmad	Researcher in the Glass Lab.

15. Nuclear Materials Corporation

Prof. Dr. S.M. El Shazly, Chairman

16. Technical Board of Mining & Refractories

Acct. M. Eldin Abdel Rahman, Deputy Minister, President

Acct. S. Shehab, Member.

17. Governorate of South Sinai

F. Aziz Ghali, Governor.
F.E. Wahba, Previous Governor
Eng. R.A. Sorrour, Planning Manager
S.M. Soliman, Member of Parliament.

18. Governorate of Suez

A. Fekry, Secretary General
Eng. Salah Aziz, General Manager of Engineering

19. Abu Zeneima City

Mohamed El Yamani, President

20. Institute of Metallurgy

Prof. Dr. A. Youssef
Prof. Dr. T. Boulos

21. General Agency for Public Mobilization& Statistics

22. Egyptian General Petroleum Corporation

Eng. B. Faragallah Barsoum, Production Manager
Geologist El Sayed G. Hantar, Prospection Manager
Eng. Halim Marcos Youssef, Distribution & Transport Manager.
Eng. Abdul Azim El Darir, Production Engineer, Sinai & Western Desert.
Chemist, Mary Isaac, Chief production chemist.

23. El Nile Company for Fluviatile Transport

Eng. M. Fathy, Chairman.

24. National Cement Company

Acct. M. El Kholy, Director of Commercial & Financial Sectors.

25. El Dekheila Iron Project

Dr. Eng. S. Taher

26. Egyptian Copper Works Company

Acct. A.M. Awad, Commercial Manager

27. El Nasr Castings Company

Acct. M. Backoum, General Manager of Commercial & Financial Affairs.

Acct. F. Khaled, Manager of Commercial Affairs.

28. The Egyptian Company for Ferroalloys

Eng. M. Baiom, Chairman.

Geoge Hanna, Ferrosilicon Plant, Idfu,

Eng. Ahmed Gamal, Ferrosilicon Plant, Idfu.

Eng. Ismail Farid, Ferrosilicon Plant, Idfu.

Eng. Drago Walts Cher, Ferrosilicon Plant, Idfu.

29. El Nasr Steel Pipes & Fittings

30. El Nasr Contracting Company H.M. Alam & Co.

31. The Arab Contractors Osman A. Osman & Co.

32. Foreign Purchasing Committee for Metallurgical Industries

A. Tiamma, Secretary General.

33. Middle East Maritime Services

34. Central Desert Mining Company.

Acct. S.H. Motawea
Gen. H. H. El Kholy

35. Suez Quarries & Supplies Company.

Acct. A.H. Mahfouz

36. Delta Steel Mills Company

Eng. Moustafa El Sherif, Chairman
A.M. Tiamma, Commercial Manager

37. National Metal Industries Company

Eng. K. Abadda, Chairman.
Eng. S. El Hadidi, Technical Manager.

38. Iron & Steel Company

Acct. S. Zakaria, Vice President, Commercial & Financial Affairs.
Eng. A. Abdel Kerim, Vice President, Mining and Quarrying Sector.

Acct. A. Abu Zeid, General Manager, Commercial Sector.
Eng. M. El Ganaing, Head Furnaces Department
Acct. A. Sedky, Head of Sales Department.

39. El Nasr Phosphate Company

Eng. I. Kamel, Chairman.
Acct. H.I. Hamdi, Commercial General Manager.
Eng. L. Wissa, Technical General Manager.
Eng. S. El Masri, Mines General Manager.

40. Red Sea Phosphate Company

Acct. Metwali Hafiz Ragab, Chairman.

41. Helwan Iron Foundries Co. (Ex. 9 military factory)

42. United States Agency for International Development

James A. Norris, Project Economist.
R. Williams, Project Manager, Suez Cement.

43. International Monetary Fund.

James Prust, Representative.

44. Matthew, Johnson Marshall & Partners

Eng. John Calder, Suez Master Plan Consultant, Project Director, Suez Governorate Technical Assistance Program.

45. Allis-Chalmers

Reduction System Division.
D.W. Rierson, Project Sales Manager
Shaochi Huang, Senior Process Metallurgist

46. Ray-O-Vac
Raw Materials Procurement Division

Stuart Davis

47. Kaiser Refractories International

Donald G. Lees, Manager International Sales Service

48. Brown Boveri Consulting Office for Egypt

Rouf Alexan, Manager Industrial Division.

49. Elkem-Spigerverket A-S.

Halldor Opedal, Group Manager
L. Grennes Hanssen, Mechanical Engineer.
Georg Elefsen, Manager Marketing Department.
Ola E. Laukvik, USA Branch Manager.

50. Petrobel Oil Company

Eng. Emil Boulos, Operations Manager
Eng. Adel Aziz, Ass. operations Manager.
Eng. V. Sizostris, Abu Rudeis
Eng. F. Salem, Abu Rudeis.

51. Suez Oil Company

Eng. Midhat Hatata Project Manager
Eng. Malcom Bonsall, Chief Civil Eng. Dep.
Eng. Said Hilal, Civil Engineering Dep.

52. Technokomplekt
Ferrosilicon Project, Idfu, Egypt.

Dip. Eng. Drago Waltschev

53. Klockner Inc.

Eng. W.A. Kurz — Engineer GRAD
Mr. Detlef E.W. Alberts — Manager Mining Dressing
Eng. H.T. Tawfik
Ferro-alloy plants — Project Manager

54. Eimco

Eng. S. Fezzi Sales Manager

55. Secoma

Eng. D. Vassan Engineer Service Commercial

56. Catterpillar

Mr. S.M. Butler General Sales Manager

Mr. S. Khalil Eorthmoring Sales representative

Documentation

DOCUMENTATION

i- SMC Documents

SMC kindly delivered to KECI the available documents, studies, reports, maps and other data relevant to this project study, included by the following letters:

- No. 21/80 dated 26 January 1980
- No. 26/80 dated 3 February 1980
- No. 27/80 dated 17 February 1980
- No. 189/80 dated 21 February 1980
- No. 47/80 dated 10 March 1980
- No. 138/80 dated 10 July 1980

These documents are classified as follows:

A. Fundamental Data

- Aerial photographs and mosaics:
  - 40 aerial photographs scale 1:40000
  - 4 mosaics scale 1:50000
- Triangulation points in study area.
- Meteorological data.

B. Geology & Ore Reserves & Mining Rights

- Technical report concerning the company's activities in the Sinai before 1967.
- Technical report concerning the Mn ore reserves in Om Bogma area.
- Technical report about the deposits in the Sinai.
- Technical report about the development and exploitation of Mn ore in Om Bogma area written by the British export geology Stanley Ford.
- Plans and maps ore reserves calculation of manganese ores.
- The full chemical analyses of the different grades of Mn ore in the Sinai.
- Technical report on the manganese ore reserves in west central Sinai to 30.6.64.
- Report concerning the inquiries from manganese ore to ferromanganese plant.

- World production of Mn and FeMn alloys.
- Topographic map for the general layout of the mines - scale 1:50000.
- Contour map of Om Bogma - scale 1:12500.
- Map showing the rainfall drainage in Om Bogma and Abu Zeneima - scale 1:50000.
- Topographic map showing the whole licenses and leases issued to Sinai Manganese Company - scale 1:50000.
- Aerial ropeways project - scale 1:50000.
- Executing drawings for the tower bases
- Working plan to productions lease No. 291-300 scale 1:2000
- Working plan to productions lease No. 293 scale 1:2000
- Working plan to productions lease No. 298-299 scale 1:2000
- Working plan to productions lease No. 296-297 scale 1:2000
- Working plan to productions lease No. 861-915 scale 1:2000
- Working plan to productions lease No. 914 scale 1:2000
- Working plan to productions lease No. Ramsy zone scale 1:2000
- Working plan to productions lease No. Area 45 1:500
- Map showing the priorities for the aerial photos scale 1:100000
- Priority No. 1 scale 1:5000
- Priority No. 11 scale 1:5000
- Priority No. 111 scale 1:5000
- Plan showing the ore reserves in the production lease 291-300 scale 1:2000

- Isopach map — scale 1:2000
- Map No. 3/5 of Ain Abu Hamata Nahman area — scale 1:5000
- Map No. 4/6 of M.P. License 613 — scale 1:2000
- Map of 10 Zone — scale 1:3000
- Map No. 4/9 of Nahman area — scale 1:5000
- Map No. 4/8 of Nahman area — scale 1:5000
- Map No. 4/7 of Nahman Hill B — scale 1:2000
- Map No. 4/12 of Wadi Nassib area — scale 1:2000
- Map No. 5/37 of lease 9 — scale 1:500
- Map No. 4/32 of lease 9 upper area — scale 1:500
- Map No. 3/26 of lease 170 — scale 1:500
- Map No. 5/20 of lease 9 main south area — scale 1:500

C. <u>Ferromanganese Plant</u>

- Report on FeMn plant in Abu Zeneima.
- Substantive terms of reference (presented from U.N.).
- Report of the short technical advisary mission to S.M.C. concerning the restoration of the Abu Zeneima FeMn plant (presented by B.R. Nighwan Senior Inter-regional adviser of (UNIDO).
- Survey and damage report on gas turbine power station of the S.M.C. in Abu Zeneima (presented by Brown Boveri and Co.) June 1976.
- Report on technical inspection of the FeMn plant at Abu Zeneima by Elkem-Spigerverket, in Nov. 1976.
- Technical report from Electrokemisk in December 1960.
- Report about the importance of making industrial region in Sinai.

- Report of the industrial committee about FeMn project.
- Report of the financial and committee about FeMn project.
- Report of the general committee about the FeMn project, power station, and distillation plant.
- Report about the possibilities to use natural gases at oil field in Abu Rudies.
- Primary report in electricity for FeMn tin, lead, and illmenite project.
- Report of the power committee about the tender study of electric power and distillation plant, presented to Sinai Manganese Co.
- Primary layout of Abu Zeneima.
- Contract of executing the erection of the civil structure of FeMn plant.
- General specification and conditions for the FeMn Building.
- Report on FeMn plant in Abu Zeneima.
- Report on Sinai smelting project written by Cambell, Gifford & Morton Ltd.
- Substantive terms of references.
- Amendment to the contract of civil erection of the FeMn loading platform in the harbour of Abu Zeneima.
- Some correspondences and offers concerning the drinking water pump station.
- Equipment specifications for gas turbine electric generating station presented by Westinghouse Electric International Co.
- Tender for the power and water distillation plant presented by the Tractor and Engineering Co.
- Executing of sanitary and drainage system project in Abu Zeneima.
- Conditions of tender and specifications for the supply and erection of an electric power station and water distillation plant at Abu Zeneima presented by the Tractor Engineering Co.
- Time schedules for executing the project.

- Calculation sheets of the following:

  - Foundation
  - Roatary kiln (smoke chamber) and stairs in S.C.
  - Furnace building slab and beams
  - Column loads
  - Bar lists
  - Furnace building slab
  - Steel foundation structures
  - Frames
  - Bins
  - Tapping and backing hall
  - Floor elevation
  - Stairways - crushing table - water tank
  - Kiln foundation - rotary kiln - the chimney

158 drawings concerning the ferromanganese plant.
64 drawings concerning the ferromanganese plant.

ii. KECI's Library References

KECI's Library References

Manganese - Mineral Commodity Profiles, July 1979, Bureau of Mines.

Two-Stage Electric Furnace Smelting of High-Iron Manganiferous Materials for Producing Ferromanganese, F. B. Petermann and R. S. Lang, Bureau of Mines. September, 1962.

Production of Manganese Slags for Manufacturing High-Grade Ferromanganese by Blowing Oxidation Spiegeleisen, Theodore Kootz and Jacob Willems, in cooperation with Willy Oelsen and Hanns Wentrup (Translated by Roy W. Tindula), Bureau of Mines Information Circular No. 7634, June 1952.

Submerged-Arc Furnaces - Mannesmann Demag Brochure, June 1979.

Electric Reduction Furnaces - References - Metallgewinnung Demag Brochure, February 1975.

Elkem-Spigerverket A/S, Engineering Div. Brochure, Cat No. 71, August, 1977.

The Elkem Control System, A Computer Control System for Electric Smelting Furnaces, Elkem-Spigerverket A/S, Engineering Division, Cat No. 73.

Accar Presentation, 1980, Allis-Chalmers, Cement, Mining & Metals Systems.

Industrial Electric Furnaces and Appliances, V. Paschkis, John Persson, 1960.

Electric Smelting Processes, A. G. E. Robiette, 1973.

1980 Annual Book of ASTM Standards, Part 2, Ferrous Castings; Ferroalloys, ASTM

Electric Melting Practice, A. G. E. Robiette, 1972.

Production of Ferroalloys Electrometallurgy, V. P. Elyutin, et al, 1961, U.S. Dept of Commerce NTIS, TT61-11429.

Electric Furnace Proceedings, Vol. 32, Pittsburgh, 1974, Iron and Steel Society of AIME.

Ferroalloys - A World Survey, Metal Bulletin, London, 1978.

iii- ACB's Library References

1. Birlec-Efco (Melting) Ltd. 1960.
   project for the production of pig iron and ferromanganese (to SMC). Deals with metallurgical process; technical data, economic appraisal & equipment specification.

2. ATKINS PLANNING (1977) A stratigic study of the Egyptian metallurgical industry phase I report (GOFI).

3. ATKINS PLANNING (1978) A stratigic study of the Egyptian metallurgical industry - Summary report (GOFI).

4. MURALIDHARAN P. 1975 - Titanum mincrals and materials - Chary Publications, Bombey, India. A world Survey through the decade 1970-1980.

5. General Egyptian Organization for Geol. Survey & Mining Projects 1973 - Mineral wealth in Sinai Peninsula.

6. Yousef, A.A., Boulos, T.R.; Ezz, S.Y. and El Geassy, A.A. (1976)- Magnetizing reduction of some iron ores with respect to their chemical constitution (Aufbereitung-Technik).

7. Boulos, T.R., Yousef, A.A., El Geasy, A.A. & Youssef, M.A. 1978) High manganese steel concentrates from some Egyptian iron ores - Aufbereitungs - Technik No. 7.

8. Malati, M.A.; Orphy, M.K. and Yousef, A.A. 1961-Beneficiation of Egyptian manganese ores; part II: magnetic separation of reduced ores, Aufbereitungs technik No. 9.

9. Yousef, A.A.; Boulos, T.R.; Ezz, S.Y. & El Geassy; A.A.(1969) Magnetic concentration of reduced manganese ores for the production of ferromanganese. Journal of mines,metals & fuels No. 6/2.

10. Ezz, S.Y.; Yousef, A.A.; Boulos, T.R. and El Geassy, A.A. Magnetic roasting of some Egyptian ferroginous manganese ores - proceeding of symposium on Non Ferrous Metals. Technology, Vol. III.

11. Boulos, T.R.; Yousef, A.A. El Geasy, A.Y. & Youssef; M.A. High manganese steel concentrates from some Egyptian iron ores.

12. Egyptian Organization for standardization 1970, Metallurgical coke.

13. SMC project for production & exploration of kaolin ores.

14. SMC (1959) Report on possibility for using the gases from petroleum, wells at Eastern Co. region at Sinai, for elect. generating at elect. station in Abu Zeneima+ gas analysis.

15. SMC Report: Ferromanganese Co. plant in Abu Zeneima Sinai (SMC project) includes the first combustion of gas turbo generator with a distillation plant operated by the waste heat of the turbines.

16. SMC Report: 5 boreholes at site of the ferromanganese plant power station of Abu-Zeneima.

17. Report on Sinai Smelting Project: Campbell Gifford & Morton LTD.

18. SMC Report on TEchnical inspection of the ferromanganese at Abu Zeneima (Elkem-Spigerverket). Supply the equipment and building and foundations.

19. Report of the economical & legal commeettee for studying the offers for the ferromanganese production (1961).

20. Report (SMC project) Ferromanganese plant in Abu Zeneima Sinai, 1961.

21. Report on the short technical advisory mission to Sinai Manganese Co. (1967 B.R. Nijhawan) concerning the restoration of the Abu Zeneima ferromanganese plant in Sinai Area.

22. Study of ore reserves in different concessions, Geol. Research Dep. of SMC.

23. Electrokemisk Report 1960 which deals with planned establishment of smelting works based on electro smelting of low grade ore.

24. Engineering/Economic Feasibility Study - Abu Zeneima ferromanganese plant. Scope of work & instructions for preparation and submittal of technical proposals.

25. Survey & Damage Report on the ABu Zeneima Power Station W. Kessler - Broun Boveri & Co., 1976.

26. Geology of Sinai Peninsula from ERTS-1 - Satellite Image

27. Proceedings of the UN/Fa0, regional seminar on remote sensing of earth resources & environment 1974 (Dr. Mohamed Abdel-Hady).

28. Demag, Sinai Report Geological & Mining, 1961.

29. Encyclopedia of Sinai. The Supreme Council for Sciences, 1960.

30. Memorandum, of the Mining Authority to its board of Directors about the ore reserves of SMC in Sinai - by M. Zaatout & M. Abu El Enein.

31. Moustafa; G. 1961, Coal Project, Wadi Thora & Wadi Buda West Central Sinai, Geologic report including calculation of the coal reserves.

32. The Egyptian General Mining Organization 1962-1966, all the memorandums submitted to its Board of Directors concerning the Sinai ferromanganese project.

33. Arab Consulting Bureau 1956, Geological Mineralogical and Chemical studies of El Khoboba glass sand, Sinai, Egypt.

34. Sinai Manganese Company 1963, Kaolin prospection and production, (including white clay, carbonaceous clay, glass sand & dolomite).

35. Sinai Manganese Company 1964, gypsum of Ras Malaab,Sinai.

36. Sinai Manganese Co., balance sheets and reports of its Board of Directors for the years, 1958, 1959, 1960, 1961, 1st half of year 1962 (30.6.1962), 1962/1963, 1963/1964, 1964/1965, 1965/1966, 1966/1967. Also report of the increase of company's capital 1963/1964 submitted to its General Assembly.

37. Egyptian Federation of Industries year Books 1956/1957, till last year book.

38. Central AGency for public mobilisation and statistics, Statistical Hand Books, (till last edition).

39. Central Agency for public mobilisation and statistics, year books for general statistics (till last books).

40. Central AGency for Public Mobilisation & Statistics - Statistical parameters 1952/1972.

41. Central Agency for Public Mobilisation & Statistics - Year Book Statistics of Arab Countries 1976.

42. Central Agency for Public Mobilisation & Statistics, Monthly Report of Foreign Trade Jan./Dec. 1977.

43. GOFI, Economic Study of Ferrosilicon Project at Idfu.

44. Sir William Halcrow & Partners, 1976 - Suez Master Plan Study.

45. Gill, D. and Ford 1956 - Manganiferous iron ore deposits of Um Bogma.

46. IDCAS, 1977 - Development of mineral resources in the Arab World.

47. Zaatout M., and Abu El Einein, M., 1964, Sinai Manganese ore reserves and replanning of SMC's production during 1964/ 1965.

48. Abu El Einein M. 1966, Sinai Manganese Ore Reserves.

49. Arab Consulting Bureau - File Geology, prospection & ore produced from Abu Zeneima Um Bogma area (including geological maps, cross sections and analytical data).

50. El Affy, E.M., 1946 - Mineral resources of Egypt

51. El Shazly, E.M., 1960 - Mining in Sinai Peninsula.

52. El Shazly, E.M., and Abdel Hady, M.A., El Ghawaby, M.A., El Kassas, I.A. and El Shazly, M.M., 1974 - Geology of Sinai Peninsula.

53. El Shazly, E.M. and Saleeb, G.S. 1959, Constribution to the mineralogy of Egyptian manganese deposits.

54. El Shazly, E.M., Shukri, N.M. & Saleeb, G.S. 1963- Geology of Oleikat, Marahil and Um Sakran Manganese deposits.

55. Saleeb, G.S. 1959 - Geological and Mineralogical Studies of some manganese iron deposits in West Central Sinai (M.Sc. Thesis).

56. Data, from Steel Complex Project.

57 Data, from Egyptian Electricity Authority.

58. Data, from the Egyptian General Petroleum Corporation.

59. Data, from the Egyptian Meteorological Authority.

60. Data, from Middle East Maritime Service.

61. Data, from the Egyptian Authority for Geological Survey & Mining Projects.

62. Data from Ministry of Reconstruction and New communities.

63. Data, from the Egyptian Authority for Bridges & Roads.

64. Thomas R. 1980- Operating hanbook of Mineral processing, Mc. Graw-Hill.

65. Hoppe, R., 1980 - Operating handbook of Mineral surface mining and exploration, Mc-Graw Hill.

66. Sirselmas, R., 1980 - Operating handbook of Mineral imder - g-ound mining, Mc-Graw Hill.

67. Dietrich, R.V., 1980 - Mineral tables, Mc Graw Hill.

68. E/Mg Magazens, 1979, 1980.

69. Mining Engineer handbook (Peele).

70. Jerusalem, 1978 - Geological Survey of Israel research in Sinai 1967 - 1978.

71. Westwood, M.A. 1978 - Deep Sea Mining of manganese nodules

72. Mart, J. and Sass, E. 1972 - Geology and origin of the manganese ore of Um Bogma, Sinai. Econ. Geol. V.67, No.2, P. 145-155.

73. Weissbrod, T., 1969 - The paleozoic outcrops of south-western Sinai and their correlation with those of southern Israel : Bull. Geol. Survey Isr. 48.

74. El Tarabili, E.S. and Adawy, N., 1972. Geologic history of Nukhul-Baba area, Gulf of Suez, Sinai, Egypt. ARE. Bull. Am. Ass. of Pet. Geol., V. 56, No.5, p. 882-892.

75. Breuner, I.B. and Mart, J. 1970 - Geochemical prospecting for copper in the Wadi Rimthy area, southern Sinai, Geol. Survey of Israel, 6p.

76. Magaritz, M. and Bremmer, I.B., 1979 - The geochemistry of a lenticular manganese ore deposit (Um Bogma, Southern Sinai). Mineral Deposits,13.

77. Lapedes, D.N., 1978 - Encyclopedia of the geological sciences, Mc-Graw Hill.

Inventory Reports

D. * Inventory Reports

The inventory reports dated 1979, conversing the SMC's facilities at Sinai.

SINAI MANGANESE CO.

Technical report presented to the con-
ference held at the Co. in 30.I.1979.

Introduction :

Welcome for everybody in our company.

Manganese is present in Sinai specially in Um-Bogma which is the most important locality for the production of the Mn. ore allover Egypt.

In 1918 a British Co. called Sinai Mining Co. started production of Mn. ore, and continued till 1956. Then in 1957 this Co. was nationalized under the name of Sinai Manganese Co.

Site :

Um-Bogma is 40 km E3. Abo-Zenima and 165 km. from Suez.

It is characterised by its rigid mountainous topography.

The mines lay on a high of about 500 to [illegible] meters over the sea level .

Geology & Occurance :

Mn. ores present in dolomitic beds related to the carboniferous period. The area is characterised by the presence of faults and fissures near which the Mn. ore allways occur.

The deposits are formed generally of Mn.oxides associated with iron oxides in the form of linticular, banana or spheroidal shape and ranges in thickness from few cm. - 10 meters.

Ore Reserves :

At June 1967 the total reserves of the [illegible] in Um-Bogma were estimated to be 4.018.000 Tons, according to the following categories : -

1- Category A which was proved and indicated ore reserves .
It was estimated to be 1.688.000 Tons in the following areas :-
a) 393.000 Tons in the productive mines .
b) 1.295.000 Tons in the prospective and developed areas.

The average chemical analysis was :-
Mn 20.8% Fe. content 34.8%

2-Category B which was the probable ore reserves :-
It was estimated to be 1.000.000 Tons.

3-Category C which was the possible ore reserves :-
It was estimated to be 1.330.000 Tons.

Prospections & Researches :-

Our Co. carried out most of the [illegible] before 1967 near the productive areas for the [illegible] in these areas. The other far areas only [illegible] and research were carried out where probable and possible ore were estimated .
It needs underground development to [illegible] quantities .
It was expected to excute a programme within [illegible] years from 1967 till 1970.

The areas through which this program would done, was divided into 3 periorities according to their neighbour to the production areas and the transport facilities .

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The following are thethree periorities and the proposed development in meteres :-

Periority I.	would be	6596	meters.
Periority II.	would be	9750	,
Periority III.	would be	7000	,
Total		23346	

It was expected that this development programme would be carried within 5 years after the withdrawal of Israel .

Mining Methods :-

The ore was produced from the production areas either by the open cast quarries , or from underground mines by R. & P. method which was the predominant .

Both of the two methods depend on the thickness of the overburden which was siltstone or mainly sandstone .

In both methods production was taken by drilling and blasting then transporting the ore by locomotives bulling small cars of capacity one ton/each to ore-bankers and then by the areal repeway to a main banker . Then by the railway to A.Z. from which the ore was loaded abroad or to the local market.

The daily production was about 500-600 tons. The policy of the production depends upon the ore reserves of each area and the grade to reach the average from 20-21% Mn.

The average productions within the last 5 years before 1967 was :-

62/63	147929	Tons
63/64	163502	,,
64/65	175535	,,
65/66	183250	,,
66/67	141437	,,

Ore bankers and Areal repeways :-

There are five main bankers within the mines areas , Their capacities varies from 450 tons to 1200 tons for each . There is main banker of 2000 tons capacity at the terminal end of the areal repeway at depot 2 .

Also another big banker of 18.000 tons at A.Z. These bankers were connected together by areal repeway which was carried on towers.

The most important data concerning the areal repeway are as follows :-

Total length till depot 2	14.175 m (single line)
No of towers	87.
No of buckets carried in the repe	257 + 8 tanks of water
Total length of the pulling repe	18.510 m (single line)
Cross section of the repe	42.m.m.
Cross section of the pulling repe	24.m.m.
Speed of the buckets in the repe	1.7 m/sect
Capacity of the bucket	685 kg.
Total amounts of the ore transported /hour	35-50 tons
Total amounts of the ore transported /day	500-600 tons.

There was a programme to erect a new areal repeway to carry the new ore reserves which would be proved in the new areas. The company began execution of the first connection of this R.W. but unferunatley the war occured.

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The total length of the new areal repeway was 6.9 km.
The total amount of the reserve would carry
was I.665.000 tons.

Railway :-

From the terminal end of the A.R. at depot 2 the ore was transported by means of locomotives of I50/h.p pulling cars of 5 tons capacity . The rails of I00 cm guage, and of I8 km length till the banker of A.Z.

The daily transport ranges from 500-600 tons.

A.Z. Banker and loading system :-

The main banker at A.Z. has a capacity of I8000 tons. Sometimes when this banker was full of the ore the excess was damped on the neighbering ground .

Then the ore was transported on a belt conveyor of a width 90 cm. carried on leading jetty of about 400 meter length.

The depth of the water at the port of A.Z. was about 27 feet at May 67 which was suitable for leading ships or vessels of about I0.000 tons.

The average leading capacity/hour ranged from 60-70 tons of the screened ore of 0.5" and from I20 - I50 tons for the unscreened ore.

The time of leading/day was about I4 hours in two shifts.

Dioxides and high grade Reserves :-

These reserves were divided inot 3 grades :-

I.Dioxides in which the Mn content was 55% and was estimated to be I.500 tons
2.High grade ore in which the Mn content was 48% and was estimated to be I2.000 tons.
3.High grade ore in which the Mn content was 42% and was estimated to be I3.500 tons.

The total amount of these reserves were 27.000 tons,. These reserves were included in the above mentioned reserves.

The prospection and development programme included the proving of the high grade ore which initially estimated by 50.000 tons.

Technical manager

Geol. Salah Dawrdash Ahmed .

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Samples from ore lots in the mines and A.Z. ready for shipment .

THE SINAI MANGANESE COMPANY
I.El-Bustan St., Cairo
Tel.970395- Telg.SIMANG-CAIRO

COMPLETE ANALYSIS OF MANGANESE DIOXIDE

CONSTITUENTS		GRADE				
		I	2	3	4	5
MnO_2	Peroxide of Manganese	89.870	89.780	87.780	81.950	74.910 47.36
MnO	Manganous Oxide	3.250	2.090	2.190	4.210	1.700 1.32
Fe_2O_3	Peroxide of Iron	0.330	1.000	0.900	3.360	3.360
FeO	Mon-Proxide of Iron	Nil	Nil	Nil	Nil	Trace
Al_2O_3	Alumina	0.550	0.300	1.100	1.240	0.800
TiO_2	Titanium Dioxide	0.010	0.001	0.010	0.625	0.020
SiO_2	Silica	0.200	0.570	0.480	0.600	0.600
CaO	Calcium Oxide	0.450	0.050	0.030	0.080	4.780
MgO	Mangesuim Oxide	0.550	0.380	0.300	0.200	1.760
BaO	Barium Oxide	Nil	1.630	2.600	2.500	1.250
$BaSO_4$	Barium Sulphate	0.200	0.100	Nil	1.440	1.900
CuO	Copper Oxide	0.038	0.163	0.075	0.225	0.175
PbO	Lead Oxide	Trace	0.040	0.130	0.020	Trace
ZnO	Zinc Oxide	0.450	0.220	0.220	0.320	0.160
NiO	Nickel Oxide	0.030	0.030	0.020	0.030	0.030
CoO	Cobaltous Oxide	Trace	0.030	0.032	0.040	Trace
AsO	Arsenious Oxide	0.005	0.005	0.015	0.018	0.010
Na_2O	Sodium Oxide	0.420	0.200	0.200	0.050	0.630
K_2O	Potassium Oxide	0.280	0.370	0.700	0.430	0.650
P_2O_5	Phosphoric Anhydride	0.070	0.046	0.046	0.142	0.083
SO_3	Sulphuric Anhydride	0.027	0.123	0.067	0.206	0.274
CO_2	Carbonic Anhydride	0.100	Nil	Nil	Trace	5.250
H_2O	Combined Moisture	3.020	2.880	3.200	2.750	1.150
	Undetermined	0.100	0.013	0.005	0.164	0.008
		100.000	100.000	100.000	100.000	100.000
Mn	Total Manganese	59.340	58.330	57.200	55.150	48.680 48.66
Fe	Iron	0.230	0.700	0.630	2.350	2.700
P	Phosphorus	0.031	0.020	0.020	0.062	0.038

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Samples from ore lots in the mines and A.Z. ready for shipment.

(2)

CONSTITUENTS		GRADE 42%	GRADE 48%	GRADE Low
MnO_2	Peroxide of Manganese	65.53	67.770	32.760 20.71
MnO	Manganous Oxide	4.00	II.I80	0.970 0.75
Fe_2O_3	Peroxide of Iron	I7.86	9.790	~~51.970~~ 51.52
FeO	~~Prot~~ Mon-oxide of Iron	Nil	Nil	36.06 Nil
Al_2O_3	Alumina	I.5	0.900	2.380
TiO_2	Titanium Dioxide	0.04	0.033	Nil
SiO_2	Silica	3.00	I.I60	5.800
CaO	Calcium Oxide	I.50	I.450	0.780
MgO	Mangnesium Oxide	0.20	0.350	0.I00
BaO	Barium Oxide	I .00	I.300	0.400
$BaSO_4$	Barium Sulphate	0.80	0.I50	0.900
CuO	Copper Oxide	0.05	0.050	0.050
PbO	Lead Oxide	Trace	Trace	0.070
BiO	Bismuth Oxide	Nil	Nil	
CoO	Cobaltous Oxide	Trace	Trace	Trace
NiO	Nickel Oxide	0.0I	0.0I0	Trace
ZnO	Zinc Oxide	0.40	0.550	Trace
Na_2O	Sodium Oxide	0.20	0.300	0.I00
K_2O	Potassium Oxide	0.30	0.4I0	0.300
As_2O_3	Arsenious Oxide	0.02	0.025	
P_2O_5	Phosphoric Anhydride	0.20	0.I85	0.236
S	Sulphur	0.I5	0.090	
CO_2	Carbonic Anhydride	0.20	0.300	0.I20
H2O	Combined moisture	3.00	3.900	3.250
	Undermined	0.04	0.097	0. 049
		I00.00	I00.00	I00.00
Mn	Total Manganese	43.69	5I.5I	2I.46
Fe	Total Iron	II.33	6.85	36.03 ?
P	Phosphorus	0.08	0.8I ? 0.08I	0.I03

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Samples from ore lots in the mines
and A.Z. ready for shipment.

(3)

	CONSTITUENTS	FINE MANGANIFEROUS ORE	M_NO_2/M_NO
Mn	Total Manganese	I9%	28.99/0.86
Fe	Total Iron	38	54.29
Al_2O_3	Alumina	2.380	
TiO_2	Titanium Dioxide	Nil	
CaO	Calcium Oxide	0.780	
MgO	Magnesium Oxide	0.I00	
K_2O	Potassium Oxide	0.300	
Na_2O	Sodium Oxide	0.I00	
BaO	Barium Oxide	0.400	
$BaSO_4$	Barium Sulphate	0.900	
SiO_2	Silica	5.800	
P_2O_5	Posphoric Anhydride	0.236	
SO_3	Sulphuric Anhydride	0.250	
CuO	Copper Oxide	0.050	
PbO	Lead Oxide	0.070	
ZnO	Zinc Oxide	Trace	
NiO CoO	Nickel and Cobalt Oxide	Trace	
As	Arsenic	0.0I5	
CO_2	Carbonic Anhydride	0.I20	
H_2O	Combined Moisture	3.250	98.89
	Undetermined	0.049	1.11

SAME ANALYSIS AS FOR LOW-GRADE ORE.

SINAI MANGANESE CO.

Housing and Services Centers
In A.Z. SINAI

I.	20	Lux buildings or villas for senior married staff.
2.	25	Buildings blocks each of 6 rooms with their services, these building for single unmarried personnel .
3.	19	Building blocks each of 4 rooms for 6-9 labreurs/ each.
4.	30	Buildings each of two flats for 60 families.
5.	I	Administrative buildings of 3 floors.
6.	I	Building for the market and Bazzar. & Furnace.
7.	I	Building for the resturant.
8.	2	Clubs buildings .
9.	I	Open air Cinema .

INDUSTRIAL BUILDINGS :-

I.	I	The Fe.Mn. Plant.
2.	I	Power station.
3.	4	Tanks for the stering the distilled water.
4.	I	Ice making plant.
5.	I	Centeral workshops.
6.	I	Centeral stores.
7.	I	Centeral Garage.
8.	I	Leading plateform with pump-house.

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Shadow Price

Shadow price is the price of good, factor or even money when it is determined solely by the competitive market forces. A shadow price is the equilibrium price when there are no outside forces interfering with the workings of market forces.

In project analysis, often it is necessary to shadow price wages and foreign exchange. However there are other prices that need to be shadow priced depending on the nature of the project.

Wages .... because of unions, minimum wages and other non-market forces, the actual wage may be higher than the wage rate if there were no interference. Particularly then when there are large unemployed unskilled labor in the country, shadow wage theoretically should equal zero for unskilled. Skilled labor may be an entirely different story

Foreign exchange .... the price of foreign exchange in the absence of FX control often the black market exchange rate is used as a proxy for shadow price of FX

Goods .... use world market prices.

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UNITED STATES GOVERNMENT

Memorandum

DATE: January 30, 1979

REPLY TO ATTN OF: Domenick J. Scarfo, U.S.A.I.D.

SUBJECT: Sinai Manganese Co. (SMC) Pre-Proposal Conference Held in SMC's main office in Cairo on Jan. 30, 1979

TO: List of Attendees

Attendees: See Attached List

The purpose of this memorandum is to record the minutes of the subject conference. The following is an attempt to record the questions, answers and statements articulated during the Conference. However, because discussion was active during the conference these minutes are by no means complete. To insure that all pertinent questions and responses have been satisfactorily recorded, Mr. Scarfo requested that all firms submit their questions in writing and these would be answered in writing. This has, in fact, been accomplished and those written questions/responses are attached hereto.

The Chairman of SMC, Mr. H.A. Abou Youssef, opened the conference at 10:15 AM. He welcomed everyone and made some general opening remarks. Mr. Shawky El-Nahas of GOFI then made some general remarks and introduced everyone attending the conference.

Mr. Salah Damardash of SMC, then read a statement which presented a historical overview of the project, provided data on raw

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Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan

OPTIONAL FORM NO. 10
(REV. 7-76)
GSA FPMR (41 CFR) 101-11.6
5010-112

materials, mining and transportation. This statement will be typed and distributed to all attendees.

Following are salient questions, responses and announcements:

1. Q. Are photographs permitted to be taken at the plant site?

   A. No.

2. S. Helwan is to be striken from the scope of work everywhere as an alternative site.

3. S. The words, "... and smelting of ilmenite ore is to be deleted from p. 21, line 3 of the scope of work and anywhere else found in the scope.

4. Q. Is SMC entering into any contract for the importation of high grade (48%) manganese ore?

   A. No.

5. Q. Is there a market for low grade mang. ore?

   A. No.

6. S. The plant at Abu-Zenima used 70,000 MTA of low grade ore and 5,000 MTA of high grade ore.

7. Q. What is composition and condition of raw material handling equipment for the Abu-Zenima plant which is presently being stored in Cairo.

   A. There is no such equipment stored at this time.

8. Q. What degree of investigation should be devoted to examination of alternate site?

   A. This is a decision that proposers would have to make.

9. S. The definition of "shadow prices" would be given to each firm on Feb. 1, 1979.

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10. Q. Is the length of time to accomplish the actual work as described in the scope of work to be rigidly adhered to?

A. Each firm should include in its technical proposal what it considers a reasonable time to accomplish the work.

11. Q. What is the content of the ores available to SMC?

A. This question was answered verbally in some detail. SMC promised to distribute or make available this information in written form.

12. Q. What is source restrictions on sub-contractors or use of personnel to work on study.

A. Study personnel will be either U.S. or Egyptian. U.S. personnel will be paid in U.S. Dollars and Egyptians in LE.

13. Q. How much time will be needed by SMC and GOFI after receipt of Phase I study report before a decision is reached to proceed with Phase II?

A. Forty-five (45) days.

14. Q. Is test data available on ores?

A. Yes.

15. Q. Does test date include geological cross-section?

A. Yes, however, complete data not available.

16. Q. Is there data on availability of limestone and dolemite?

A. No. However, huge quantities of these materials are available in Egypt.

17. Q. Is there any ore deposit information available from data gathered by satellites?

A. No. However, to be certain, SMC will check with appropriate Egyptian entity responsible for remote sensing activities and advise the attendees prior to their departure from Egypt.

18. S. Mr. Woody explained A.I.D.'s interest and extent of its involvement in the study. Also, dollar and LE financing was described.

19. S. SMC and GOFI wish that the firm who undertakes the study to provide an executive summary of important findings and recommendations which will appear in the body of the final study report. This requirement will be incorporated in the contract between SMC and the U.S. firm.

20. S. It was agreed by all that the TECHNICAL PROPOSALS WOULD BE RECEIVED IN EGYPT BY MARCH 31, 1979. PROPOSALS RECEIVED AFTER APRIL 1, 1979 WOULD NOT BE CONSIDERED.

21. S. Scope of Work was amended to include the fact that GOFI was to also receive three (3) copies of the technical proposals.

IIDPS:DJScarfo:st:1/30/79
Clear:IND:DCWoody 131

The Sinai Manganese Company
THE EGYPTIAN GENERAL ORGANIZATION
FOR THE METALLURGICAL INDUSTRIES
Head office 1 Kasr El Nil St. Cairo. A.R.E.—Tel. 70395—Cables : Simang Cairo

RECEIVED
MAR 5 1979
KAISER ENGINEERS
G L MARQUIS

Cairo in : 18.2.1979.

Our Ref : 59/79.

Messrs.
Kaiser Engineers and Constructors, Inc
300 Lakeside drive
P.O.Box 23210
OAKLAND California 94623
USA.

Sub : Fe.Mn. Project at Abu-Zenima .

Dear Sirs,

Referring to the pre-proposed conference concerning the above mentioned subject which was held at the main office of S.M. Co. in Cairo , Jan.30.1979 . and the visit of Abu-Zenima site during 1st & 2nd Feb. 1979.

Please you will find enclosed herewith the answers to some questions which were not available during this conference .

We thank you for your attendance and kind co-operation in this respect , mean while we remain , Dear Sirs.

Very Truly yours

Eng. H.A.Abou-Zoulof
(Chairman)
SINAI MANGANESE COMPANY.

cc.Eng.

J. K. TAYLOR
MAR 2 1979
KAISER ENGINEERS INC.

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Question ,by BECHTEL :-

What is the annual consumption of ferro-manganese at Hellwan steel plant ?

Answer :

The exact present annual consumption of ferro-magnanese at the Helwan plant is not available at the moment , a rough estimate would be in the region of 7000 tons metric.

When the Helwan plant reaches full capacity after blowing in blast furnace 4 and adding the needs of the three existing semi-integrated steel plants , the estimated annual consumption in I980 - I982 would be in the region of 2I000 tons.

~~Answer~~ :

The consumption of ferro-magnaese in the planned integrated plant at Dikheila, Alexandria, would add another 96000 tons per annum .

Thus the total expected requirements of ferro-manganese in I985 would be in the region of ~~3000~~ 30,000 tons per annum .

Accurate figrures / estimates / timing will be obtained from the market study when it is carried out by the consultant.

Questions by U.S.Steel

What is the prevailing wind direction in A.Z. and typical wind velocity ?

Answer :

Percentage of the number of times of surface winds during the year, from the directions at the weather forecast station at Abu.Zenima ,(Calculated from the weather forecasts taken 3 times daily at 800/1400/2000 hours locally)

Direction :	North	N.E	East	S.E	South	S.W.
Percentage:	I8.5	4.8	0,8	I.9	I.7	I.

Deirection:	West	N.W.	No wind
Percentage:	6.4	4I.3	23,6

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Question :

In proposed smelting plant what method , if any of deposal of dust from rotary kiln was foreseen ?

Answer :

Not Known .

Question :

What are natural gas reserves associated with palaim oil fields ? Are there any other plans for utilization of this gas ? (pipeline to suez for instence for construction of Ammonia plant for fertilizer ?)

Answer :

Unofficial information to-date indicates that no surplus gas is available from palaim oil fields . If this situations changes the information will be made available.

Question :

What is the expected sulphor content of natural gas delivered to Abu-Zenima ?

Answer :

Not Available .

When mining operations are resumed what is expected R.O.M size consist of ore ?

Answer :

To be determined later .

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SINAI MANGANESE COMPANY

I.Kasr El-Nil St., Cairo E G Y P T

P R O G R A M M E

of visit to Abou-Zeneima In S I N A I
at thus.Ist & Fri.2nd , February I 9 7 9 .

I. Site : I20 km. south Suez.

2. Aim : Visiting the Ferremanganese plant , and the harbour infrastructure .

3. Thursday Ist. Feb, I979:-

a.m. 9.30 Transport by bus from the head quarter of the Sinai maganese Co. (I.kasr El-Nil St. El-Tahrir Sq.) Cairo , To the Airport.

II.00 Departure by plane.

I2.00 Arrival to Abou-Rudies.

p.m. I2.30 Lunch at Rast house of Belayim Oil fields Co. at Abou-Rudies.

I3.30 Transport by bus to Abou-Zeneima and starting the visit to the Ferremanganese plant.

I7.00 Hot drinks at Abou-Zeneima.

I9.00 Retrun by bus to Abou-Rudies.

20.00 Supper at Abou-Rudies.

20.45 Back to Abou-Zeneima

4. Friday 2nd February I979 :

a.m. 8.00 Break-fast at Abou-Zeneima.

9.00 Continuing the visit of the site.

I2.00 Return back to Abou-Rudies.

p.m. I2.30 Lunch at Abou-Rudies.

I4.30 Departure to Cairo .

I5.30 Arrival to Cairo Airport .

I6.30 Arrival to Head quarter of the Co. at Cairo .

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SINAI MANGANESE COMPANY

List of the available documents

A) Fil contains : (English)

- Report in Fe.Mn. plant in A.Z.
- Substantive terms of Reference (presented from U.N.)
- Report of the short technical advisory mission to S.M.C. concerning the restorations of the A.Z. Fe.Mn. plant (presented by B.R. Nighawan Senior Interregional adviser of (UNIDO).
- Survey and damage report on gas Turbine power station of the S.M.C. in A.Z. (presented by Brown Beveri and Co.) June 76.
- Report on Technical inspection of the Fe.Mn. plant at A.Z. by Elkem - Spigerverket , in Nov. 76.
- Technical report from ELEKTROKEMISK in Dec.1960.

B) Fil contains : (Arabic)

- Technical report concerning the company's activities in SINAI befor 1967 .
- Technical report concerning the Mn. ore reserves in Omegma area .
- Technical report about the deposites in SINAI .
- Technical report about the development and exploitation of Mn. ore in Omegma area written by the British expert geology STANLY FORD . (ENGLISH) .
- The full chemical analyses of the different grades of Mn.ore in SINAI .

C) Fil from THE EGYPTIAN GEOLOGICAL SURVEY AND MINING AUTHORITY conatins : (Arabic)

- Technical report on the manganese ore reserves in west central SINAI till 30 june 64.
- Report concerning the inquirs from manganese ore to Ferro-manganese plant.

SINAI MAGNANESE CO.

List Of Available Documents

I. Fil contains : (In Arabic)

a. Report about re-planning A.Z.
b. Rough plane shewing activity areas of the Co.
c. ,, ,, ,, ,, ,, ,,

2. Fil contains : (In Arabic)

a. Report about the importance of making an industrial region in SINAI .
b. Report of the industrial committee about Fe.Mn. Project.
c. Report of the Financial and committee about Fe.Mn.Project.
e. Report of the general committee about the Fe.Mn. project & power station and distillation plant.
f. Report about the possibilities to use natural gases at oil field in Abou-Rudies.
j. Primary report in Electricity for Fe.Mn. , Tin lead and Fe.-Ilmenite project .
k. Report of the Power committee about the tender study of Electric power and distillation plant, presented to Sinai Manganese Co.
i. Primary layout of A.Z.

3. a) Contract of excuting the erection of the civil structrum of Fe.Mn. Plant. (Arabic)
b) General specification and conditions for the Fe.Mn. building (Arabic) .

4. Fil contains : (~~Arabic~~) (English)

a) Report on Fe.Mn. Plant., in Abou-Zeneima .
b) Report on Sinai Smelting project written by COMBELL ,GIFFORD & MORTON Ltd.
c) Supstaintive terms of referrence .

5. Ammendment to the contract of civil erection of the Fe.Mn. Leading plateform in the harbour or A.Z. (Arabic) .

6. Fil contains : (Arabic)

Some coresspondances and offers concerning the drinking water pump station .

7. Fil contains :(English)

Equipment specifications for a gas turbin electric generating station presented by westing house electric international Co.

8. Fil contains : (English) .

Tender for the power and water distillation plant presented by The Tracter and Engineering Co.

9. Fil contains (Arabic)

Execution of sanitary and drainage system project in A.Z.

I0. Fil contains : (English)

Conditions of tender and specifications for the ~~supply~~ supply and erection of an Electric power station and water distillation plant at A.Z. presented by the Tracter and Engineering Co.

II. Fil contains : (Arabic)

Time scheduels for executing the project .

I2. Thirteen fils contains the calculations sheets of the following (English):

a. Foundation .
b. Rotary kiln.(smoke chamber) and stairs in s.c.
c. Furnace building slab & Beams.
d. Column leads .
e. Bar lists.
f. Furnace building slab .
g. Steel foundation structures.
h. Frames .
i. Bins.
j. Tapping and backing hall .
u. Floor elev.
k. Starways - crushing table - water tank .. etc.
l. Kiln foundation - Rotary kiln - the chimny .

I3. Fil contains (Arabic & English)

Correspondances and reports about the wind and test of the soil in A.Z.

SINAI MANGANESE COMPANY.

List of the available documents concerning

the Ferro-manganese plant .

We have the drawings of the following : - (English)

- General lay-out of the power station .
- General lay-out of the A.Z. port.
- Rotary kiln plant.
- Tapping and packing hall .
- Furnace .
- Conveyor .
- Pig casting machine.
- Foundations.
- Electrods.
- Gas cleaning plant.
- Crushing plant.
- Suspensions for telepher track .
- Tapping platform .
- Power stations .

Note:

The total number of the drawings are more than I85 ,

List of the plans and maps concerning
the Manganese Mines .

	Desc.	Scale
I.	Topographic map the general lay-out of the mines	I: 50.000
2.	Contour map to Om.Bogma	I: I2.500
3.	Map showing the Ranfall drainage in Om.Bogma and A.Z	I: 50.000
4.	Topographic map showing the whole licences and leases issued to the Co.	I: 50.000
5.	Arial Ropeways project	I: 50.000
6.	Excuting drawings for the tweer bases (4 drawing)	
7.	Working plare to productions lease No.29I-300	I: 2.000
8.	, , , , 293	I: 2.000
9.	, , , , 298-299	I: 2.000
I0.	, , , , 296-297	I: 2.000
II.	, , , , 86I-9I5	I: 2.000
I2.	, , , , 9I4	I: 2.000
I3.	, , , , Ramssy Zone	I: 2.000
I4.	, , , , Area 45 .	
I5.	Map showing the priorities for the arial photos	I: I00.000
I6.	Priority I.	I: 5.000
I7.	, , II.	I: 5.000
I8.	, , III.	I: 5.000
I9.	Plane showing the ore reserves in the productions lease 29I-300	I: 2.000
20.	Isopack map	

Not : the above mentioned maps and planes are in Arabic .

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Meteorological Data

(Form No. 73. M.A.)

THE EGYPTIAN METEOROLOGICAL AUTHORITY

SUEZ

G.O. Govt. Printing Offices 4366 A, 1979-7000 ex.

	January	February	March	April	May	June	July	August	September	October	November	December	Year Period
Mean air Temperature °C	14.7	16.0	18.0	22.0	25.0	27.9	28.9	28.9	27.0	24.2	20.4	15.8	1964-73
Mean Max. air " °C	19.2	21.4	23.4	28.1	31.0	33.7	34.5	34.6	31.8	29.2	24.6	20.3	" - "
" Min. air " °C	10.4	11.5	13.2	16.2	19.3	22.4	23.6	24.1	22.6	19.9	16.5	11.8	" - "
Absolute Max. air " °C	26.2	28.9	33.2	38.9	43.5	46.1	41.6	45.8	40.0	37.8	34.0	28.4	" - "
" Min. " " °C	4.1	6.1	7.8	9.6	13.6	18.6	19.4	19.7	16.9	14.8	9.9	5.5	" - "
Mean Relative Humidity %	55	53	46	42	44	44	50	54	55	55	56	55	" - "
Highest " " %	99	99	99	92	97	96	95	95	99	99	100	98	" - "
Lowest " " %	10	1	1	1	1	4	11	15	17	12	6	2	" - "
Mean total amount of Rain	5.0	0.3	2.6	0.6	2.6	0.0	0.0	0.0	0.0	6.2	1.0	1.3	" - "
Max. amount of Rain in one day (mms)	9.9	0.8	3.6	1.4	22.0	0.0	0.0	0.0	0.0	49.6	8.8	10.0	" - "
No of days of :—													
Thunderstorms	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	" - "
Sandstorms - vis < 1000 (metres)	0.2	0.0	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.2	" - "
Sandrising - vis ≥ 1000 (metres)	0.8	0.7	2.1	1.9	1.5	0.0	0.0	0.0	0.2	0.5	0.2	1.4	" - "
Fog - vis < 1000 (metres)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	" - "
Mist vis ≥ 1000 (metres)	0.7	1.2	0.4	0.0	0.2	0.1	0.6	0.5	0.7	0.0	1.1	0.7	" - "
Mean Surface wind speed (knots)	5.9	6.8	8.4	9.1	9.4	9.3	10.5	9.4	10.4	8.8	7.4	6.2	"
Prevailing Winds	NW	NW/N	NW/N	NW/N	NW/N	NW/N	NW/N	NW/N	NW/N	NW/N	NW/N	NW	"

Remarks : °C = Degrees Celsius or Centigrade

One Knot = 1.85 Kilometres per hour.

N = North S = South E = East W = West.

Fehia 1980

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جمهورية مصر العربية
الهيئة العامة للأرصاد الجوية

(استمارة رقم ٧١ م ا ٠ ع ٠) ٠

		يناير	فبراير	مارس	أبريل	مايو	يونيه	يوليه	أغسطس	سبتمبر	أكتوبر	نوفمبر	ديسمبر	السنة القدرة
متوسط درجة الحرارة العظمى	سنتي	١٦,٠	١٦,٨	١٩,٢	٢٢,٠	٢٥,١	٢٧,٦	٢٨,٦	٢٩,٦	٢٧,٩	٢٥,٩	٢٢,١	١٧,٦	١٩٦١-١٩٧٧
متوسط الدرجة الصغرى للحرارة العظمى	سنتي	٢٠,٨	٢١,١	٢٤,١	٢٦,٩	٢٧,٧	٢٧,٧	٢٧,٢	٢٢,١	٢٠,٨	٢٨,٧	٢٦,٦	٢٢,٦	" "
متوسط الدرجة الصغرى	" "	١١,٠	١٢,٢	١٤,٢	١٧,٧	٢٠,٩	٢١,١	٢٥,٨	٢٦,٤	٢٤,٩	٢١,٩	١٧,٢	١٢,٧	" "
أكبر درجة عظمى	" "	٢٨,٥	٢٩,١	٣٤,٢	٣٨,٠	٤٠,٦	٤١,٥	٣٩,٥	٤٢,٠	٣٨,٠	٣٩,٤	٣٧,٠	٣٠,٢	" "
أصغر درجة صغرى	" "	٦,٠	٧,٢	٩,٠	١٠,٩	١٥,٥	٢١,٢	٢٢,٦	٢٢,٨	٢١,٥	١٦,٠	٩,٠	٧,٨	" "
متوسط الرطوبة النسبية	٪	٥٧	٥٥	٥٢	٥٢	٥٥	٥٥	٥٩	٥٩	٦٢	٦١	٥٨	٥٨	" "
أقل قيمة للرطوبة النسبية	٪	٩٦	١٠٠	٩٦	٨٩	٩٢	٨٥	٩٠	٨٧	٩٢	٩٦	٩٢	١٠٠	" "
أقل قيمة	٪	٢٢	١٨	٦	٧	١٠	١٢	١٩	١٠	٢١	١٢	١٢	١٧	" "
متوسط مجموع كمية المطر	مللمتر	٤,٨	١,٠	٠,٢	٠,٢	أثر	٠,٠	٠,٠	٠,٠	٠,٠	٠,١	٠,٢	١٥,٠	" "
أكبر كمية من المطر سقطت في يوم واحد	مللمتر	٨,٢	٢,٢	٠,٨	٠,٢	أثر	٠,٠	٠,٠	٠,٠	٠,٠	٠,٢	١,٢	٢٢,٩	" "
متوسط سرعة الرياح السطحية	عقدة	٥,٢	٧,٥	٨,٤	٧,٨	١٢,٥	١٢,١	١٢,٢	١٢,٤	١١,٤	٩,٤	٤,٤	٧,٢	
أكبر سرعة للرياح السطحية	عقدة	٢٢	٢٩	٤٥	٢٩	٤١	٢٩	٤٠	٤١	٢٨	٢٨	٢٥	٤١	
اتجاه أشد الرياح السطحية		سجع	سجع	سجع	سجع	سجع	سجع	سجع	سجع	سجع	سجع	سجع	سجع	
متوسط عدد ساعات الهواء الراكد														
الساعات الماطرة		٠,٠	٠,٠	٠,٠	٠,٢	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	١٩٦١-١٩٧٧
الأيام الماطرة	" "	٠,٨	١,٥	٠,٢	٢,٧	٢,٤	٠,٠	١,٤	٠,٠	٠,٠	٠,٢	٠,٠	٠,٧	" "
الضباب	" "	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	" "
العواصف الرعدية		٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	" "
الأيام الغائمة تماما		٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	٠,٠	" "

ملاحظات : [illegible]

الهيئة العامة لشئون المطابع الأميرية ٢٢٢٢ - ٢٠٠٠

Climatic Data (Abu Rudies) Meteorological Authority

	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Period
Average of Air temp. C^o	16.0	16.8	19.2	22	25.1	27.6	28.6	29.6	27.9	25.9	22.1	17.6	1961-1967
Average of Maximum Air temp. C^o	20.8	21.1	24.1	26.9	27.7	31.7	32.3	33.1	30.8	28.7	26.6	22.6	"
Average of Minimum Air temp. C^o	11.0	12.2	14.3	17.7	20.9	24.1	25.0	26.4	24.9	21.9	17.3	12.7	"
The highest Maximum Air temp. C^o	28.5	31.1	34.3	38	40.6	41.5	39.5	43	38	39.4	37	30.3	"
The lowest Minimum Air temp. C^o	6	7.3	9	10.9	15.5	21.3	22.6	23.8	21.5	16	9	7.8	"
The average of relative humidity %	57	55	53	53	55	55	59	59	62	61	58	58	"
The highest value of relative humidity %	96	100	96	89	92	85	90	87	92	96	93	100	"
The lowest value of relative humidity %	22	18	6	7	10	13	19	10	21	13	12	17	"
The average of total quantity of rain Mm	4.8	1.0	0.2	0.2	Trace	0.0	0.0	0.0	0.0	0.1	0.2	15.0	"
The greatest quantity of rain in one day Mm	8.3	3.3	0.8	0.3	Trace	0.0	0.0	0.0	0.0	0.3	1.3	32.9	"
The average speed of surface wind Knot	5.3	7.5	8.4	7.8	12.5	13.1	13.3	12.4	11.4	9.4	4.4	7.2	
Knot	33	39	45	39	41	39	40	41	38	38	35	41	
The predominant direction of surface wind	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	
The average days of the occurance of the following phenomena													
Sand storm-Horizontal view less than 1000 M	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	"
Excited sand-Horizontal view more than 1000 M	0.8	1.5	3.0	2.7	2.4	2.4	1.0	2.0	1.0	0.2	0.0	0.7	"
Fog - Horizontal view less than 1000 M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	"
Thunder storms	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	"
Thick mist - Horizontal view more than 1000 M	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	"

APPENDIX 2

(III.B.1 & III.B.2)

Manganese Ore Reserves/Geology

TABLE OF CONTENTS

- Geology of the Mining District
- Prospection for Manganese Ore
- General Data Review
- Mining Rights Review
- Remedial Surveys and Mine Mapping
- Estimated Ore Reserve Quantities
- Chemical and Physical Characteristics
- Comment on Adequacy of Ore Reserves
- Definition of Additional Exploration Requirements
- Ferruginous Manganese Ores, Outside Om Bogma District

I. GEOLOGY OF THE MINING DISTRICT

A. Geologic Setting

The study area is covered by rocks of the following ages from oldest to youngest:

- o Precambrian: igneous and metamorphic rocks.
- o Carboniferous: sandstones, dolomites, clays, and siltstones with local manganese-iron deposits.
- o Permo-Triassic: basalt sills at the top of the Paleozoic section.
- o Cretaceous:
  - Early Cretaceous represented by sandstones of the Nubia Formation.
  - Late Cretaceous represented by limestones, marls, and clays (Cenomanian, Turonian, Santonian, and Campanian).
- o Eocene: limestones and clays.
- o Miocene: conglomerates, sandstones, siltstones, and limestones together with basalt and dolerite intrusions.
- o Pleistocene and Recent: alluvial gravels and sands.

B. Stratigraphy of Carboniferous Succession

The carboniferous rocks which enclose the manganese-iron deposits are briefly described below:

1. Lower Adedia Formation

This lower sandstone formation lies on the nearly leveled surface of the peneplained Precambrian igneous and metamorphic complex. No clear unconformity could be observed with the overlying Om Bogma Formation, although Mart and Sass (1972), indicated a surface of unconformity in between. The formation is represented by fine sandstones, reddish brown in color, with many lacustrine shallow water intercalations of glauconitic shaley beds. The total thickness is about 130 m with the following general succession:

o Reddish and brownish sandstone	70 meters
o Greenish shaley beds	30 meters
o Red sandstone and grit	30 meters

These sandstones are harder and more compact than the upper Abu Zarab Formation since they contain more kaolinitic cement.

According to Weissbrod (1969), the lower 100-meter thick succession of these sandstones, with local spotty copper mineralization, is of Cambrian age.

It is separated from the overlying 30-meter thick succession of poorly bedded nonfossiliferous sandstones by unconformity. At a horizon near the top of these sandstones turquoise occurs at some localities associated with film of copper carbonates.

On local structural highs of basement rocks, generally trending northeast-southwest, the lower sandstones are either highly reduced or totally missing, e.g., at Gebel Nukhul near the high reaches of Wadi Khaboba. In this case, the younger Om Bogma Formation lies directly on the peneplained surface of the basement.

2. Om Bogma Formation

This formation has a maximum thickness of 40 meters, but usually does not exceed 20 meters. It is composed of hard crystalline dolomite and soft marly limestone and dolomite with lenses of ferruginous manganese materials at the base with few shaley and silty intercalations. According to Ball (1916), it belongs to Middle Carboniferous, but Mart and Sass (1972), assign a Lower Carboniferous age.

Four members can be differentiated from bottom to top:

a. Dolomite and Manganese-Bearing Member

The dolomite is crystalline, thickly bedded, and pink in color, and shows a mosaic texture with crystals 0.5 - 1 mm. Ghosts of ooids with skeletal fragments and/or quartz grains as cores are locally observed, e.g., at Gebel Zobeir.

The manganese bodies lie nearly at the same stratigraphic level as the basal dolomite and usually have abrupt contacts. The manganese bodies are usually surrounded by a zone of calcareous shale, siltstone, or sandstone that forms a transition with the surrounding dolomite. The base of the manganese lenses is frequently topographically lower than the base of the dolomite, filling depressions in the underlying sandstone of the Adedia Formation.

The thickness of this member is a maximum of 15 meters in the non-mineralized areas, but usually is 4 to 8 meters where manganese iron bodies occur.

b. Silt Shale Member

Purple to yellow ocherous silty shales are conformable with the lower member. The maximum thickness is about 2 meters but the average is 0.5 meters. Some crystal aggregates of dolomite occur, e.g. Hill 8 of Om Bogma.

The formation is evidently correlated with presence of mineralization; otherwise silt-shale is absent.

c. Marly Dolomite and Silt Member

This overlies unconformably either the silt-shale member or the basal dolomite and ore member, and is represented by alternating layers of dolomite and marl 10 to 50 cm thick. Ghost ooids and fossils are also recorded. Silty quartz grains are common, toward the southeast, gradually forming well-bedded siltstone with some ferruginous lenses. The maximum thickness in the northwest parts of the area is about 15 meters.

d. Upper Dolomite Member

This is a yellow-pink and greyish crystalline dolomite, poorly bedded and cliff-forming. The formation is best developed in the northwest at Gebel Nukhul reaching 8 to 10 meters, but at Om Bogma it is only about 5 meters thick.

The Om Bogma Formation shows a very marked lateral lithological and thickness variation. The thickness isopach contours run roughly from northeast to southwest, and the thickness varies from 0 in the southeast to about 40 meters in the northeast, e.g. 5 meters at Gebel Marahil, 10 to 20 meters at Om Bogma, and 40 meters at Gebel Nukhul.

The rock type variation is mainly demonstrated by the clastic/dolomite ratio, whose contours run roughly parallel to the manganese isopach contours. Thickening is correlated with lower values of this ratio. The contour of 1/1 ratio separates a detrital (silty) facies in the southeast from a dolomitic one to the northwest. The area of Om Bogma lies along the transition zone which contains better development and thicker ore bodies.

3. Abu Zarab Formation

This formation, about 150 meters thick, is represented by sandstone, medium to coarse grained, with lepidodendron prints. In some places it is dark red or brown in color. Some beds are almost snow-white and friable, where they are exploited as glass sand. Three layers of kaolinitic clay can be recognized, passing locally into black shale and coal.

This formation is locally covered by basalt sheets (Permo-Triassic?) that caused the immediately underlying beds, up to 2 meters, to become quartzitic. At Farsh El Azraq, the basalt sheet (Permo-Triassic?) attains 70 meters in thickness.

C. Structures

In the study area, faulting is much more pronounced than folding.

1. Folding

Locally, folding influences the Carboniferous sediments having axes trending nearly north-south. Folding is most conspicuous in the central parts of the area around Om Bogma. A late Paleozoic age (Permian ?) can probably be assigned to this weak folding phase since the basalt sheets covering the Carboniferous succession are not affected.

2. Faulting

Four main directions are recognized in the study area: east-northeast to west-southwest, north-northwest to south-southwest, and north-northeast to south-southwest. These faulting systems form a complex structural setting with local tilting of the faulted beds and shearing near the fault planes. These faults have a great influence on the prominent surface relief, but faulting does not seem to have any direct relation to the manganese-iron mineralization. It is only through faulting's indirect effect of exposing the ore bodies that an intermediate relationship is noted.

Since Miocene strata have been displaced by faulting, faulting is believed to have taken place at about the close of the Miocene. Faulting may have occurred along with the intrusion of the Tertiary volcanic sheets and dikes. However, the fault systems were probably inherited from the older structural directions developed in the Precambrian basement. This was followed repeatedly by rejuvination during the time period until the Miocene. By this time the final deformation of the area had been established and was repeated by the Red Sea tectonic development.

D. Ferruginous Manganese Ores

The ferruginous manganese ores in the Om Bogma district and contiguous areas occur in the form of lens-shaped bodies at or near the base of the dolomitic Om Bogma Formation. This stratigraphic control is convincing evidence of the lower dolomite and manganese association.

In the larger ore bodies, a sort of zoning with a maximum of three zones can be recognized through their different structural and mineralogical characteristics.

- The inner zone is usually massive and contains radial concretions of pyrolusite needle crystals. The main ore minerals include psilomelane and pyrolusite, with some hematite, while the gangue minerals are represented principally by montmorillonite and illite.

- The intermediate zone usually forms the major part of the mineralized body, which is massive and crossed by veins of pyrolusite, commonly containing barite. The main ore mineral constituents are psilomelane, pyrolusite, and hematite, with minor goethite. Barite and clay minerals are the main gangue minerals.

- The outer zone is composed mainly of hematite and goethite with minor psilomelane and spherulitic concretions of pyrolusite. Detrital quartz is common near the body margins.

It is clear that the manganese and iron minerals are exclusively represented by oxides. Manganese minerals of a high oxidation state, psilomelane and pyrolusite, are by far the most dominant, while those of a low oxidation state, manganite, pyrochroite, and hausmannite, are only rare constituents.

II. PROSPECTION FOR MANGANESE ORES

A. Introduction

Prospection programs for manganese ores in the Om Bagma district were previously sponsored by several workers. Those who proposed prospection programs based on available geological information include Demag (1961), and Ford (1963), and Mart and Sass (1972). In determining earlier proposed prospection programs, methods were based on then currently accepted hypotheses for manganese formation.

Before describing the methodology for manganese ore prospection in the Om Bogma district and surrounding areas, data pertinent to the exploration problem are discussed below.

The genesis and mode of formation of the Om Bogma manganese deposits is covered by two major hypotheses. The first suggests a hydrothermal epigenetic or metasomatic origin and the second a sedimentary or epigenetic origin.

The hypothesis suggesting a hydrothermal origin was formulated by Ball (1916), and adopted by Fennine (1931), Attia (1956), Gill and Ford (1956), and Ford (1963). It suggests that the ore was formed in Late Miocene through the dissolution of Carboniferous dolomite by thermal waters related to volcanic activity. According to Ball (1916), these thermal waters, ascending along fault fissures, affected the concentration and oxidation of the manganese and iron carbonates originally contained in the calcareous rocks. However, Fennine (1931), believed that the manganese and iron compounds were carried by the thermal solutions derived from deep acidic igneous rocks. The thermal solutions dissolved the dolomite by varing degrees and deposited the manganese and iron minerals in place. Attia (1956), believed that the mineralized bodies were associated with the abundant faults and volcanic dikes.

On the other hand, a sedimentary origin was first proposed by Barthous (1923). In this theory, ores were deposited as a result of the alteration by submergence of the eruptive rocks at the beginning of a marine transgression over a continental surface of granites, schists, and diorites. However, no arguments were put forward to support his theory.

El Shazly, Shukri, and Saleeb (1963), adhered to the sedimentary hypothesis and gave arguments in support of their modified hypothesis. The latter assumes that sedimentation of the ore took place in a Carboniferous sea of shallow to

moderate depth. Iron minerals were concentrated nearer the shoreline, while manganese minerals tended to be relatively more abundant further away. Both are believed to be derived from the weathering of basement rocks. The probable presence of a minor stratum or formation at the base of the Middle Calcareous Series may have played a part in the preliminary concentration of the ore minerals. Later modifications due to intermediate sediment changes, and tectonic, and volcanic activity have brought the ore bodies to their actual state. Recently, Mart and Sass (1972), advocated the sedimentary hypothesis and recognized two stages of ore formation:

- An accumulation stage, during which manganese and iron oxides were absorbed and finely particulate forms were trapped in tidal pools of low mechanical energy, while ooids accumulated in the high energy areas surrounding these pools.

- A differentiation stage, during which the cores of the lenses were enriched in manganese and the margins, in iron. This differentiation process took place concurrently with the dolomitization of the surrounding ooids. Both processes were intermediate to sedimentary rock formations and terminated before deposition of the overlying strata.

B. Mode of Formation and Genesis

In the present work, and based mainly on previous and recent field observations, KECI and ACB are fully convinced of the validity of the sedimentary origin of the deposits. However, additional modifications and details of the hypothesis previously proposed by El Shazly, Shukri, and Saleeb are presented to support the observations recently completed in the field.

The main criteria characterizing the studied deposits, which represent the basis for adhering to the sedimentary hypothesis, are critically discussed below. The whole hypothesis on the mode of formation and genesis is then formulated, followed by the appropriate recommendations for prospection methods.

C. Main Criteria Characterizing Ore Bodies

Four major topics are briefly illustrated in the following pages which are:

- Form and stratigraphic position of ore bodies.
- Facies evolution.
- Relation between mineralization and faulting.
- Structures, mineral formation, and textures in the ore bodies.

1. Form and Stratigraphic Position of Ore Bodies

Most, if not all, previous workers agree that the manganese ore bodies occur in lenticular shape more or less regular in form at or near the base of the dolomitic Om Bogma Formation. However, discrepancies between the views of different authors should be noted in reference to forming any concrete hypothesis on the ore formation and its prospection methods.

El Shazly (1956), mentioned that the ore occurs in the form of lenses or lenticular beds which vary greatly in thickness and extension. Usually the thickness varies from tens of centimeters up to 8 m, while the extension is only a few meters in the small lenses and reaches hundreds of meters in the lenticular beds.

Attia (1956), noticed that the small lenses are usually formed of pure manganese minerals, whereas the lenticular beds are composed mostly of a mixture of manganese and iron minerals.

Demag (1961), indicated that every possible form and orientation of ore bodies occur. Common to all, with few exceptions, is an unusually constant stratigraphic horizon at the base of the middle, thin bedded, platy dolomite unit. The ore bodies lie either superjacent to the lower sandstone in the areas where the pink basal dolomite has eroded or, where present, on the upper boundaries of this dolomite. The ore bodies may be accompanied both in the underlying or overlying stratum by argillaceous and ferruginous friable sandstone layers.

According to El Shazly, Shukri, and Saleeb (1963) the deposits are of the stratiform type though tending to be of lenticular shape, almost flat, slightly inclined, or gently folded. They occur in the lowerpart of the Middle Calcareous Series either immediately overlying the Lower Sandstone Series or separated from it by one or more layers of a maximum of a few meters thick.

Ford (1963), indicated that economic concentrations of manganese minerals virtually always occur either immediately above the top of the lower sandstone which is commonly known in the mines as the "sandstone pavement," or S.P., or separated from it by less than a meter of "pavement shale." The S.P. is thus the most important marker horizon in the manganese field and is the only one worth investigating. Ford adds that the individual ore bodies tend to be tabular and follow the S.P. Deposits vary from a few centimeters to ten or fifteen meters

in thickness, averaging about 2 meters, and from a meter or two to several hundred meters in lateral extent. In areas of less wide-spread mineralization, ore bodies tend to be elongated or grouped along axes striking northeast to southwest. Locally persistent fractures, stained with iron and manganese can be seen in the lower sandstone near ore deposits and on the northeast to southwest strike. In more strongly mineralized areas the isopaches for the thicker parts of the ore beds sometimes also trend in this direction.

Mart and Sass (1972), mentioned that the deposit comprising lenses of manganese and iron oxides is restricted to a 6-meter thick zone at the base of the Om Bogma Formation. The lowest member in this formation, dolomite and ore, is composed of two rock facies: a dolomitic facies and an ore facies. The quartz content of the dolomite increases laterally toward the contact of the ore lenses. The ore forms lenses in this dolomite rock facies. The bases of the lenses are topographically lower than the base of the dolomite and fill depressions in the underlying lower sandstone. They vary from 1 meter to 200 meters in diameter and from 0.2 to 6 meters in thickness. The transition between the ore bodies and the surrounding dolomite is abrupt and is distinguished by enrichment in quartz sand.

Based on recent detailed field investigation by KECI and ACB, it can be stated that the manganese deposits of the Om Bogma district and surrounding area occur in the form of tabular and lenticular deposits. These belong to a well defined time stratigraphic level, showing evident later facies variations. The deposits are invariably flattened parallel to the stratification, i.e., they are stratiform bodies. In the rare cases where the largest dimension of the ore body is oblique or perpendicular to stratification, these deposits have been formed by later secondary processes well after the main period of ore concentration. This corresponds to the gap between the termination of deposition of the lower member of the dolomitic Om Bogma Formation, and the start of deposition of the unconformably overlying thin bedded platy dolomite. In other words, the ore bodies are neither earlier nor contemporaneous with the lower pink dolomite member of the Om Bogma Formation. They are most frequently adjacent and occur at the same stratigraphic level. This can be explained by the following:

a. When the pink basal dolomite is present and adjacent to ore lenses, a rather sharp contact exists with the ore and partly underlies the ore lenses. The situation simulates filling of cavings and pits in the

dolomite. In many cases, rounded and highly polished boulders of this dolomite are observed, indicating reworking. In some cases, and in the absence of ore, these worked dolomite boulders lie adjacent to and below the younger platy dolomite sequence. The lowest beds arch up against the boulders and the following beds become flatter and flatter. It is thus evident that the lower dolomite member has been exposed to a process of emersion and erosion during a period of regression. At that time there was active chemical weathering of both the basement and the sedimentary cover. Insoluble manganese and iron oxides were thus concentrated in the residual phase. During the subsequent transgression, these oxides were driven to the shallow water basins to be deposited in the form of a gel. This filled the cavings and pits produced by previous partial erosion of the basal dolomite.

b. It has been discovered during the present field investigations that in some localities, e.g., Om Rinna and Tafeiria, manganese oxides pseudomorphose coral reefs. It is evident that such a pseudomorphism cannot take place during the growth of the reefs. Replacement has taken place later during a subsequent period of submergence.

c. In some cases, e.g., at Sid El Banat, the bases of the ore lenses are topographically lower than the bases of the adjacent lower dolomite member and fill depressions in the underlying sandstone. This occurs when ore material fills up relatively deep erosion pits during later submersion. In other words, the position of the ore in the stratigraphic succession does not perfectly coincide with its period of formation.

d. The ore lenses in most cases are intimately associated with a fine detrital facies, either underlying, overlying, or lying laterally within the ore body. This detrital material must have accompanied the ore during its transportation from the land weathering surface, to be deposited together in the depressions on the floor of the invading shallow sea.

e. At the plateau of Gor to the north and northwest of Om Bogma area, the mineralization, whose widespread extension was indicated during the present work, occurs in the form of more regular beds. But these still have a tendency toward lateral tapering and are underlain by a relatively thick dolomitic material apparently with no replacement textures. This is

material that was deposited a great distance from the Carboniferous shoreline where older dolomite unit was preserved under water during the period of regression and thus protected from the action of weathering. Sedimentation of calcareous (generally marly) material was then taking place contemporaneously with erosion in other emerged areas. During the later phase of transgression, the ore material carried from the continental surface partially escaped deposition in the nearest ore zones and reached the zone of deeper waters. There, deposition of ore material took place over a relatively even sea floor, thus producing more regular stratigraphic deposits with less pronounced thickness variations. The gelly nature of the deposited ore material would indicate a tendency towards tapering and lensform. Contemporaneously with ore material accumulation, dolomite deposition in these deeper zones resulted in an intimate admixture of ore with a dolomitic "matrix." We are confronted with a case in which there is a seaward border to a zone of ore deposition. Although the stratigraphic position and form of the ore deposit in this area may appear to be unusual when compared to the major part of Om Bogma district, it is actually in its proper time stratigraphic position and it was only due to local variations in the paleogeographic conditions that it acquired such a form and position in the rock strata.

The case is much simpler in the southwestern parts of the area (Adidiya and Marahil) where the ore forms relatively regular beds directly overlying the lower sandstone and underlying the upper sandstone successions. The ore is highly ferruginous and rich in detrital quartz grains. Located nearest to the Carboniferous shoreline, the basal carbonates were lacking, and chemical weathering during emersion periods was not effective. During the subsequent period of submersion, the ore was deposited on a relatively even floor. Sand and silt-sized materials were actively deposited along with the ore in these shallow zones, where iron oxides tend to be particularly concentrated (appropriate Eh/pH conditions).

It was concluded that the ore was deposited in a shallow transgressing sea after a period of emergence. Therefore, its principal control was its stratigraphic position by time. Variations in the paleogeographic conditions within the depositional zone resulted in discrepancies in the form and the rock stratigraphy of the mineralization.

2. <u>Facies Evolution</u>

All previous workers agreed that the main manganese deposits in the study area occur associated with and belong to the

dolomitic Om Bogma Formation. Most investigators agree that a number of ore bodies are not wholly confined to the dolomitic facies but also occur in siltstones, e.g., at Adidiya and Om Riglien, not as cementing material for sandstone but as ore-rich bodies. In the absence of a chemically reactive facies, the hypothesis of metasomatic replacement by ascending hydrothermal solutions loses a great deal of its basis. Therefore, the statement of Ford (1963), that minerals of the host rocks have been selectively dissolved, should have very limited application.

The work carried out by Mart and Sass (1972), shows that there is an intimate correlation between the thickness changes and the facies changes of the Om Bogma Formation. Three main features are recognized:

- The manganese mineralization isopach contours run in a general northeast to southwest direction; the formation thickens from zero in the southeast to 41 m in the northwest, with a local thickening around the Om Bogma mines.

- The contours of the clastics/dolomite ratio run parallel to the manganese thickness isopach contours with a corresponding increase in the dolomite content around Om Bogma. Thus, based on the 1/1 contour, two facies are recognized: a detrital one, mainly silty, southeastwards, and a dolomitic one northeastwards from Om Bogma.

- The better-developed and thicker ore bodies are located close to the transitional zone between the detrital and dolomitic facies where the formation thickness is 10 to 20 meters.

The theory developed with regard to the lateral facies changes of the Om Bogma Formation is highly consistent with the conclusions reached in this study, after a review of the previous data. Towards the east-southeast, nearshore deposition was predominately detrital. In this area, during the time of ore deposition, sandy and silty material was accumulated with the ore. Towards the west-northwest, on the other hand, relatively deep water deposition resulted in the building up of a thicker succession of dolomite conformably overlain by tapering ore, stratiform-bodied, containing appreciable amounts of contemporaneously precipitated dolomitic matrix. No interruption of sedimentation can be observed in these northwestern areas.

Still further northwest, e.g., at Gebel Nukhul and the lower reaches of Wadi Khaboba, the still deeper waters were exclusively carbonate precipitating. No appreciable amounts of ore oxides reached these sites, and they are generally

barren. Facies contour lines passing near Om Rinna and Tafeiria show the occurrence of coral reefs pseudomorphosed by manganese-iron oxides. This seems indicative of the seaward limit of the manganese depositional basin.

In the medium water-depth zone, it is evident that the basal dolomite member has been subjected, during a phase of regression, to a process of mainly chemical erosion. Subsequent resubmersion under medium-depth waters, with a local semi-closed inland embayment at the site of the Om Bogma mining area, resulted in the deposition of manganese-iron oxides. Mainly, this occurred in the erosion depressions along the sea floor. The resulting ore bodies are of lenticular or irregular shape with marked local thickness variations. There is also rapid lateral change to the older dolomitic host rocks. Moreover, water depth conditions did not permit important accumulations of detritals nor precipitation of chemicals.

Thus, the following conclusion can be drawn: It may be possible to predict partially the form, mode of occurrence, rock strata position, relative abundance, and purity of the ore through the facies setting, yet the mineralization is not confined to a single facies but occurs in a broad zone manifesting important lateral facie changes.

3. Relation Between Mineralization and Faulting

Those advocating the metasomatic hypothesis suppose that the ore deposits are always connected with fault fissures since these serve as channels for the mineral solutions coming from the depths. However, this belief, without prejudice to its validity, can be seen from a different point of view: While the area is so dissected by faults and fissures that there are few important ore bodies that might not be related to a fault passage, there are many examples of ore lenses with their greatest extent and thickness distant from any apparent relation to faulting.

Close field inspection has indicated that the ore deposits are older than the predominant faulting in the district. In many cases, the deposits are seen cut and displaced by faults and even dragged along the fault planes. Moreover, no hydrothermal phenomena are associated with the ore deposits, either within the deposits themselves or at their contacts. The white clay containing alunite, occasionally associated with some alunite deposits, is considered to have been developed later than the ore deposition. This was associated with near-surface secondary alteration to which the ore deposits were subjected

after their initial formation.

The theory advanced by the advocates of the hydrothermal hypothesis - that many fault planes contain small amounts of iron and manganese minerals - does not contradict the sedimentary hypothesis. These fault and fissure-plane fillings represent, most probably, cavity filling by ore material leached and transported by surface waters and deposited in the fissure openings during the downward percolation of these waters. Supporting this is the fact that these fillings are limited almost exclusively to levels lower than those of neighboring ore bodies, i.e., along the lower sandstone, whereas the upward extension of the fissure plane above the ore level is usually barren.

In conclusion, it may be stated that the relation between faulting and outcrops of ore bodies is not one of direct cause and effect, but is rather an indirect relation. As the main water courses in the area follow the random planes, exposed outcrops of ore bodies are thus more noticeable along the sides of their linear directions. The main faulting process is clearly later than the ore formation and the ore bodies are very frequently affected by faults, particularly the smaller one. Even Ball (1916), an advocate of the metasomatic theory, admitted the effect of faults on ore bodies.

4. Structures, Mineral Origins, and Texture in Ore Bodies

El Shazly, Shukri and Saleeb (1963), have reported that the normal ore mineral association in the deposits includes: pyrolusite manganite, psilomelane, and cryptomelane, together with goethite and hematite. Another minor or uncommon mineral is ramsdellite. The gangue minerals include dolomite, barite, calcite, gypsum, shale, and occasionally alunite.

It was stated that, among the manganese minerals, ramsdellite was the first to be precipitated, followed by manganite. The main part of the psilomelane and cryptomelane is later than the manganite. Pyrolusite was the last to be formed, partly by dehydration of manganite. Regeneration and recrystallization of pyrolusite is a common feature. The above authors noted that colloform and related textures, which are common in the ore minerals, indicate their deposition from low temperature gels, in most cases recrystallized.

In the more recent work of Mart and Sass (1972), the large ore bodies are differentiated into three zones:

- The inner zone is largely composed of psilomelane and pyrolusite, with rare manganite, hausmannite, polianite, and pyrochroite. Hematite and clay minerals usually do not exceed 25%. The structure is massive, but radial

concretions of pyrolusite are found locally.

- The intermediate zone consists mainly of psilomelane, pyrolusite, and hematite, with some, up to 15% goethite, quartz, barite, and clays. The ore is massive and constitutes the main ore reserves at Om Bogma.

- The outer zone is composed mainly of hematite and goethite with minor psilomelane. Detrital quartz is common, and spherulitic concretions are frequent.

Mart and Sass believe that in the inner zones, manganese minerals of low oxidation state were first formed and later replaced by oxidized minerals. In the outer zones only oxidized manganese minerals were precipitated. Primary geochemical separation of manganese from iron usually results in shallow water deposits being richer in iron, and in deeper water deposits being richer in manganese (similar to the southeastern and northeastern occurrences in the Om Bogma district). The zoned ore lenses indicate low pH- high Eh at the rims, and high pH - low Eh in the cores. This implies that during intermediate phases, after the deposition of undifferentiated material, manganese migrates away from the rim and precipitates in the cores, whereas iron migrates in an opposite direction.

The mineral-forming associations of the studied deposits are all of low temperature formation, with a high or low degree of oxidation. The associations are typical for sedimentary manganese deposits.

D. Proposed Model for Genesis and Mode of Formation

According to findings in this study, a proposed theory has been developed for the genesis and mode of formation of the manganese deposits of the Om Bogma district. The theory is based on the previously discussed criteria taken from information given in previous works and from current field observations. It might be emphasized, however, that the proposed theory should not be considered as the only possible theory. This theory is the one that best fits the available data and presents the most convincing arguments on the subject. The sedimentary origin theory will have to be amended and hopefully will seem most likely when the exploration program now in progress is completed. It is believed that most of the principles supporting this theory are based on solid criteria. New information is unlikely to cause any significant changes.

The sedimentary hypothesis is described, as follows, in the form of the visualized geologic history of the period related to the formation of the studied deposits. During the Carboniferous era and after the hiatus following the deposition of the lower sandstone succession, the terrain was submerged

below a shallow-to-moderate transgressing sea with a shoreline running roughly north-northeast to south-southwest and with an open sea towards west-northwest. The tidal zone was limited in the seaward direction by coral reefs. In the shallow waters, i.e. near shore zones, detritals were deposited, resulting in silty and sandy facies. Further seaward, and up to the reef zone, some detrital material deposition occurred. Beyond the reefs, more active carbonate rock precipitation resulted in a thicker succession of purer carbonate beds.

During subsequent regression, a new shoreline was established far from the coral reef. Erosion started to the south and southeast, and further northwest, sedimentation continued. The erosion, mainly of a chemical nature, created an irregular surface with pits and caves. Leaching of the different rock types resulted in accumulation of a residual rich in iron and manganese.

When the following sea transgression began, the residual iron-manganese rich material was transported to the rising shoreline. Close to the shoreline, ore minerals were deposited together with some detritals. Further out, the finely divided particles of iron-manganese minerals were trapped in the eroded dolomite, filling pits, caves and other irregularities of the rock.

In some cases, erosion has broken across the upper contact of the lower sandstone succession causing the base of the deposited ore bodies to lie at lower levels than the contact line. The resulting ore bodies are thus more lenticular and tend to be irregular, with rapid thickness, shape, and grade variations. The isopach and facie contour distribution of the Om Bogma district, as studied by Mart and Sass (1972), points toward a local, semi-closed embayment of the sea at the location of the Om Bogma mines. There, ore deposition would have been most pronounced. The older coral reefs which were bordering the tidal zone were also important loci of ore deposition, and of pseudomorphism with the filling of the animal structural cavities.

Further northwestwards, until the start of deep waters, the material rich in ore minerals was precipitated on a rather even surface of older impure dolomites. This produced regular stratiform ore bodies with relatively consistent thickness and grade. Deposition of carbonate material in these deeper zones resulted in an intimate admixture of ore dolomite constituents. The iron is, then, expected to be comparatively low. The available ore material has apparently precipitated in this zone, in such a manner that no significant deposits were formed in the deeper zones.

Once the source of ore material on the land was exhausted, only some shales and siltstones were carried to the sea to be deposited mainly in the near-shore, shallower waters, conformably over the ore bodies and enclosing rocks. In deeper waters more carbonate chemical facies continued to be deposited. Intermediate changes resulted in the redistribution of the collectively deposited iron and manganese oxide gels which adapted to the physio-chemical conditions. Zoning of the ore bodies resulted. The inner zones were enriched in manganese and the outer zones enriched in iron. Dolomitization of the enclosing carbonate rocks may have taken place contemporaneously with the secondary differentiation of the ore bodies.

Later, near-surface modifications in the ore bodies took place due to recrystallization, to tectonic effects, and to vulcanicity. Surface waters locally leached some exposed ore bodies and deposited the iron-manganese oxides out of solution along some of the open fault and fissure planes at lower levels.

E. Proposed Principles Guiding Prospection in Study Area and Contiguous Areas

A successful prospection work depends principally on three main factors:

- The presentation of a logical theory for the mode of formation and genesis of the prospected ores is required. The hypothesis should explain most, if not all, of the geologic observations, and account for the discrepancies in the mode of occurrence and geologic setting between various locations within the mineralized district.

- A very good understanding of the geology of the prospected area is necessary for a comprehensive extrapolation of surface observations to the subsurface. This should be combined with regional observations, a detailed and critical inspection on a small scale of the rock outcrops, and structural studies in the prospected area. Associated geologic mapping and profile construction are necessary and should require a great number of outcrop sketches.

- Lastly, a well-conceived prospection program that supports both the hypothesis and the geology is indispensable. The choice of the areas to be prospected in detail and the methods to be applied should be based on theories developed from geologic observations related to ore formation.

Based on the advocated theory of ore formation in the contiguous and study areas, general principles can be formulated that help to define the prospection program. These principles are based on the observation of regional geologic features. When precise, local, detailed knowledge of the geology is available for a defined area, a well designed exploration program will

result. However, the exploration program should conform to the broad principles developed by field investigations and discussed below.

1. Manganese mineralization appears to be characterized broadly as:

   - Dolomitic occurrences associated with a carbonate facies.
   - Sandy occurrences having a sandy or a silty facies.
   - Manganese in isolated occurrences in small low grade quantities.

   Theory indicates that manganese mineralization represents a well defined time unit, but its rock strata position has only local significance. Related to the sandy or silty facies is manganese in the southeast areas occurring and interbedding between the lower and upper Carboniferous sandstone strate. In the northern area, manganese is found overlying the Om Bogma basal dolomite formation, occurring at the same relative elevation as the Om Bogma Formation, or cutting across the top of the lower sandstone. The latter is defined as the "sandstone pavement," S.P., by Ford. Toward the northwest, the ore is underlain by silty and sandy dolomite covered by a thick succession of dolomite capping. The overlying dolomitic rocks frequently contain a matrix of manganese minerals that may contain low grade dolomitic manganese mineralization.

2. Variations in the rock strata succession comprising the manganese mineralization are a reflection of the changes in the paleogeographic conditions during the period of manganese deposition. The position of a locality relative to the old shoreline, and the limits of the tidal shallow water zone in the basin of deposition, are highly determinative in the ore formation, its quality and quantity, and the enclosing rocks.

3. The structures, mainly faults, are of secondary effect on the mineralization. It is in the dislocation of the ore lenses and beds that faulting plays a role determining final configurations.

4. It is only through understanding the detailed geology of a given area that successful exploration can be undertaken. With a good understanding of ore genesis and a detailed geological map with relevant sections, one can formulate a reasonably logical program for prospection. Good identificiation of rock varieties and structural detail are useful in mineral target identification.

5. The summary of the sedimentary theory for ore genesis has given rise to an interesting shape for the study area (Figure 2-1). The various mineralized areas have been dotted on a map using the three main category definitions.

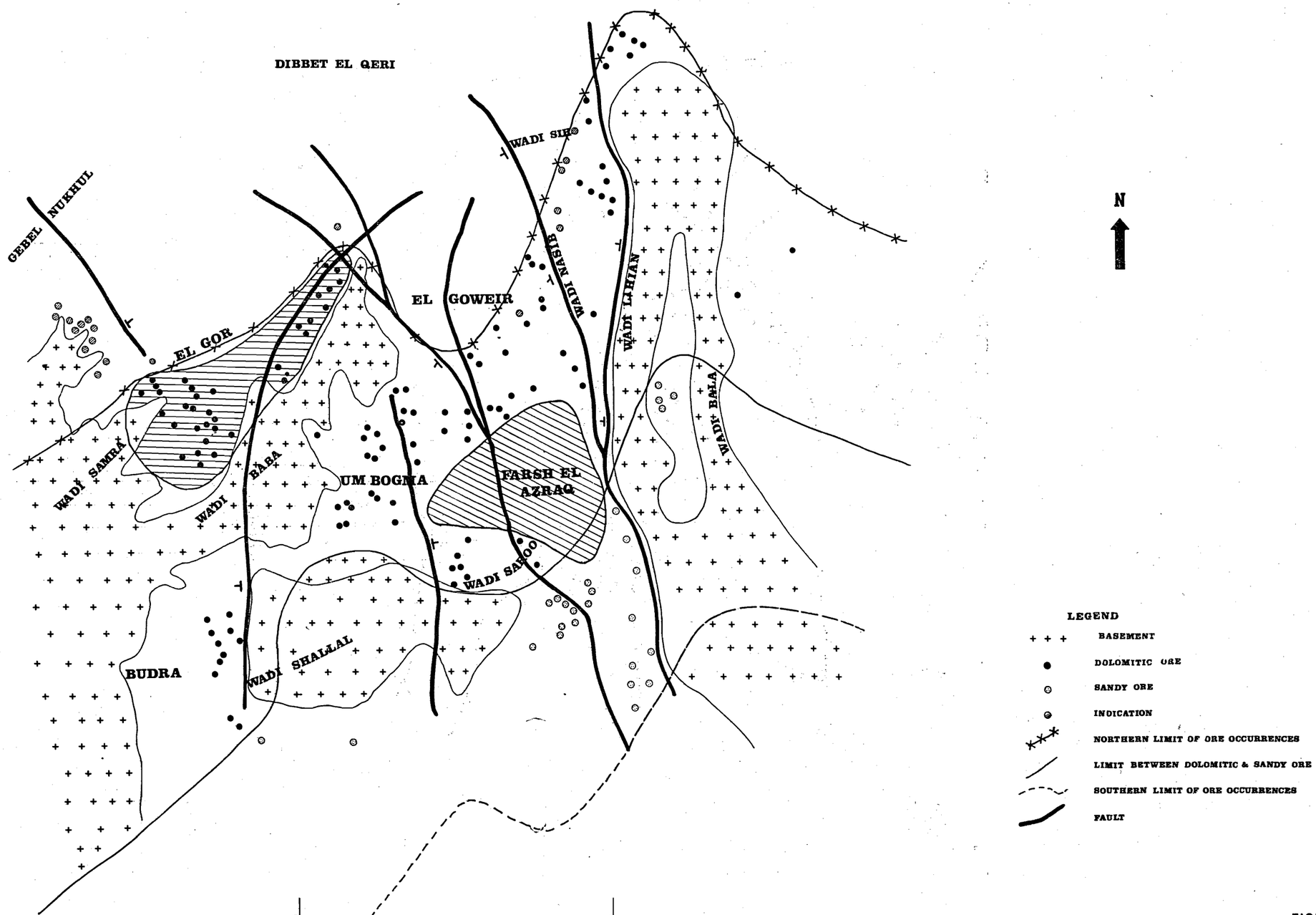

FIGURE 2-1

NO.	DATE	REVISION	BY CHK	APP.	APP.

NOTES

DESCRIPTION — COST ACCOUNT

WORK COVERED BY THIS DRAWING CHARGED TO COST ACCOUNT ABOVE

APPROVAL	DATE	SCALE: 1 : 50,000	DATE
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		APPROVED BY	
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THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI

PALEOGEOGRAPHIC MAP

The isolated occurrences represent local concentrations of ore material escaping deposition after reaching relatively deep waters. The physio-chemical conditions are not appropriate for concentration of manganese iron oxides and the formation of deposits.

6. Inspection of Figure III.E-1 indicates two main areas likely for detailed prospection:

   - The area to the south of El Qor and north of Wadi Baba, which may prove to contain high or medium quality ore with important reserves. A short-term program of preliminary prospection in this area can highlight its potential. It is recommended that such a preliminary prospection program be implemented as soon as possible.

   - The area of Farsh El Azraq, north of Wadi Saaho and south of Abu Zarab (covered by a thick succession of upper sandstones and basalt). Although this area is promising for finding good quality ore and important reserves, the thick cover renders its prospection relatively costly and should be a long term target.

   On the other hand, it is almost certain that the vast areas of El Qor, Gebel Nukhul, El Queir, and Dibbet El Qeri seem to be barren of mineralization. A few deep pits would assure the validity of this assumption. Toward the east and southeast, the field inspection has already proved the absence of ore occurrences.

   It has been concluded, from study data, that the manganese mineralization as a whole lies within a zone, at its maximum 10 km wide, running roughly northeast to southwest with two sinuous flexures. The southern boundary of this zone roughly represents the shoreline of the depositional basement. The northern border corresponds to the limit of the water depths appropriate for manganese-iron deposition, i.e. the tidal zone. The finding of pseudomorph coral reefs along this northern border, e.g. at Om Rinna and northeast of Abu Thor, is corroborative criteria.

   It is worthy of note that most of the mineralization localities in the southeastern parts of the mineralized zone belong to sandy-type occurrences. This most southeasterly strip is believed to correspond to the shallow waters, with relatively high mechanical energy, high eH, and low pH. Iron was precipitated here more dominantly than manganese in a silty and sandy facies.

   Along the northern border of the mineralized zone, all the minor manganese concentrations lie dispersed among nearby dolomitic occurrences. This can be explained by a relatively rapid deepening of the basin waters beyond the reef line.

III. GENERAL DATA REVIEW

A. Location

The total area, embracing SMC mining leases, is located between

Latitude	Longitude
27° 55' 00"	33° 18' 00"
29° 04' 00"	33° 26' 00"

The number of leases for manganese ore exploitation is 27, while the main mines are:

- The lease 288 area 8.
- The leases 296 and 297 area of Abu Hamat Shemal.
- The leases 293 and 402 area of Abu Thor.

B. Historical Review

Petri mentioned that three manganese oxide samples had been found in ancient Egyptian sites. These samples were described as follows:

- The first sample of wad type which is clayey uncrystalline manganese dioxide dates from the 12th dynasty.
- The second sample of pyrolusite dates from the 18th dynasty.
- The third sample of psilomelane is of unknown date. It may or may not be ancient.

Manganese oxides were used in ancient Egypt to give glass or glass glazing a red-purple color. Pyrolusite was used in coloring a tomb during the 12th dynasty. It was also used as eye powder.

The geologist Barron, working for the Egyptian Geological Surveying Department, discovered the manganese deposits in the southwest part of Sinai between October 1898 and March 1899. In 1907, he published a report on the topography and geology of the southwest part of Sinai. This included general geology, and a description and analysis of the deposits of manganese and iron. In 1910 the first prospecting license for manganese was issued.

Ball (1916) found four prospecting adits on the west side of Gebel El Ramsy and illustrated their exposed section in his book. These adits were presumably made about the end of the

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last century. Ball planned the first mine layout of the Sinai Manganese Company. Presumably the approximately 7-m-deep pit in the embayment of the upper sandstone in the southwest part, as well as the fifth and sixth tunnels in the northeast, were part of this exploration work.

During World War I, production ceased. In 1918, mining operations were resumed. An annual production of about 190,000 tonnes continued until the beginning of World War II. During World War II, production stopped.

In 1945, mining started again reaching an annual production rate of 200,000 tonnes and continued until October 1956, the time of the Suez Crisis.

In 1957, the mines and the mine management were taken over by the Egyptians. Production started after overcoming difficulties and reached about 750 tonnes per day until June 1967.

In June 1967, production stopped again and has been suspended until the present time.

About 5 million tonnes of run-of-mine ore is the total amount of manganese material which was produced in the southwest part of Sinai, mainly from the Om Bogma district from 1918 to June 1967.

Before nationalization of the mining industry in 1961, private companies and individuals rather than The Sinai Manganese Company were active in the exploration and exploitation of high grade manganese ores and dioxides. The private sector companies at work were:

- Technical Bureau for Mining & Commerce (TBMC) - Monir El Kholy.
- Soc. Misr. Mines Union in partnership with TBMC - Monir El Kholy.
- Labib Nassim and Sons Co.
- Khalil Toubia Brothers Company in partnership with Monir El Kholy.
- Mr. Robert Hakow.
- Manganese Mining Co. - Monir El Kholy and Company.
- Egyptian Manganese Mining Company, S.A.E. (El Kholy).

After July 1961, The Sinai Manganese Company became the only company responsible for the exploration and exploitation of the manganese ores in Om Bogma and its contiguous areas.

C. Existing Data

SMC delivered to KECI the available documents, studies, reports, maps, and other data relevant to this project study, covered by the following letters:

- No. 21/80, dated 26 January 1980
- No. 26/80, dated 3 February 1980
- No. 27/80, dated 17 February 1980
- No. 189/80, dated 21 February 1980
- No. 47/80, dated 10 March 1980

These documents are classified as follows:

1. Mapping and Weather

   - Aerial photographs and mosaics.
   - Forty aerial photographs - scale 1:40000.
   - Four mosaics - scale 1:50000.
   - Triangulation points in study area.
   - Meteorological data.

2. Geology, Ore Reserves, and Mining Rights

   - Technical report concerning SMC's activities in Sinai before 1967.
   - Technical report concerning the manganese ore reserves in Om Bogma area.
   - Technical report about the deposits in Sinai
   - Technical report about the development and exploitation of manganese ore in Om Bogma area written by the British geologist, Stanley Ford.
   - The full chemical analyses of the different grades of manganese ore in Sinai.
   - Technical report on the manganese ore reserves in west central Sinai until 30 June 1964.
   - Report concerning questions about the manganese ore going to the ferromanganese plant.
   - World production of manganese and ferromanganese alloys.
   - Topographic map for the general layout of the mines - scale 1:50000.

- Contour map of Om Bogma - scale 1:12500.
- Map showing the rainfall drainage in Om Bogma and Abu Zeneima - scale 1:50000.
- Topographic map showing all licenses and leases issued to The Sinai Manganese Company - scale 1:50000.
- Construction drawings for the tower bases.
- Working plan to production lease No. 291-300 - scale 1:2000.

  Working plan to production lease No. 293 - scale 1:2000.

  Working plan to production lease No. 298-299 - scale 1:2000.

  Working plan to production lease No. 296-297 - scale 1:2000.
- Working plan to production lease No. 861-915 - scale 1:2000.

  Working plan to production lease No. 914 - scale 1:2000.

  Working plan to production lease No. Ramsy zone - scale 1:2000.

  Working plan to production lease No. Area 45 - scale 1:500.
- Map showing the priorities for the aerial photos scale 1:100000.

  Priority No. 1 - scale 1:5000.

  Priority No. 11 - scale 1:5000.

  Priority No. III - scale 1:5000.
- Plan showing the ore reserves in production lease No. 291-300.
- Isopach map - scale 1:2000.
- Map No. 3/5 of Ain Abu Hamata Nahman area - scale 1:5000.
- Map No. 4/6 of M.P. License 613 - scale 1:2000

- Map of 10 Zone - scale 1:3000.
- Map No. 4/9 of Nahman area - scale 1:5000.
- Map No. 4/8 of Nahman area - scale 1:5000.
- Map No. 4/7 of Nahman Hill B - scale 1:2000.
- Map No. 4/12 of Wadi Nassib area - scale 1:2000.
- Map No. 5/37 of lease 9 - scale 1:500.
- Map No. 4/32 of lease 9 upper area - scale 1:500.
- Map No. 3/26 of lease 170 - scale 1:500.
- Map No. 5/20 of lease 9 main south area - scale 1:500.

3. Ferromanganese Plant

- Report on ferromanganese plant in Abu Zeneima.
- Substantive terms of reference (presented by U.N.).
- Report of the short technical advisory mission to S.M.C. concerning the restorations of the Abu Zeneima ferromanganese plant (presented by B. R. Nighwan, senior interregional advisor of UNIDO).
- Survey and damage report on gas turbine power station of the S.M.C. in Abu Zeneima (presented by Brown Bovari and Co.) June 1972.
- Report on technical inspection of the ferromanganese plant at Abu Zeneima by Elkem-Spigerverket, in November 1976.
- Technical report from Electrokemisk in December 1960.
- Report about the importance of making an industrial region in Sinai.
- Report of the industrial committee about ferromanganese project.
- Report of the financial committee about ferromanganese project.
- Report of the general committee about the ferromanganese project and power station and distillation plant.

- Report about the possibility of using natural gases at oil field in Abu Rudeis.
- Primary report in electricity for ferromanganese, tin, lead, and illmenite project.
- Report of the power committee about the tender study of electric power and distillation plant, presented to The Sinai Manganese Company.
- Primary layout of Abu Zeneima.
- Contract for construction of the civil structure of ferromanganese plant.
- General specification and conditions for the ferromanganese building.
- Report on ferromanganese plant in Abu Zeneima.
- Report on Sinai smelting project written by Cambell, Gifford & Morton Ltd.
- Substantive terms of references.
- Amendment to the civil work contract for the ferromanganese loading platform in the harbor of Abu Zeneima.
- Correspondence and offers concerning the potable water pump station.
- Equipment specifications for a gas turbine electric generating station presented by Westinghouse Electric International Co.
- Tender for the power and water distillation plant presented by the Tractor and Engineering Co.
- Construction of sanitary and drainage system project in Abu Zeneima.
- Conditions of tender and specifications for the supply and erection of an electric power station and water distillation plant at Abu Zeneima presented by the Tractor Engineering Co.
- Time schedules for constructing the project.
- Calculation sheets of the following:

  - Foundation.
  - Rotary kiln (smoke chamber) and stairs.
  - Furnace building slab and beams.
  - Column loads.
  - Bar lists.

- Furnace building slab.
- Frames.
- Bins.
- Tapping and backing hall.
- Floor elevation.
- Stairways, crushing table, and water tank.
- Kiln foundation, rotary kiln, and chimney.

o One hundred fifty-eight drawings concerning the ferromanganese plant.

o Sixty-four drawings concerning the ferromanganese plant.

4. Inventory Reports

The inventory reports dated 1979, covering the SMC's facilities at Sinai were delivered.

5. ACB References

ACB forwarded to the study team its library's available references about this project. These references follow this report.

D. SMC Declared Manganese Ores Reserves

The reserves at Om Bogma mines are classified into three categories:

o Proven reserves.

o Probable reserves.

o Possible reserves.

The proven reserves are found in two groups. Group number 1 includes the production areas which have accessible transportation methods such as aerial ropeway or trucks. The following table shows the proven reserves at various such production areas:

Area	Reserve	Average		Units	
	1000 tonnes	Mn%	Fe%	Mn	Fe
286	3	16.0	37.0	48.0	111.0
288	308	19.5	38.4	6,006.0	1,827.2
296	30	21.9	38.0	38.0	1,140.0
292	52	28.3	27.7	1,471.6	1,440.4
TOTAL	393	20.8	36.9	8,182.6	4,518.6

Group number 2 includes the prospecting areas which can produce high-grade ore only. The following table shows the proven reserves at such prospecting areas:

Area	Reserve	Average		Units	
	1000 tonnes	Mn%	Fe%	Mn	Fe
291	251	20.7	33.3	5,194.6	4,065.8
Ramsy	364	16.6	36.3	6,060.0	13,237.1
401/402	30	22.3	31.5	670.8	946.8
294	64	30.5	25.4	1,950.7	1,925.1
298	230	17.2	38.6	3,956.6	8,754.3
861	231	21.1	33.9	4,986.6	7,841.4
658	21	22.1	33.9	464.1	711.9
293	104	36.2	20.7	3,765.0	2,154.3
Total	1,295	20.9	34.2	27,048.9	44,336.7
Total Proven Reserves	1,688	20.8	34.8	35,231.5	58,855.3

There are approximately one million tonnes of probable reserves and approximately 1,330,000 tonnes of possible reserves.

The total proven, possible and probable ore reserves calculated as follows:

Proven Reserves	
Production Areas	393,000 tonnes
Prospecting Areas	1,295,000 tonnes
Probable Reserves	1,000,000 tonnes
Possible Reserves	1,330,000 tonnes
Total	4,018,000 tonnes

E. SMC-Declared Chemical and Physical Characteristics

Table 2-1 on the following page shows the chemical analysis of manganese ores.

KAISER ENGINEERS

TABLE 2-1

CHEMICAL AND PHYSICAL CHARACTERISTICS

THE SINAI MANGANESE COMPANY

MANGANESE ORES

CHEMICAL ANALYSESE

Components	Manganiferous Iron Ore	Fine Mang. Ore (Approx)	42 % Mn. Ore (Approx)	48 % Mn. Ore	MANGANESE DIOXIDE Grade I	Grade II	Grade III	Grade IV	Grade V
	%	%	%	%	%	%	%	%	%
Mang. Dioxide	32.760	Mn 19	65.53	67.770	89.870	89.700	87.780	81.950	74.910
Mang. Oxide	.970		4.00	11.180	3.250	2.090	2.100	4.210	1.700
Ferric Oxide	51.470	Fe 38	17.80	9.700	.330	1.000	900	3.360	3.800
Ferrous Oxide	—		—			—	—	—	-
Alumina	2.380	2.380	1.500	.900	.550	300	1.100	1.240	.800
Titanium Dioxide	—	—	040	.032	.010	.000	010	.025	.020
Silica	5.800	5.800	3.000	1.160	.200	.570	.480	000	.600
Calcium Oixde	.780	.780	1.500	1.450	.450	.050	.030	.080	4.780
Magnesium Oxide	.100	.100	.200	.350	.550	.380	300	200	1.760
Barium Oxide	.400	.400	1.000	1.300	—	1.680	2.600	2.500	1.250
Barium Sulphate	.900	.900	.576	015	.200	100	—	1.440	1.900
Copper Oxide	.050	.050	.050	.050	.088	.163	.075	.225	0.175
Lead Oxide	.070	.070	Trace	—	Trace	.040	.130	.020	—
Zinc Oxide	Trace	Trace	.400	.550	.450	.220	.220	.320	.160
Nickel Oxide	Trace	Trace	.010	.010	.030	.030	.020	.030	.030
Cobalt Oxide	Trace	Trace	Trace	—	Trace	.030	.032	.040	—
Arsenic Oxide	.015	.015	.020	.025	.005	.005	.015	.018	.010
Sodium Oxide	.100	.100	.200	.300	.420	.200	.200	.050	.630
Potassium Oxide	.300	.300	.300	.410	.280	.370	.700	.430	[illegible]
Phosphoric Anhydrite	.236	.236	.200	.185	.070	.046	.046	.142	.083
Sulphuric Anhydrite	.250	.250	.374	.225	.027	.123	.067	.206	.274
Carbonic Anhydrite	.120	.120	.200	.300	.100	—	—	—	5.250
Moisture	3.250	3.250	.300	3.000	3.020	2.880	3.200	2.750	1.150
Undetermined	.049	.049	.040	.097	.100	.013	.005	.664	.008
Total	100. —	—	100. —	100. —	100 —	100. —	100. —	100. —	100. —
Maganese	21.460	19. —	43.690	51.51	59.340	58.330	57.200	55.150	48.680
Iron	36.030	38. —	11.330	6.85	.230	.700	.630	2.350	2.700
Phospherous	.051	.051	.087	.810	.031	.020	.020	.062	.038

MECHANICAL CONDITION

	Lumps (more than 2,5 inches)	Rubbles (from 2.5" - 0.5")	Fines (less than .5")
Manganiferous Iron Ore	35%	35%	30%
Fine Manganiferous Ore	—	—	100%
42% Manganese Ore	Not more than 5"		
48% Manganese Ore	Not more than 5"		
Manganese Dioxide	Lumps of 4 inches		

IV. MINING RIGHTS REVIEW

A. Introduction

The Sinai Manganese Company, in its letter no. 37/80 of March 3, 1980, has indicated its mining rights in the study area.

ACB verified the accuracy of the given data about SMC's mining rights with the regulatory authority which is the General Administration of Mines and Quarries, Ministry of Industry and Mineral Wealth.

The mining rights of SMC in the study area are summarized in the following table.

Number of leases/contracts	Purpose
27	Manganese exploitation
1	White clay exploitation
8	Kaolin exploitation
1	Gypsum exploitation
5	White sand exploitation
22	Land contract
2	Pipeline contract
1	Aerial ropeway contract
1	Telephone cables contract
1	Railway contract
3	Jetty contract

B. Ferruginous Manganese Ores Mining Rights

According to law 86 for the year 1956, SMC is granted by the Egyptian government 27 mining leases for the exploitation of manganese ores. Two mining leases were granted for the exploitation of manganese ores. Two mining leases were granted for the exploitation of manganese and colors while 18 mining leases were granted for the exploitation of manganese and iron, and the remaining 7 mining leases were granted for the exploitation of manganese.

During this study, on May 11, 1980, KECI/ACB submitted to SMC a report on additional exploration requirements for manganese ore in the Om Bogma district and contiguous areas. In this report the discovery of two major areas of mineralization, which were not yet covered by SMC leases, were registered. KECI/ACB recommended that SMC should immediately apply for a

prospection license or licenses which cover the two new areas. SMC acted accordingly and applied for two prospection licenses which, at the time of drafting this report, are under issue.

The 27 manganese mining leases' total area covers 784.61 hectares, which vary in size between 70.0 and 0.35 hectares.

The geographic locations of the 27 manganese concessions are illustrated in Figure III.B-1 and in Table 2-2 below. After reviewing the mining rights and making field visits to the 27 manganese mining leases, we have the following comments:

1. A Missing Mining Lease - El Ramsy (367)

   Mining lease no. 367, located at El Ramsy, was not indicated in the list forwarded to us by SMC in its letter no. 37/80 dated March 3, 1980. It was mentioned in SMC's letter No. 52/80 of March 12, 1980, concerning ore reserves. Also, this mining lease was recorded in SMC's report on ore reserves.

2. Mining Leases' Locations and Names

   Some concessions are not named in official documents by their proper locations. Several other mining leases were granted under the same location name. This formula for naming mining leases causes confusion. Table 2-3 shows the official name of each concession and the proper known name.

   The following examples illustrate the naming confusion:

   a. Example B-1

      Seven mining leases which have the location name of Om Bogma should have been nominated by their proper location name. The individuals of the Om Bogma family are listed hereunder.

      - Lease 286 Om Bogma known as Hill 5
      - Lease 288 Om Bogma known as Area 8
      - Lease 291 Om Bogma known as Abu Hamat Yemin
      - Lease 300 Om Bogma known as Abu Hamat Shemal
      - Lease 353 Om Bogma known as El Alluga
      - Lease 354 Om Bogma known as El Alluga (also)
      - Lease 426 Om Bogma known as Ras El Homarra

TABLE 2-2

LOCATION OF MINING LEASES

THE SINAI MANGANESE COMPANY

Serial No.	Mining Lease No.	P.L. No.	District as in Mining Lease	Dimensions W Meters	Dimensions L Meters	Area in Hectares	Longitude	Latitude	Azimuth	Remar
1	239	608	Wadi El Saaho	200	1,000	20.00	33°24'52"	28°58'00"	59°30'00"	
2	240	—	Gebel El-Adediya	220	750	16.50	33°25'21"	28°57'09"	144°00'00"	
3	253	—	Wadi El Lahian	350	850	29.75	33°24'30"	29°01'50"	90°00'00"	
4	256	—	Wadi El Lahian	400	400	16.00	33°24'47"	29°03'50"	112°30'00"	
5	265	608	Wadi El Saaho	468	1,000	46.80	33°24'01"	28°58'24"	59°30'00"	
6	266	669	Gebel Abo Kafas	350	700	24.50	33°18'36"	28°56'21.03"	33°41'36"	
7	267	669	Gebel Abo Kafas	600	700	42.00	33°19'20.02"	28°55'45.9"	33°41'36"	
8	283	815	Gebel El Adediya	400	500	20.00	33°25'16.27"	28°56'36.45"	127°00'00"	
9	286	instead of 177	Om Bogma	215	240	5.16	33°21'32.0"	28°29'15"	61°51'00"	
10	288	instead of 179	Om Bogma	540	927	50.05	33°21'00"	29°00'13.25"	74°00'00"	
11	291	instead of 183	Om Bogma	700	1,000	70.00	33°22'23.005"	29°00'27.724"	175°24'00"	
12	292	instead of 184	Wadi El Shalal	700	700	49.00	33°18'41"	28°57'11"	110°17'58"	
13	293	instead of 185	Wadi Abu Homata	600	800	48.00	33°23'04"	29°01'33"	150°54'00"	
14	294	instead of 233	Wadi El Noaman	300	500	15.00	33°21'50"	29°00'06"	85°24'00"	
15	295	instead of 234	Wadi El Noaman	300	510	15.30	33°21'51.989"	28°59'50.12"	175°24'00"	
16	296	instead of 241	Wadi El Noaman	470	500	23.50	33°21'35.018"	29°00'51.108"	90°00'00"	
17	297	instead of 242	Wadi El Noaman	500	700	35.00	33°21'37.604"	29°00'34.868"	90°00'00"	
18	298	instead of 243	Wadi Abu Hamra	300	600	18.00	33°23'05.65"	29°00'31.82"	60°54'00"	
19	299	instead of 244	Wadi Abu Hamra	200	200	4.00	33°22'57.4"	29°00'31.50"	60°64'00"	
20	300	instead of 250	Om Bogma	100	700	7.00	33°22'22.709"	29°00'30.962"	85°24'00"	
21	311	637	Wadi El Hessenia	500	1,000	50.00	33°22'34.0"	28°58'47.00"	85°24'00"	
22	312	612	Wadi Nassib	800	800	64.00	33°23'20.0"	29°01'42.0"	60°54'00"	
23	353	861	Om Bogma	550	1,100	60.50	33°23'40.9"	29°00'49.2"	60°54'00"	
24	354	861	Om Bogma	550	900	49.50	33°23'42.45"	29°01'23.44"	60°54'00"	
25	401	914	Abu Thora	100	170	1.70	33°22'47.8"	29°01'05.3"	46°00'00"	
26	402	914	Abu Thora	50	70	0.35	33°22'45.7"	29°01'11.8"	77°00'00"	
27	426		Om Bogma	100	300	3.00	33°20'33.23"	28°58'56.94"	81°29'00"	

TABLE 2-3

NAMES OF MINING LEASES

THE SINAI MANGANESE COMPANY

Serial No.	Mining Lease No.	Mining Lease Names	Actual Location and Known Name	Area in Meters	Duration of Lease Year	Expiry Date	Annual Rent LE
1	239	Wadi El Saaho	Om Ratam	1000 x 200	30	6.6.1997	50.0
2	240	Gebel El Adedia	Gebel El Adedia	750 x 220	30	6.6.1997	42.5
3	253	Wadi El Lahian	South Lahian or long hill	850 x 350	30	9.4.1998	75.0
4	256	Wadi El Lahian	Zober-Lahian or V-shaped hill	400 x 400	30	9.4.1998	40.0
5	265	Wadi El Saahu	El Hashash	1000 x 468	30	11.6.1998	235.0
6	266	Gebel Abu Kafas	G. Om Tmayim north	700 x 350	30	12.3.2000	125.0
7	267	Gebel Abu Kafas	G. Om Tmayim north	700 x 600	30	16.3.2000	210.0
8	283	Gebel El Adedia	Gebel Adedia	500 x 400	30	6.2.2000	100.0
9	286	Om Bogma	Hill 5	240 x 215	30	18.6.1999	40.0
10	288	Om Bogma	Area 8	927 x 540	30	18.6.1999	255.0
11	291	Om Bogma	Southern Abu Hamat Yemin	1000 x 700	30	18.6.1999	350.0
12	292	Wadi El Shalal	Wadi El Shalal	700 x 700	30	18.6.1999	245.0
13	293	Wadi Abu Homata	East Abu Thor	800 x 600	30	18.6.1999	240.0
14	294	Wadi El Noaman	El Korba	500 x 300	30	18.6.1999	75.0
15	295	Wadi El Noaman	El Beida	510 x 300	30	18.6.1999	80.0
16	296	Wadi El Noaman	Abu Hamat Shemal	500 x 470	30	18.6.1999	120.0
17	297	Wadi El Noaman	Abu Hamat Shemal	700 x 500	30	18.6.1999	195.0
18	298	Wadi Abu Homata	East Abu Zarab	600 x 300	30	18.6.1999	90.0
19	299	Wadi Abu Homata	West Abu Zarab	200 x 200	30	18.6.1999	40.0
20	300	Om Bogma	Northern Abu Hamat Yemin	700 x 100	30	18.6.1999	40.0
21	311	Wadi El Hessenia	Gebel Om Sylat	1000 x 500	30	9.10.2000	250.0
22	312	Wadi Nassib	Wadi Nassib	800 x 800	30	9.10.2000	320.0
23	353	Om Bogma	Gebel El Alluga	1100 x 550	5	4.11.1983	
24	354	Om Bogma	Gebel El Alluga	400 x 550	5	4.11.1983	250.0
25	401	Abu Thor	Southern West Abu Thor	170 x 100	30	6.1.2006	40.0
26	402	Abu Thor	Northern West Abu Thor	70 x 50	30	6.1.2006	40.0
27	426	Om Bogma	Ras El Homarra	300 x 100	30	4.11.2007	40.0

b. Example B-2

The mining leases (239 and 265) are named Wadi El Saaho. Wadi El Saaho is a very long wadi, hence the name does not define exact location. Accordingly the concessions are known as Om Ratam and El Hashash respectively, these names describing location properly.

c. Example B-3

Two mining leases (266 and 267) are named Gebal Abu Kafas, although they are not located near Gebal Abu Kafas. They are located in an area known as Om Tmayim.

d. Example B-4

Two mining leases (253 and 256) are named Wadi El Lehian, an area to which the manganese ore is hauled. The known names are the following:

- L 253 - the South Lahian or the long hill.
- L 256 - the Lahian-Zobeir or the V-shaped hill.

e. Example B-5

Four mining leases are named Wadi Noaman but known as follows:

- L 294 - El Korba
- L 295 - El Beida
- L 296 & 297 - Abu Hamat Shemal

f. Example B-6

Two mining leases (298 and 299) are named Wadi Abu Hamat, but known as Abu Zarab after Abu Zarab hill.

g. Example B-7

Mining lease 311 is named Wadi El Hessenia, this being far away from the location of the mining lease. Hence it is known as Om Sylat after Om Sylat hill.

3. Northwestern Corner as a Claim Corner

According to the mining lease contract model stated in law no. 86 from the year 1956, the northwestern corner of the mining lease should be identified as the claim corner of the mining leases. In some leases other corners were considered for the claim corner, but not in accordance with the law.

4. Labeling of the Location and Direction Beacons

According to law 86, the northwestern corner of the mining lease should be identified by a claim corner built of stone and cement. The number and name of the mining lease should be written on the marker. Also, at a reasonable distance another marker, a direction marker, should be constructed and labeled.

Most of the location and direction beacons which were inspected had no written labels to identify the number and name of the mining leases.

5. Mining Leases not Including Manganese

During field studies, it was noticed that some manganese workings are partly or wholly outside the boundaries of the mining leases. This is true of two mining leases (353 and 354) of Alluga.

6. Overlapping Mining Leases

It was recorded during the field studies that two mining leases overlap, namely leases 293 and 312.

7. Small Mining Leases

The annual assessment due on each mining lease is LE5 (five Egyptian pounds) per hectare. A minimum rental charge per each mining lease should be not less than LE40 per year. Hence, the Sinai Manganese Company can enlarge the following small mining leases, whose areas are less than 8 hectares with the same rental charges: 286, 299, 300, 401, 402, and 426.

C. Land Contracts

According to article No. 37-A of law 86, 1956, SMC is entitled to be granted land contracts required for one or more of the following purposes:

- Housing of laborers.
- Offices, workshops, and garages.
- Storage of ore.
- Construction of explosives magazines.
- Ore beneficiation and industrialization.

Table 2-4, below, lists the land contract number, the district, the area, the duration, the starting date, the expiration date, the annual rent, and the known name of each land contract.

TABLE 2-4

LAND CONTRACTS

THE SINAI MANGANESE COMPANY

Ser. No.	Land Contract No.	District	Size in Meters	Duration in Years	Starting Date	Expiration Date	Annual Rent LE	Known Name
1	122	Abu Zeneima	18 Hectares	1	26.7.1979	25.7.1980	90	
2	145	Abu Zeneima	250 x 40	1	26.7.1979	25.7.1980	5	
3	161	Abu Zeneima	250 x 40	1	26.7.1979	25.7.1980	5	Jetty-El Alfi
4	162	Abu Zeneima	250 x 40	1	26.7.1979	25.7.1980	5	Jetty-El Kholy
5	164	Abu Zeneima	250 x 40	1	26.7.1979	25.7.1980	10	Jetty-El Kholy
6	165	Abu Zeneima	700 x 500	1	26.7.1979	25.7.1980	160	
7	166	Om Bogma	228 x 132	1	26.7.1979	25.7.1980	15	Ras El Momarra
8	167	Abu Zeneima	269 x 150	1	26.7.1979	25.7.1980	20	
9	168	Om Bogma	100.56 x 85	1	26.7.1979	25.7.1980	5	K.9-Wadi El Markha
10	169	Om Bogma	1200 x 600	1	26.7.1979	25.7.1980	360	Allowat El Markha
11	170	Om Bogma	195.63x195.5	1	26.7.1979	25.7.1980	20	
12	171	Om Bogma	100 x 100	1	26.7.1979	25.7.1980	5	Bir El Soofi
13	172	Abu Zeneima	530 x 231	1	26.7.1979	25.7.1980	65	Depot 2
14	207	Om Bogma	200 x 200	1	26.7.1979	25.7.1980	20	Wadi Om Sakaran/El Kholy
15	208	Om Bogma	100 x 100	1	26.7.1979	25.7.1980	5	G. El Marahil El Kholy
16	213	Om Bogma	100 x 16.5	1	26.7.1979	25.7.1980	5	Abu Natsh/ El Alfi
17	224	Om Bogma	540 x 350	1	26.7.1979	25.7.1980	95	
18	225	Om Bogma	100 x 600	1	26.7.1979	25.7.1980	300	
19	226	Om Bogma	300 x 250	1	26.7.1979	25.7.1980	45	
20	235	Om Bogma	320 x 270	1	26.7.1979	25.7.1980	40	Abu Thor
21	236	Om Bogma	300 x 100	1	26.7.1979	25.7.1980	15	El Ramsy
22	248	Om Bogma	100 x 50	1	26.7.1979	25.7.1980	5	Abu Natsh-Budra

D. Subordinate Contracts

According to article No. 37-B of law 86, 1956, SMC is entitled to subordinate contracts which are required for one or more of the following purposes:

- Water pipelines.
- Gas pipelines.
- Electric cables.
- Telephone cables.
- Aerial ropeway.
- Railway.

Table 2-5 illustrates the subordinate contract number, the type, the district, the duration, the starting and expiration dates, the annual rent, and the purpose of each contract. SMC has been granted five subordinate contracts.

E. Jetty Erection Licenses

According to article No. 37-C of law 86, 1956, SMC is entitled to be granted licenses to erect the jetty or jetties which are required for the exploitation of the granted mining leases. SMC has been granted three licenses for jetty erection.

Table 2-6 gives the jetty erection license number, the district, the duration, the starting and expiration dates, the annual rent, and the known name of each jetty.

F. Other Mineral Mining Rights

According to law 86, 1956, SMC is to be granted 10 mining leases for the exploitation of white clay, kaolin and gypsum, as well as five quarrying leases for the exploitation of glass sand.

Table 2-7 illustrates the type of lease, the number, the ore, the district, the area, the duration, the expiration date, and the annual rent of these mining leases.

TABLE 2-5

SUBORDINATE CONTRACTS

THE SINAI MANGANESE COMPANY

Ser. No.	Contract No.	Type of Contract	District	Duration	Starting Date	Expiration Date	Annual Rent LE	Remarks (Purpose)
1	25	Pipeline	El Markha-Om Bogma	1	26.7.1979	25.7.1980	117.5	Water
2	28	Pipeline	Balaim-A.Z.	1	26.7.1979	25.7.1980	260.0	Gas
3	6	Ropeway	Om Bogma	1	26.7.1979	25.7.1980	58.890	Ropeway
4	3	Telephone line	A.Z. - O.B.	1	26.7.1979	25.7.1980	205.500	Telephone
5	34	Railway	A.Z. - O.B.	1	26.7.1979	25.7.1980	94.250	Railway

TABLE 2-6

JETTY ERECTION LICENSES

THE SINAI MANGANESE COMPANY

Ser. No.	Contract No.	District	Duration Years	Starting Date	Expiration Date	Annual Rent LE	Remarks
1	25	Abu Zeneima	1	26.7.1979	25.7.1980	20	Labib Nissim Jetty (Sinking Jetty)
2	28	A. Z. Gulf	1	26.7.1979	25.7.1980	20	Old Manganese Co. (Ship Loading Plant)
3	30	Abu Zeneima	1	26.7.1979	25.7.1980	20	El Kholy Jetty (Main Abu Zeneima)

TABLE 2-7

OTHER MINERAL MINING LEASES

THE SINAI MANGANESE COMPANY

Serial No.	Lease Type	Lease No.	Mineral	District	Area in Meters	Duration	Expiration Date	Annual Rent LE
1	Mining	190	White clay	Wadi Budra	750 x 400	30	21.3.1995	75.000
2	Mining	191	Kaolin	Wadi Abu Natsh	600 x 300	30	21.3.1995	45.000
3	Mining	374	Kaolin	Wadi Geni	100 x 500	10	9.4.1995	250.000
4	Mining	382	Kaolin	El Dehissa	1500 x 500	10	10.8.1995	375.000
5	Mining	406	Kaolin	El Mussaba Salama	400 x 200	30	1.11.2005	40.000
6	Mining	407	Kaolin	El Mussaba Salama	400 x 200	30	1.11.2005	40.000
7	Mining	411	Kaolin	El Mussaba Salama	400 x 200	30	18.4.2006	40.000
8	Mining	414	Kaolin	Farsh El Guzlan	600 x 500	30	21.5.2006	150.000
9	Mining	423	Kaolin	Abu Natsh	500 x 200	30	22.12.2006	50.000
10	Mining	43	Gypsum	Abu Soeir-Ras Malaab	4000 x 3885	30	3.10.1992	150.000
11	Quarrying	145	Glass sand	Wadi Budra	100 x 50	1	6.8.1980	300.000
12	Quarrying	313	Glass sand	Om Tmayim	100 x 50	1	3.7.1980	300.000
13	Quarrying	320	Glass sand	Om Tmayim	100 x 50	1	29.7.1980	300.000
14	Quarrying	295	Glass sand	Abu Kafas	100 x 50	1	under renewal	
15	Quarrying	269	Glass sand	El Khaboba	100 x 50	1	under renewal	

V. REMEDIAL SURVEYS AND MINE MAPPING

SMC delivered to KECI and ACB in two lots the available mine maps of the leases and concessions of SMC manganese ores. After reviewing these maps, we found that they do not represent the actual conditions of the mines as of June 1967, the last date of mine operation.

The following list shows the preparation dates of each map which varies from 1930 to 1963:

Serial No.	Description	Scale	Date
1	Lease No. 296-297	1:2000	13.2.1963
2	Lease 45	1: 500	31.12.1962
3	Lease 179 (old lease drive 12/13)	1: 500	29.11.1962
4	Alluga District (concession 811,915)	1:2000	13.7.1962
5	El Ramsy	1:2000	1.2.1962
6	Lease No. 293	1:2000	22.3.1961
7	Lease 291-300	1: 200	January 1960
8	M.P.L. 665, 666 Wadi Nassib	1:2000	22.9.1955
9	Lease No. 170 12 W, 16 W, 20W	1: 500	8.6.1955
10	Lease No. 613	1:2000	22.8.1954
11	Ain Abu Hamata Nahman areas from Lease 8	1:5000	19.9.1951
12	Lease 9 Main South & drive 15 areas	1: 500	January 1949
13	Nahman area: Hill B	1:2000	25.8.1937
14	Nahman area: Areas B & C license 231	1:5000	3.3.1934
15	Nahman area: Areas A & license 228	1:5000	2.3.1934
16	Lease 95 upper area	1: 500	10.8.1930

It is critical to the present study to know what changes, if any, should have been made to reflect actual operations until June 1967. KECI proposed on March 1, 1980, that SMC's surveying department begin updating these maps as soon as possible, with priority given to those areas known to have had the greatest production activity.

On March 11, 1980, SMC inquired about the types and extent of the mine maps which required updating. On April 3, 1980, KECI submitted to SMC its recommendations for remedial surveys and mine mapping.

The recommendations defined scope, schedule, and priorities which were needed to provide basic data for the ore reserves and mine planning parts of this study.

The proposed remedial surveys and mine mapping were as follows, in descending order of priority:

- Update surveying and mapping for pillars and rooms in the following area:
  - Lease 288 (District 8 of Om Bogma).
  - Lease 296 and 297 (Abu Hamat Shemal).
  - Lease 300 (Abu Hamat Yemin).
- In the following leases, no mine maps have been provided, so complete mine surveying and mapping is required:
  - Leases 266 and 267 (Wadi Shalal).
- Plotting all outcrops of manganese ore on topographic maps with scale 1:500 and a contour interval of 1 meter in the following areas:
  - Leases 298 and 299 (Abu Zarab - area about 1,500 x 1,000 meters).
  - Lease 253 (El Lahian).
  - Lease 256 (El Lahian-El Zobeir).
  - Lease 353 and 354 (Alluga).
  - Lease 312 (Wadi Nassib).
  - Lease 311 (El Hessenia).

On April 17, 1980, SMC accepted, contingent upon formal approval of U.S. AID and GOFI, the proposal for the KECI and ACB remedial mine surveying and mapping program. The field work started on April 21, 1980. The remedial mine surveying and mapping program was finished on June 5, 1980. This was the same date on which U.S. AID informed SMC that it had approved Amendment No. 1 covering the services of this program.

The updated maps were utilized in calculating the ore reserves and mine planning studies.

VI. ESTIMATED ORE RESERVE QUANTITIES

A. Ore Reserves Classifications

For many years it has been recognized that the reliability and uniformity of the classifications for in situ ore reserves vary widely. This economically important fact has been reflected in various proposals for systems to classify ore reserves. The first classification (Argall's) appeared in the United States in 1902. Hoover's system, 1909, divided all reserves into three classes: proved, probable, and possible. Hoover's system became more popular than Argall's in the United States as well as in other countries. It was adopted in Great Britain and the British Commonwealth in 1946.

Following discussions in 1943, a new system of classification was adopted by the U.S. Bureau of Mines. This system used the terms measured, indicated, and inferred reserves. The term measured in this system calls for a computation within a margin of error not exceeding ± 20%.* On April 15, 1974, the U.S. Bureau of Mines and the U.S. Geological Survey adopted as their recognized terminology for mineral resources the terms proven, probable, and possible. These correspond to the previous terms of measured, indicated and inferred.

The first Soviet system, introduced in 1927, identified measured, indicated, and inferred reserves by the same three classes but used the symbols A, B, and C. New Soviet classification systems were successively introduced in 1932, 1941, and 1953. In 1960 the terms A, B, C, and C_2 were established. This latest system is accepted as having the standing of law.

The classification of reserves under the different headings depends on:

- The reliability of the estimated reserves.
- The knowledge of the geological conditions of mineralization.

1. System Adopted by KECI and ACB

The system of the U.S. Bureau of Mines and the U.S. Geological Survey as adopted April 15, 1974, is used as the basis

*See Mining Engineering, July, 1975, pp. 74-78, which is included at the end of this section.

of the classification in this report. According to this classification, the definition of the three categories is as follows:

a. Possible Ore Reserves

Mineralized material, the dimensions and grade of which are based on geologic correlations between samples so widely spaced or so erratic that additional exploration is required to establish whether ore reserves are present.

b. Probable Ore Reserves

An ore reserve for which sufficient continuity of dimensions and grade can be assumed for preliminary financial planning, but for which the risk of failure in continuity is greater than for proven ore.

c. Proven Ore Reserves

Any ore reserve so extensively sampled that the tonnage, grade, geometry, and recoverability of the ore within the block or blocks of ground under consideration can be computed with sufficiency, so that the uncertainties involved would not be a factor in determining the positive feasibility of a mining operation. The degree of accuracy is estimated to be ± 20% by definition. In addition, proven ore reserves are classified into two types:

(1) Geologic Ore Reserves

These comprise reserves whose grade of valuable mineral content meets industrial use specifications and whose quantity, mode of occurrence, and other conditions made their presence indisputable.

(2) Mineable Ore Reserves

These are equal to the geologic reserves minus the overall losses as envisaged by the selected scheme of mining operations.

See Table 2-8.

TABLE 2-8

CLASSIFICATION OF ORE RESERVES

1903	U.S. Bureau of Mines 1974	Soc. Econ. Geol 1957		Soviet Union	GDMB 1959		International
		Reserves	Potential Mineral		Mineable Mineral	Potential Mineral	
Visible	Proven	Proved		A_1	Proved A	a	Visible
			Demonstrated	A_2	Probable B	b	
Probable	Probable	Probable		B			Probable
				C_1	Indicated C_1	C_1	
Possible	Possible	Possible	Inferred	C_2	Indicated C	C_2	Possible
						Prognostic d	

Proven : The tonnage is computed from its well-known dimensions and the grade determined from detailed sampling.

Probable: The tonnage is partly computed from measurements and partly deduced from projections for a reasonable distance according to the geological evidence.

Possible: The estimation is based on the broad knowledge of the geological character of the deposit.

A_1 : The contours of the deposit are known completely and so are the technological properties. Ready for exploitation.

A_2 : The contours are sufficiently exposed, the technological properties are known by large scale tests on typical deposits. The reserves allow the planning of exploitation.

B : The contours are approximately known and properties of the mineral are investigated by no more than a few tests. The reserves allow the elaboration of projects.

C_1 : The reserves are known from several exposures and deductions from the geological evidence. The general properties of the mineral are known from a few samples. Deposit allows investments for a research program.

C_2 : The reserves are inferred from geological conclusions. Geological and geophysical investigations can be started.

KAISER ENGINEERS

B. Estimated Geologic Ore Reserves

1. Quantity

a. Data

The basic data for ore reserves quantity estimations are as follows:

- The area of the mineral body in square meters.
- The thickness of the body in meters.
- The volume in cubic meters.
- The specific weight in tonnes per cubic meter.

b. Calculations

Ore areas are deliniated by:

- Natural boundaries.
- Estimated boundaries outlined by exploratory openings.
- Geologic interpretation by structure or exploration.

The ore reserves are calculated on the basis of their geometric area. The method of estimating the area is by planimeter measuring of most of the areas except pillars which are computed by means of a measuring grid drawn on a tracing paper ruled into squares. The grid is imposed on the plan and the number of squares inside the contour of the area of each pillar is counted for the area of each pillar. The areas of the pillars are added and subtracted from the total area, giving the net area.

The natural boundaries of each lease were shown to the field team by an SMC delegate. Reserves of the leases shown below do not include any material from the new exploration areas.

c. Thickness

Thickness is determined by direct measurement. Provided the measuring points are distributed, the average thickness of a deposit segment or block is determined by the arithmetic mean method.

In calculating the geologic reserves the mineable thickness is not considered.

d. Volume

By multiplying area in square meters by thickness in meters, the result in volume is cubic meters.

e. Specific Weight

For the calculation of the SMC manganese ore reserves, the applied average specific weight is 3 tonnes per cubic meter. The calculations by Demag in their ore reserves estimate used the same weight.

2. Quality

a. Method of Estimation

The quality of the proven ore reserves is based on the mean percentage of manganese and iron in each block and each mine. This figure can be derived by two methods, arithmetic and geometric.

If one sample represents the block, its analysis is considered to represent the block by both arithmetic and geometric methods.

If a block is represented by more than one sample, the mean percentage of manganese and iron is obtained as follows:

(1) Arithmetic Method

The manganese percentages of the samples are added together and then divided by the number of samples to obtain the mean arithmetic percentage of manganese and iron.

(2) Geometric Method

The thickness is multiplied by the percentage of manganese in the sample. The results of the multiplication of all the samples of the block are added together. They are then divided by the total thicknesses represented by samples to obtain the geometric mean percentage of manganese of the block. The same is done when obtaining the percentage of iron in the block. To calculate mean percentage of the mine, the tonnage of each block is multiplied by the mean percentage either for manganese or iron. These results are added, then divided by the total tonnage of the mine, to obtain the mean percentage of manganese and iron.

3. Estimated Total Ore Quantity

a. Ore Reserves

The total ore reserves as of June 1, 1980, are as follows:

Proven ore reserves	1,135,050	tonnes
Probable ore reserves	187,670	tonnes
Possible ore reserves	189,445	tonnes
	1,512,165	tonnes

b. Manganese Ore in Bunkers and Stockpiles

(1) At Abu Zeneima

Stockpile of fine manganese	166,754	tonnes
Ore in the main bunker	4,987	tonnes
Stockpile	4,020	tonnes
	175,761	tonnes

(2) At the Mine

Normal grade ore in bunkers	2,670	tonnes
Normal grade ore in stockpiles	22,028	tonnes
High grade ore in stockpiles	1,240	tonnes
Total	25,938	tonnes
Grand total	1,713,864	tonnes

c. Mineable Ore Reserves

(1) Underground Mines

The mining ore reserves are estimated to be 75% of the proven ore reserves, that is, 925,868 x.75 = 694,401 tonnes.

This takes into consideration the following factors:

1 - The method of mining which will be used.

2 - The method of supporting, which will be roof bolting.

TABLE 2-9

PROVEN ORE RESERVES

by KECI/ACB

X 100

			O.R.	Mineable O.R.	Cum Mn/Fe	Cum Mn	Cum Fe	Cum Tonnes
1.	Abu Thor/293	2.30	42672 u	32004	2.30	38.81	16.85	3200
2.	Lahian dump	2.18	98533	98533	2.21	35.85	16.20	1305
3.	Abu Thor/401-402	2.03	20475 u	15356	2.19	35.60	16.32	14589
4.	El Korba	1.84	2000	Nil				
5.	Nassib/312	1.83	3600	Nil				
6.	Area 45/292	1.77	16137 u	12102	2.16	35.32	16.37	15799
7.	Lahian/253	1.64	7812 o	7030	2.13	34.99	16.39	16502
8.	Om Sylat	1.32	54855 o	49369	1.89	34.09	18.02	21439
9.	Alluga	1.17	78520 u	58890	1.69	33.08	19.57	27328
10.	Abu Zarab	1.13	116370 u	90266	1.51	32.45	21.43	36355
11.	Abu Kafas	1.05	9293 u	6969	1.50	32.30	21.47	3705
12.	Lahian/256	1.02	24450 o	22005	1.47	32.16	21.90	3925
13.	El Ramsy	0.87	343071 u	267303	1.20	28.62	23.81	6498
14.	Abu Hamat Shemal	0.84	u 46794 u	35095	1.18	28.45	24.51	6849
15.	Area 8	0.81	160494 u	120370	1.11	28.03	25.28	8052
16.	Abu Hemat Yemin	0.62	106974	80230	1.05	27.54	26.28	8855
17.	Hill 5		3000	Nil				
			1,135,050	885,522				

3 - The hard dolomite roof of most of the manganese mines.

4 - A review of the existing old work.

(2) Open Pit Mines

The open pit mines are at Abu Zarab, Lahian, Lahian-Zobeir, and Om Sylat. These ore reserves total 110,649 tonnes. The mineable ore reserves for the open pit are estimated to be 90% of the proven reserves, that is, 110,649 x .90 = 99,584 tonnes.

(3) Previously Dumped Ore

There are 98,533 tonnes of ore in dumps at Lahian-Zobeir.

(4) Stockpiled and Bunker Ore

There are 201,699 tonnes of ore in stockpiles and bunkers.

(5) Summary

The total of the mineable ore reserves is as follows:

Underground ore reserves	694,401	tonnes
Open pit ore reserves	99,584	tonnes
Subtotal	793,985	
Previously dumped ore	98,533	tonnes
Subtotal	892,518	
Stockpiled and bunker ore	201,699	tonnes
Grand Total	1,094,217	tonnes

The following table shows the present reserve tonnages and manganese-to-iron ratios resulting from the current KECI/ACB field work. Out of the 27 manganese leases granted to SMC, 14 have been calculated as having 1,135,050 t of proven ore at a grade of 27.54% Mn and 26.28% Fe. This is a cumulative Mn/Fe ratio of 1.05:1. Converted to actual mineable reserves, this is 885,522 t, omitting 3 areas of very small tonnages. Mining at about 70,000 t/yr, this reserve will be exhausted in 12+ years, or typical of the case I example.

C. Mining Leases

1. El Ramsy - Lease 367

This area has no lease according to SMC letters of leases, but it is recorded in the SMC letter of ore reserve.

a. Location

It is to the north of Abu Thor, along Wadi Baba.

b. Topography

It is a relatively low-lying elongated hill along the eastern flanks of Wadi Baba.

c. Surface Area

Its surface area is 1300 x 500 meters.

d. Geology

At wadi floor, lower sandstones of the Adedia Formation outcrop, are overlain by the Om Bogma Formation and the upper sandstones of the Abu Zarab Formation. The hill is cut near its northern extremity by a fault running N 60° W, passing across Wadi Baba. Another fault plane running N 30° W, passes on the eastern side of the hill, where the ore horizon lies against basement rocks. Other small faults dissect the hill resulting in local minor displacements of the ore horizon.

e. Mode of Occurrence

The ore horizon is covered by the Abu Zarab Formation in the northern part of the hill, whereas to the south it is uncovered. The underground tunnels for ore development show that the ore bodies are highly differentiated into an inner richer zone and an outer ferruginous one.

f. Ore Reserves

No production has been made in this area. The total ore reserves are estimated at 419,112 tonnes as follows:

- Proven ore 343,071 tonnes
- Probable ore 76,041 tonnes

See figures at the end of this section for more details on ore reserves.

g. Transport and Haulage

The desert road to Ramsy bifurcates the Abu Zeneima/Wadi Nassib asphalt road at Dababat, then continues through Wadi Baba to Bir Rakaiz. It was decided to extend the bi-cable tramway for 2.5 kilometers from Abu Hamat Shemal to El Ramsy in order to accommodate the need for ore haulage. This was called leg 4.

2. El Alluga - Leases 353-354

a. Location

They are located on the western side of Wadi Nassib at its upper reaches.

b. Surface Area

- Lease 353 is 1100 x 550 meters.
- Lease 354 is 900 x 550 meters.

c. Topography

They are on relatively low-lying hills, except in the southern parts of the area which forms the northward continuation of the high topography of Abu Zarab.

d. Geology

The fault running through Wadi Nassib has a marked down-throw (about 100 m) to the west. On the eastern side of this fault plane the basement is covered by a thick succession of the Adedia Formation. On the western side only a part of this formation is visible overlain by the Om Bogma Formation and a part of the Abu Zarab Formation. It is only in the southern parts of the area that this latter formation is complete and is overlain by basalt sheets.

e. Mode of occurrence

The ore outcrops at three main locations. The northern location is a small faulted block along the floor of Wadi Nassib, with little overburden. Half a kilometer further south, the second occurrence is in a low lying hill, 20 to 30 m above wadi level, where the ore is covered by dolomitic rocks of Om Bogma Formation. At the southernmost occurrence the ore outcrops along the hillside, where it is overlain by Abu Zarab Formation and basalt sheets.

f. Ore Reserves

The total ore reserves are estimated at 102,048 tonnes as follows:

- Proven ore - 78,520 tonnes
- Probable ore - 4,251 tonnes
- Possible ore - 19,277 tonnes

See figures at the end of this section for more details on ore reserves.

g. Transport and Haulage

From Bir Nassib, 23 km of bad desert road passes along Wadi Nassib to El Alluga. Haulage was decided to be the extension of leg 3-c from Abu Zarab to Alluga.

3. Area 8 - Lease 288

a. Location

This lease is to the north of area 9 by about 800 meters and southwest of Abu Hamat Shemal.

b. Surface Area

Its surface area is 926.85 x 540 meters.

c. Topography

The relatively high-lying hill is bordered on the north and northeast by Wadi El Himera of El Dissa.

d. Geology

The floors of the Wadi bordering the higher topography are occupied by basement rock overlain by sandstones of the Adedia Formation which form the hill slopes. Rocks of the Om Bogma Formation outcrop along the hill slopes all around. These are overlain by sandstones of the Abu Zarab Formation. The area is cut by two main faults running roughly in a north-south direction. The western one cuts only the northern extremity of the area. On the other hand, the eastern one (N 15° W), with a down-throw of about 40 m on the western side, has a marked effect on the ore horizon.

e. Ore Occurrence

This area was one of the richest at Om Bogma and has been extensively ored and mined. The ore occurs in large, thick lenses bodies. Outcrops on the hillsides appear here and ther in a discontinuous but frequent manner. The ore was exploited by underground method.

f. Ore Reserves

The reserves still in the underground mine are estimated at 160,494 tonnes of proven ore. See figures at the end of this section for more details on ore reserves.

g. Transport and Haulage

The road from Bir Nassib to Om Bogma passes by the area. Ore haulage was by the main bi-cable tramway connection joining the area with the station at area 9 which acts as a transfer station.

4. Abu Thor - Leases 293-401-402

a. Location

These leases are to the north of Abu Zarab and west of Wadi Nassib.

b. Surface Area

- Lease 293 is 800 x 600 meters.
- Lease 401 is 170 x 100 meters.
- Lease 402 is 50 x 70 meters.

c. Topography

There is hilly country to the south and a flat plain to the north. The area is bordered by Wadi Abu Thor on the west and branches of Wadi Abu Hamat on the south.

d. Geology

The lower sandstones of Adedia Formation are overlain by the Om Bogma Formation and the Abu Zarab Formation. No major faults were detected in the area.

e. Mode of Occurrence

In the northern plain area, the ore outcrops on the surface and was open pit mined. To the south the ore outcrops along the hill slopes and was mined underground.

f. Ore Reserves

The total ore reserves are estimated at 85,317 tonnes as follows:

- Proven ore in lease 293 - 42,672 tonnes.
- Probable ore in lease 293 - 3,813 tonnes
- Proven ore in leases 401-401 - 20,475 tonnes.
- Probable ore in leases 401-402 - 18,357 tonnes.

See figures at the end of this section for more details on ore reserves.

g. Transport and Haulage

The area lies along the Bir Nassib/Om Bogma road. No ropeway legs connect the area with Om Bogma.

5. Abu Hamat Shemal - Leases 296-297

a. Location

These leases are to the northeast of area 8, and northwest of Abu Hamat Hemin.

b. Topography

They have a relatively high topography bound from the north, east, and southeast by Wadi Abu Hamat and from west by Wadi Hemera.

c. Surface Area

- Lease 296 is 470 x 500 meters.
- Lease 297 is 550 x 700 meters.

d. Geology

The wadi floors surrounding the area are occupied by basement rocks, overlain by the succession of Adedia Formation, Om Bogma Formation and Abu Zarab Formation. The southern parts are cut by a north-northwest to south-southeast fault with the downthrow on the eastern side.

e. Mode of Occurrence

Outcrops of the ore can be observed all around the hill as lensitic bodies separated by dolomite and ferruginous clays. It is only at a few sites that ore is covered by only a thin overburden of rocks belonging to Om Bogma Formation where mining was carried out in open pits, but now the remaining part of the area is pillars which will be exploited by underground method.

f. Ore Reserves

The area is exhausted and the remaining reserves are estimated at 71,523.6 tonnes as follows:

- Proven ore - 46,794 tonnes.
- Probable ore - 10,008 tonnes.
- Possible ore - 14,721.6 tonnes.

In block 8A the cross cuts were driven in the hanging wall and, because ore was exposed in some winzes across the adits, it is considered possible ore. Also, two tunnels around trangulation point M 68 contain some very low-grade ore with small thicknesses ranging rrom 0.02 meters to 0.40 meters, considered negligible reserves. See figures at the end of this section for more details on ore reserves.

g. Transport and Haulage

A special road joins the area with the main road of Bir Nassib/Om Bogma. Moreover, a leg of the main bi-cable tramway joins it with hill 8, then area 9 and area 10 of Om Bogma.

The area is considered to be the center for the bi-cable tramway. From this area a leg of the tramway was under construction to Abu Hamat Yemin, joining Abu Zarab and El Alluga. It was suggested that the other leg join El Ramsy.

The ore was hauled from working points to the bunker of the tramway by railway and locomotives.

6. Area 45 - Lease 292

a. Location

This area is to the southwest of Ras El Homarra and on the northern flanks of Wadi Shalal.

b. Topography

The ore occurs on the northern slopes of Wadi Shalal, at a relatively low height.

c. Surface Area

The surface area is 700 x 700 meters.

d. Geology

The floor of Wadi Shalal is occupied by sandstones of the Adedia Formation which outcrop for some meters along the northern hill slopes. Along Wadi Shalal and one of its branches (Himera of Shalal), the Om Bogma Formation outcrops above these lower sandstones and is overlain in turn by the upper sandstones of Abu Zarab Formation. Along Wadi Shalal, a fault plane running east-west, having its downthrow to the south, results in the outcropping of the Om Bogma Formation at wadi level.

e. Mode of Occurrence

The ore lenses crop out both on the southern and eastern slopes of the hill in discontinuous lensitic bodies. On the southern side of Wadi Shalal (on the southern downthrown block of fault plane) outcrops of ore appear just at the wadi level, overlain by upper sandstones.

f. Ore Reserves

The ore reserves in this area are estimated at 18, 321 tonnes. The breakdown is as follows:

- Proven ore - 16,137 tonnes
- Probable ore - 2,184 tonnes

See figures at the end of this section for more details on ore reserves.

g. Transport and Haulage

The road joining Depot 2 with Ras El Homarra and Om Bogma through Wadi Shalal passes the foot of the hill. A branch of this road joins the level of the ore horizon with that of the main road on the floor of Wadi Shalal.

The area was exploited by underground methods, and the ore of this area was used for sweetening the low grade ore of other mines.

7. Abu Hamat Yemin - Leases 291-300

a. Location

These leases are located to the east of Om Bogma area and to the west of Abu Zarab and Abu Thor.

b. Surface Area

- Lease 291 is 1000 x 700 meters.
- Lease 300 is 100 x 700 meters.

c. Topography

The area is bound on the west, north, and east by branches of Wadi Abu Hamat. The ore outcrops at more than 100 m above wadi level, and the hill forms a northwards protruding tongue more than a km long and 0.5 km wide.

d. Geology

A thick succession of sandstones, the lower Adedia Formation is overlain by the Om Bogma Formation including the ore horizon, followed by the upper sandstones of the Abu Zarab Formation. A major north-south fault borders the area on the east, with its downthrown side to the west.

e. Mode of Occurrence

The ore outcrops along the scarp faces of the hill on the west, north, and east. It forms a well defined horizon, though the ore outcrops in a discontinuous manner.

f. Ore Reserves

The area has been developed by tunnels and only limited extraction has been undertaken. The total ore reserves are estimated at 192,583 tonnes as follows:

- Proven ore - 106,974 tonnes.
- Probable ore - 45,531 tonnes.
- Possible ore - 40,078 tonnes.

See figures at the end of this section for more details on ore reserves.

g. Transport and Ore Haulage

The Abu Thor - Om Bogma road passes by the area of Abu Hamat Yemin. Haulage of ore was planned to be through the leg of the aerial ropeway to Abu Hamat Shemal and then to hill 8, area 9, area 10, and Om Bogma.

8. Abu Zarab - Leases 298-299

a. Location

These leases are to the south of Abu Thor and to the east of Abu Hamat Yemin.

b. Surface Area

- Lease 298 is 200 x 200 meters.
- Lease 299 is 300 x 600 meters.

c. Topography

This is an elevated area bordered on the west by Wadi Abu and on the north by the upper reaches of Wadi Abu Thor.

d. Geology

The wadi floor is occupied by the lower sandstones of the Adedia Formation, overlain by the Om Bogma Formation and the Abu Zarab Formation, which are followed upwards by basalt sheets. Two rather parallel faults border the area at the west. A horst uplifted block is included in between these two fault planes.

e. Mode of Occurrence

The ore outcrops along the western slopes of the area in a discontinuous manner, forming relatively big lenses.

f. Ore Reserves

The total ore reserves including the two leases are estimated at 183,708 tonnes as follows:

- Proven ore - 116,370 tonnes.
- Probable ore - 14,940 tonnes.
- Possible ore - 52,398 tonnes.

The quantity of the ore in block 4 was not reviewed due to the collapse blocking the entrances and, therefore, should be considered possible ore.

See the figures at the end of this section for more details on ore reserves.

g. Transport and Ore Haulage

The area of Abu Zarab is connected by a desert track which connects with the Abu Thor - Om Bogma road. Previous planning was to connect the area by aerial tramway leg 3-b to Abu Hamat Yemin. There exists an old jigback cableway to get the ore from the open pit to the wadi floor. From the wadi it would go by truck-car to Abu Zeneima.

9. El Korba - Lease 294

a. Location

It is located to the east of Wadi Beida and to the west of Abu Hamat Yemin.

b. Surface Area

The surface area is 500 x 300 meters.

c. Topography

The hill forms a small northward protrusion bounded on the north and east by Wadi Abu Hamat and on the west by Wadi Beida. At Abu Hamat the ore horizon is some 100 meters above the level of Wadi Abu Hamat.

d. Geology

The geology is the same as for Abu Hamat Yemin. The Adedia Formation is overlying by the Om Bogma and Abu Zarab Formations. On the western side the hill is bordered by a fault plane running north-south with the downthrow toward the east. The block including Abu Hamat and El Korba is a down-faulted graben area.

e. Mode of Occurrence

The ore outcrops on the hill slopes are only at a few locations.

f. Ore Reserves

Total ore reserves are 2500 tonnes as follows:

- Proven ore - 2000 tonnes.
- Probable ore - 500 tonnes.

g. Transport and Haulage

The Abu Thor - Om Bogma road passes by the area. This road is the only way for both transport and ore haulage to the area 8 bunker.

10. Abu Kafas - Leases 266-267

a. Location

These leases are to the south of Wadi Shalal and north of Wadi Budra.

b. Surface

- Lease 266 is 350 x 700 meters.
- Lease 267 is 700 x 600 meters.

c. Topography

This is a relatively low to moderate lying hilly area bordered on the north by Wadi Om Tmayim.

d. Geology

The lower sandstones of Adedia Formation are overlain by the Om Bogma Formation which is reduced to 8 to 10 meters of ferruginous shale and marly dolomite with ore lenses. This formation is overlain by the upper sandstones of the Abu Zarab Formation.

e. Mode of Occurrence

The ore occurs either on the surface with only a thin cover of shales and marly dolomites, or along the hill slopes covered by Abu Zarab sandstones. Along Wadi Shalal, a fault has lowered the ore horizon to the Wadi level.

f. Ore Reserves

The total ore reserves are 35,093 tonnes as follows:

- Proven ore - 9,293 tonnes
- Probable ore - 1,302 tonnes.
- Possible ore - 24,498 tonnes.

See figures at the end of this section for more details on ore reserves.

g. Transport and Haulage

The road from Depot station 2 to area 45 passes by the western extremity of the area. A branch road joins the various locations with this main road, making trucks the best transport method.

11. Lahian - Long Hill - Lease 253

a. Location

This lease is to the east of Bir Nassib, south of Zobeir - Lahian (V-shaped), and northeast of El Alluga. It is known as the long hill.

b. Topography

This is a topographic high, limited from the east and northeast by Wadi Lahian and from the west by Wadi Nassib.

c. Surface Area

The surface area is 850 x 350 meters.

d. Geology

The basement rocks forming the floors of Wadi Nassib and Wadi Lahian are overlain by the sandstones of the Adedia Formation. The latter are locally covered by patches of rocks belonging to Om Bogma Formation (including the ore horizon.) From the east, along Wadi Lahian the area is bordered by a north-south fault with the downthrow on the western side. The northwest-southeast fault passing along Wadi Nassib borders the area in the west. The area was worked by open pit method.

e. Mode of Occurrence

The relatively small patches of Om Bogma Formation lying on the top of the topographic high enclose ore lenses of variable sizes covered by only a few meters of overburden.

f. Ore Reserves

The reserves are estimated at 7,812 tonnes of proven ore. This ore will increase with the prospection of the continuity of the hill. This ore was used as sweetener ore.

See figures at the end of this section for more details on ore reserves.

g. Transport and Ore Haulage

The area is connected by two roads, one passing along Wadi Nassib and the other along Wadi Lahian. However, no roads go up the hill and ore haulage was affected by means of a double drum bi-cable to Wadi Lahian and Wadi Nassib where it was stockpiled. With trucks the ore was transported from the stockpiles to Abu Zeneima.

12. Om Sylat (El Hessenia) - Lease 311

a. Location

This lease is two kilometers to the west of Sheikh Hashash, on the western flanks of Wadi Saaho, south of Hill 5.

b. Surface Area

The surface area is 500 x 1000 meters.

c. Topography

The topography is in two main parts:

- An eastern downthrown block a few meters higher than the level of Wadi Saaho, forming a protrusion into Wadi Saaho.

- A western upthrown block forming a high summit called Gebel Om Sylat.

d. Geology

The downthrown block begins with a few meters of lower sandstone covered by the ore-dolomite horizon. The latter is overlain by the upper sandstone toward the south with a gradually increasing thickness. A major fault plane trending north-northwest to south-southeast (N 20° W), with a downthrow of about 150 meters, separates the upthrown and the downthrown blocks.

In the upthrown block, a few meters of basement are exposed at the hill foot, covered by some 120 meters of lower sandstone. The dolomite (with ore) forms the summit plateau.

e. Mode of Occurrence

In the downthrown block, the ore bodies are well exposed and frequently form small outliers. Outcrops of ore are indicated on both the eastern and western sides of the low hill (15 meters from wadi level). Toward the south and southeast, the ore is covered by a small overburden of thinly bedded dolomite and then by upper sandstone. On the eastern side of the hill, the ore outcrops

at two sites, with a thickness of about two meters and extension of 50 meters. A vertical shaft near the northern-most extremity cuts across ore. On the western side, the ore outcrops for about 70 meters, with three local thickenings. At the northern site of opencast extraction, the ore thickness reaches 7 meters, while to the south it is reduced to 3 meters. Here, an inclined shaft is driven in the ore horizon.

In the upthrown block, the ore occurs at the hilltop overlain only by a few meters of dolomite. The ore bodies vary in thickness from 1 to 3 meters, with a thin intercalation of a red sandy shale band (maximum 1 meter thick). This intercalation is best developed in the opencast face on the western edge of the hill. The ore shows a tendency to uniform spreading and a differentiation between manganese and iron minerals. Thus, small high-grade bodies of manganese oxides (commonly pyrolusite) are interbedded in a more ferruginous ore material. Toward the southern extremity of the hill, the ore horizon is highly affected by erosion, and only the ore below the shale intercalation persists (either as outliers or floats), while that above the intercalations is completely missing.

In addition, there are indications of the presence of ore as a continuation of the down-faulted block running southeast and east. Similarly, ore indications have been observed in a peak to the south of the main Om Sylat hill, from which it is separated by a small fault plane trending east-northeast to west-southwest. Here, an occurrence of some 10 meters extension and 3 meters thickness outcrops on the southern slopes. Both these two sites of ore indications have to be more thoroughly explored.

Along the main fault plane separating the Om Sylat hill from the ore near the wadi level, small dislocated bodies of ore are observed, but with no extension on either side.

f. <u>Ore Reserves</u>

The estimated ore reserves for the whole area comprise:

- Proven ore - 54,855 tonnes.
- Probable ore - 10,743 tonnes.
- Possible ore - 34,573 tonnes.

But there are many stockpiles of low-grade and medium-grade ore due to the selection of the dioxide manganese, which was worked before at the period of Labib Nissim.

See figures at the end of this section for more details on ore reserves.

g. Mining

The opencast method of mining has been used, and is the most suitable for both the upthrown and downthrown blocks, since the overburden is relatively thin in almost all cases. But for the downthrown block, in future operation a part of it will be open cast, while the other will be underground for the thick overburden.

h. Transport and Haulage

The down faulted block is easily accessible from Wadi Saaho, whereas the summit is connected to the wadi by a drum ropeway starting from the northern edge. The transportation will be done by trucks, so the company must repair the road of Shalal because it is the most suitable road and the shortest one.

There is also another road between Wadi El Saaho and area 9, but this road is not in use because of the war. If it is used, the ore can be transported by truck to the bunker of area 9.

13. Lahian-Zobeir (V-Shaped hill) - Lease 256

a. Location

This lease is to the south of Om Rinna, bordered from the east by Wadi Zobeir, from the west by Wadi Lahian, and from the north by Wadi El Sih.

b. Surface Area

The surface area is 400 x 400 meters.

c. Topography

The area is formed of two elongated hills joined from the south to form a V-shape, with eastern (Zobeir) and western (Lahian) wings. The two wings are separated by a small north running khor. A small separate summit is found to the south of the V-shaped hill.

d. Geology

Basement rocks from the lower parts of the area are overlain by a lower sandstone succession. The top of the V-shaped hill and the small separate summit are covered by a few meters of dolomitic rocks and ore. From the east the area is bordered by the major Lahian fault which runs basically north to south.

e. Mode of Occurrence

Ore bodies are found at many sites, sometimes covered by a few meters of dolomitic and shaley rocks or with no overburden. The thickness of ore varies from one to four meters, and the lenses tend to be flattened, i.e., ore tends to be stratiform. Pisolitic, reniform structures are predominant, while oolites are frequent. Few samples give the impression of coral reef structures pseudomorphosed by ore minerals, particularly in the western wing (Lahian hill). Yet such reefal structures are not as well developed as at Om Rinna. Concretions and bombs of variable sizes formed principally of pyrolusite are very common, causing surrounding ore to be more ferruginous than elsewhere.

f. Ore Reserves

There are 24,450 tonnes of proven ore but there are stockpiles due to the exploitation of dioxide ore, stockpiles of medium and low-grade ore, total about 98,533 tonnes. More accurate reserve figures will be available after further exploration.

See figures at the end of this section for more details on ore reserves.

g. Mining

In the western wing there is an open pit which was undergoing extraction and several sites with small-scale workings. The ore in the eastern wing was exploited for dioxide only, leaving medium-grade ore as waste. All work was by open cast method.

h. Transport and Haulage

The ore from the western wing was hauled downhill by a drum ropeway to Wadi Lahian. Two ropeways were installed at Wadi Zobeir for the ore from the eastern wing. From both wadis a short distance (maximum 4 km) connects to the asphaltic road of Abu Zeneima and Abu Thor at Diret El Nasb. Trucks can be used for transportation of ore.

14. Gebel Om Rinna - Lease 368

a. Location

This lease is two km north of the V-shaped hill, about five km northeast of Bir Nassib, 8.5 km from the entrance of the main asphalt road, and about 45 km from Abu Zeneima.

b. Surface Area

The surface area is about two square km. However, the lease had been cancelled.

c. Topography

This is a relatively high plateau divided into two main parts. The western part is lower in elevation than the eastern one.

d. Geologic Setting

Basement rocks at the foot of the hill, particularly exposed along Wadi Om Rinna, are overlain by lower sandstone. The hilltops are covered by dolomite and ore forms the plateau cap. Toward the north, the area is limited by a fault plane trending roughly east to west, and the capping dolomite to the south passes into upper sandstone toward the north. A major fault plane passing along Wadi Om Rinna (a continuation of the Lahian fault) separates the eastern topographically higher upthrown block from the lower western downthrown part. This fault trends north-northwest to south-southeast with a downthrow of about 70 meters.

e. Mode of Occurrence

The ore horizon is infrequently exposed at the surface, usually covered by a few meters of dolomite (maximum 5.0 meters). The outcrops of ore appear sporadically along relatively long distances and are thus well extending particularly in a northeast to southwest trend.

In the downthrown block, the ore which has been partially extracted is covered by few meters of dolomite but is also sometimes exposed on the surface. In the upthrown block, natural outcrops of a 2-meter average thickness are seen at several sites below the dolomite cover. Along the east-west fault, and at some 1.5 km to the west of the main upthrown mineralized area, an ore bed 1.3 meters thick (sample 133) is shown to extend for 50 meters along a gentle slope to the south of the upper sandstone hill.

Whether this occurrence covered by a thin layer of erosion debris continues farther northwards below the sandstone cover or stops against the fault plane is not clear. Further exploration work may provide a satisfactory answer.

f. Ore Reserves

In the downthrown site, reserves are estimated at 7,500 tonnes of probable and 10,000 tonnes of possible ore. More prospection and development can prove additional reserves and assure those already known.

In the upthrown part, there are believed to be 150,000 tonnes of possible reserves on the basis of the information supplied by existing exposures. An accurate calculation will be possible after exploration program and topographic surveying.

g. Mining

Previous mining in the downthrown block was by the open-cast method. No mining was undertaken in the upthrown block, but there was work in the float at the western part of the upthrown block near the fault.

h. Transport and Haulage

Transport and haulage from the whole area is feasible using the truck road that starts from the upper reaches of Wadi El Khefi. This road, accessible for trucks carrying 20 tonnes of ore or more, is connected with the asphalt road of Abu Zeneima via Wadi Nassib. There was no program to connect this area to the bi-cable way.

15. Hill 5 - Lease 285

a. Location

This area is to the south of area 9 of Om Bogma and to the east of area 10.

b. Surface Area

The surface area is 700 x 1000 meters.

c. Topography

The lease is on an elevated hill above the level of area 9.

d. Geology

A major fault running north-northwest to south-southeast has its downthrown side to the west. The ore of Hill 5 lies on the upthrown eastern side of this fault plane. The lower sandstones of the Adedia Formation are overlain by the Om Bogma Formation and then by the Abu Zarab Formation. The Om Bogma Formation is reduced to 5 to 7 meters of highly contorted ferruginous siltstones and calcareous shales, including the ore lenses.

e. Mode of Occurrence

Ore occurs both on the surface, where it was mined by opencast method, as well as along the hill slopes where it was extracted from underground tunnels. In these tunnels the ore is cut at the west by the major fault plane. It seems, then, that no extension of ore should be expected in this direction.

f. Ore Reserves

The reserves are estimated at 3000 tonnes of proven ore. This ore may be exploited by the underground method because opencase mining has already reached high overburden.

g. Transport and Haulage

The ore is transported by railway cars to the bunker. From there it is carried by bi-cable tramway with one carriage on each cable. The ore is discharged on a bunker at area 9. From these the ore is transported by railway cars and locomotive to bunker no. 9 and then to depot 2 by the main bi-cable tramway.

16. Om Ratam (El Saaho) - Lease 265

a. Location

This lease is to the southwest of the junction of Wadi Om Ratam and Wadi Saaho, about 1 km to the northwest of the northern hill of Adedia.

b. Surface Area

The surface area is 468 x 1000 meters.

c. Topography

The area is bounded by Wadi Saaho to the north and Wadi Om Ratam to the east, and is formed by a relatively high hill.

d. Geologic Setting

Two main faults intersect with each other, one running northeast to southwest with the downthrow in the northwestern side, and the other running northwest to southeast with the downthrow on the northeast side; as a result, the ore-bearing horizon occurs only in the two western blocks. In the northern block a few meters of the lower sandstone crop out. The sandstone is covered by the ore-horizon, then by the upper sandstone, and finally a basalt sheet. In the southern block a few meters of basement rocks crop out. These rocks are overlain by a thick succession of lower sandstone, followed by the ore horizon and a small thickness of upper sandstone. In the two eastern blocks only basement rocks and overlying lower sandstone outcrop, while the ore horizon is completely absent.

The general dip in the area is about 10° toward the northeast.

e. Mode of Occurrence

On the northwestern block the ore occurs in the form of lensitic bodies, forming a discontinuous outcropping bed on the hillside about 20 to 60 meters above the wadi level. The outcrops appear for about ½ km and vary in thickness from 1.5 to 3 meters. The ore is found in a sandy-silty horizon and dolomitic rocks are completely lacking. In the thicker parts of the ore, a silty intercalation of about 50 cm separates an upper and a lower ore "bed."

In the southwestern block the ore occurs in a silty-dolomitic horizon intercalated between the lower and the upper sandstone successions. The dolomitic bands overlying the ore are thin-bedded and silty, with shale and siltstone bands alternating between them. The ore horizon outcrops in two main sites. The first is along the southern slopes of the hill covered by basalt. The second is on both the northern and southern slopes of the L-shaped hill covered by upper sandstone. These two occurrences are separated from each other by an east to west fault which follows the course of Wadi Talet-El Zarqa. Six to seven main lensitic bodies are apparent on these outcrops. The ore thickness is 2 to 3 meters.

f. Ore Reserves

Based on the exposure outcrops, there is an estimated 250,000 tonnes of possible ore reserves. This estimate will be verified after prospecting is completed.

g. Mining

Due to overburden thickness, the underground mining method may be used.

h. Transport and Haulage

The ore from the northern block is about 3 meters higher than the wadi level, and hence can be transported along Wadi Saaho. Since the difference in level between the outcrop of the southern block and the Wadi Om Ratam level is about 10 meters, it can be hauled through a main tunnel which enters at Wadi Om Ratam. The outcrop can be used as a bunker for loading trucks. The ore can be transported to Abu Zeneima by trucks through the Wadi El Saaho after the El Shalal road is repaired; the ore can also be transported to the area 9 bunker of the bi-cable way after the hill road is continued.

i. Comments

The El Shalal road must be repaired and the hill road between area 9 and Wadi El Saaho must be continued.

17. Wadi Nassib - Lease 312

a. Location

This area is to the west of El Alluga, southwest of Bir Nassib and northeast of Abu Thor. It can be considered the continuation of the Abu Thor area.

b. Topography

The lease is a low topography area with a plain surface and low hillocks.

c. Surface Area

The surface area is 800 x 800 meters.

d. Geology

The area is covered mainly by the Om Bogma Formation, and is locally covered by a small thickness of Abu Zarab Formation. No important fault planes were detected in the area.

e. Mode of Occurrence

The main bulk of the ore occurs on the plain surface and extends below the local patchy covers of Om Bogma Formation and Abu Zarab sandstones.

f. Ore Reserves

Despite the previous open cast mining of the ore, reserves are estimated at 7,500 tonnes as follows:

- Proven ore - 3600 tonnes.
- Possible ore - 3900 tonnes.

See figures at the end of this section for more details on ore reserves.

g. Transport and Haulage

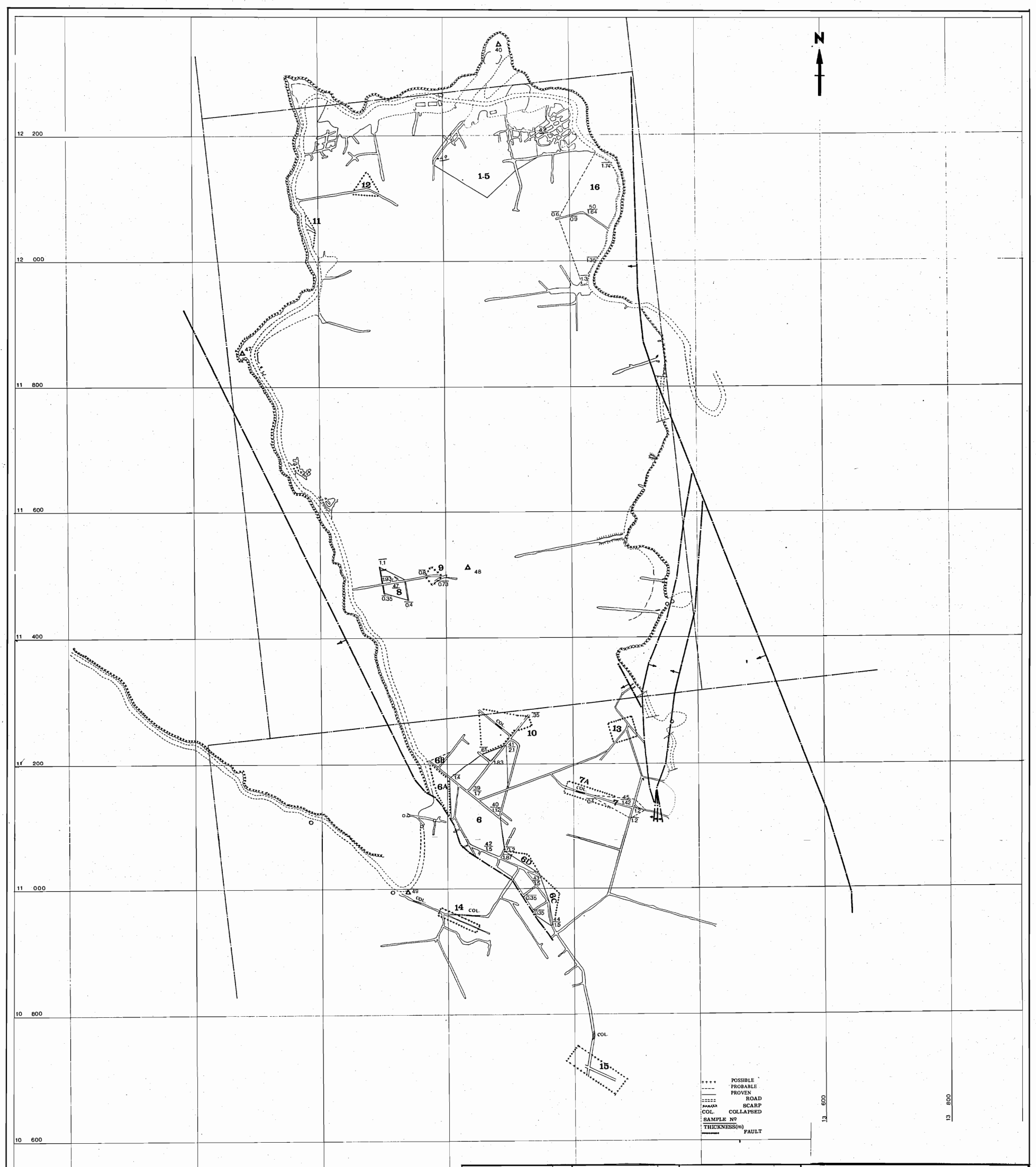
The area is connected with the Bir Nassib - Om Bogma road by a smaller road. Another road connects the area with El Alluga. The low relief topography facilitates ore haulage along this road, so trucks were used to transpor the ore.

18. Mining Leases - Drawings

The following drawings are presented immediately after this list:

Mining Lease		Drawing Number
Abu Hamat Yemin, 291-300	1:2000	102-G
Abu Hamat Yemin, 300	1:500	103-G
El Alluga 353-354	1:2000	104-G
El Alluga 1, 353-354A	1:500	105-1-G
El Alluga 2, 353-354A	1:500	105-2-G
El Alluga 3, 353-354A	1:500	105-3-G
El Alluga 1, 353-354B	1:500	106-1-G
El Alluga 2, 353-354B	1:500	106-2-G
El Alluga 3, 353-354B	1:500	106-3-G
Abu Thor, 393	1:2000	107-G
Abu Thor, 401-402	1:2000	108-G
Abu Kafas 1, 266-267	1:2000	109-1-G
Abu Kafas 2, 266-267	1:2000	109-2-G
Abu Kafas 3, 266-267	1:2000	109-3-G
Abu Kafas 4, 266-267	1:2000	109-4-G
Abu Zarab, 298-299	1:2000	110-G
Abu Zarab, 298	1:500	111-G
Abu Zarab 1, 298	1:500	111-1-G
Abu Zarab 2, 298	1:500	111-2-G
Abu Zarab 3, 298	1:500	111-3-G

Mining Lease		Drawing Number
Abu Zarab 4, 298	1:500	111-4-G
Abu Zarab 5, 298	1:500	111-5-G
Abu Zarab 6, 298	1:500	111-6-G
Abu Zarab 7, 298	1:500	111-7-G
Abu Zarab 8, 298	1:500	111-8-G
Abu Zarab, 299	1:500	112-G
Lahian- Zobier, 256	1:500	113-G
Lahian-Zobeir 1, 256	1:500	114-1-G
Lahian-Zobier 2, 256	1:500	114-2-G
Lahian-Zobier 3, 256	1:500	114-3-G
Om Ratam, 265	1:1000	115-G
El Hessenia 1, 311	1:500	116-1-G
El Hessenia 2, 311	1:500	116-2-G
El Hessenia 3, 311	1:500	116-3-G
El Hessenia 4, 311	1:500	116-4-G
El Hessenia 5, 311	1:500	116-5-G
El Hessenia 6, 311	1:500	116-6-G
El Ramsy, 367	1:2000	117-G
Area 8, 288	1:500	118-G
Abu Hamal Shemal, 296-297	1:2000	119-G
Abu Hamal Shemal, 296-297	1:500	120-G
Lihian 1, 253	1:500	121-1-G
Lihian 2, 253	1:500	121-2-G
Area 45, 292	1:2000	122-G
Wadi Nassib 1, 312	1:500	123-1-G
Wadi Nassib 2, 312	1:500	123-2-G
Wadi Nassib 3, 312	1:500	123-3-G
Wadi Nassib 4, 312	1:500	123-4-G
Wadi Nassib 5, 312	1:500	123-5-G
El Himera	1:1000	124-G
Area A	1:5000	125-G
Area B	1:5000	126-G
Key Survey Map	1:500	127-G



APPROVAL	DATE	SCALE: 1 : 2000	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. IN ASSOCIATION WITH ARAB CONSULTING BUREAU
	Aug 25'82	DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		DRAWN BY		DWG. No. 102 - G	
		CHECKED BY F.A. Owaida	Aug 25'82	REVISION R-	ABU HAMAT YEMIN M. L. 291 - 300
		APPROVED BY			
		APPROVED BY			

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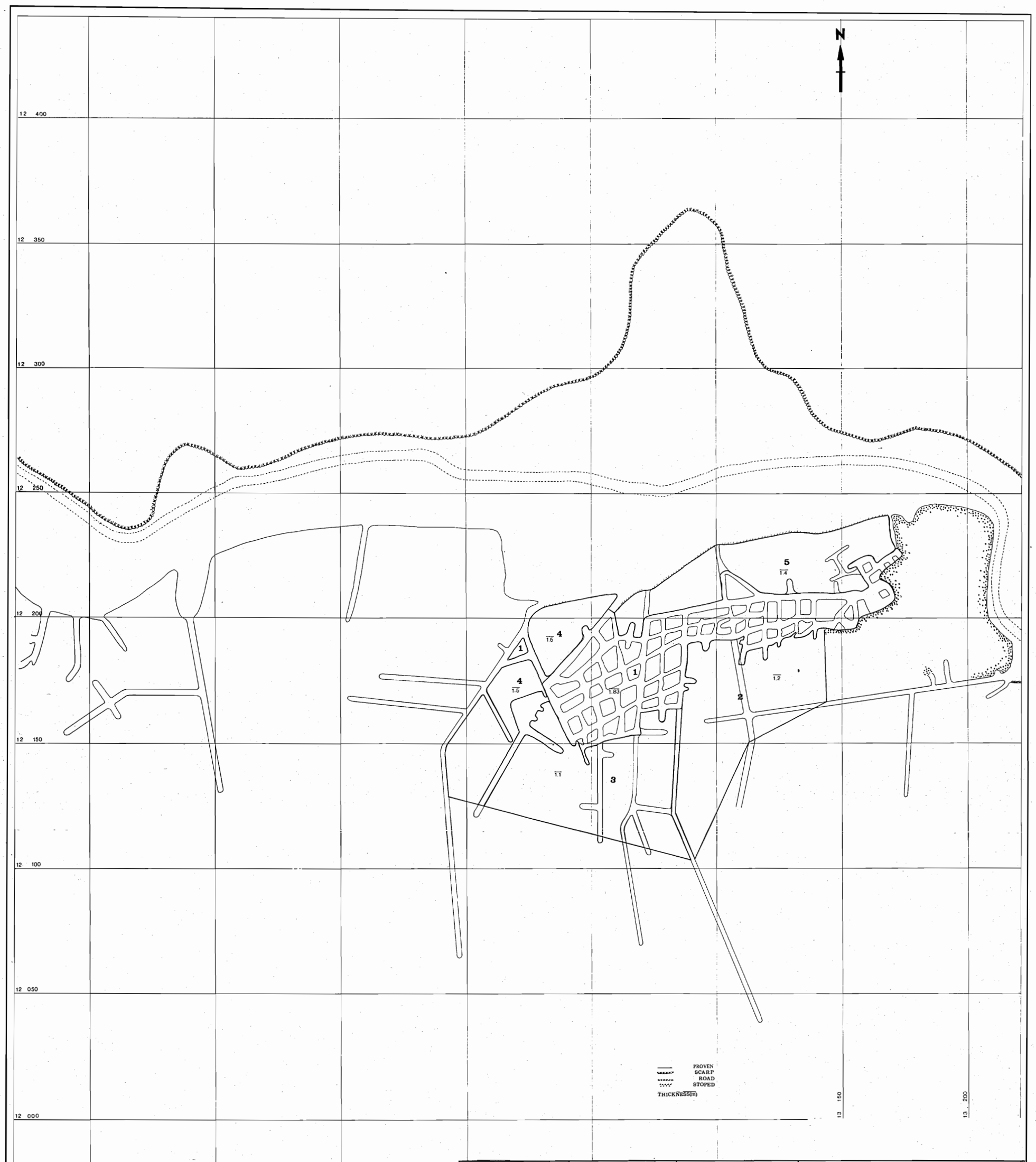

APPROVAL	DATE	SCALE: 1:500	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. IN ASSOCIATION WITH ARAB CONSULTING BUREAU
		DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		DRAWN BY		DWG. No. 103 - G	ABU HAMAT YEMIN M. L. 300
		CHECKED BY F. A. Amado		REVISION R-	
		APPROVED BY			
		APPROVED BY			

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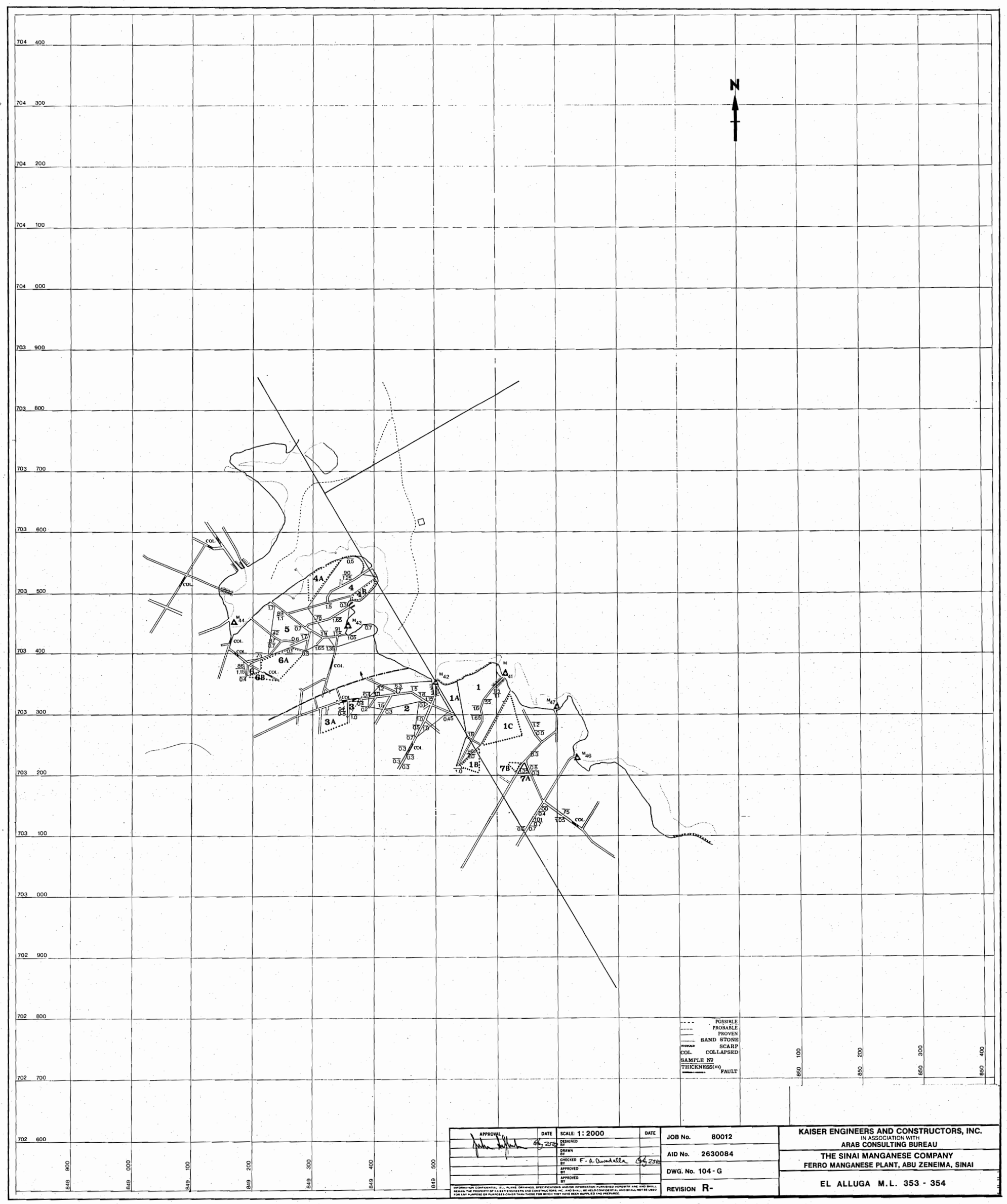

APPROVAL	DATE	SCALE: 1: 2000	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. IN ASSOCIATION WITH ARAB CONSULTING BUREAU
		DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		DRAWN BY		DWG. No. 104 - G	EL ALLUGA M.L. 353 - 354
		CHECKED BY F. A. Quadella		REVISION R-	
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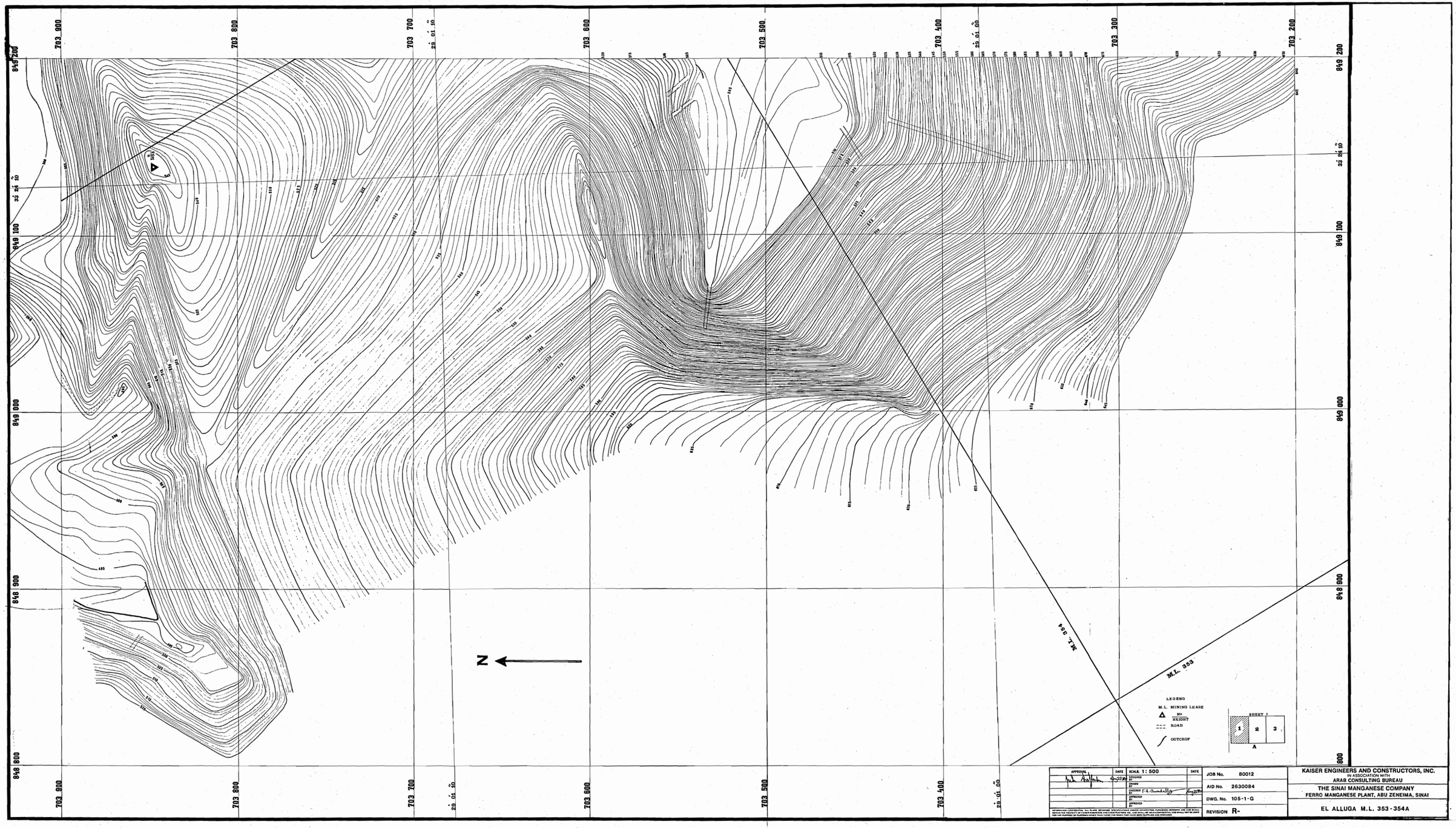
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848 800
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M.L. 354
M.L. 353
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M.L. MINING LEASE
NO HEIGHT
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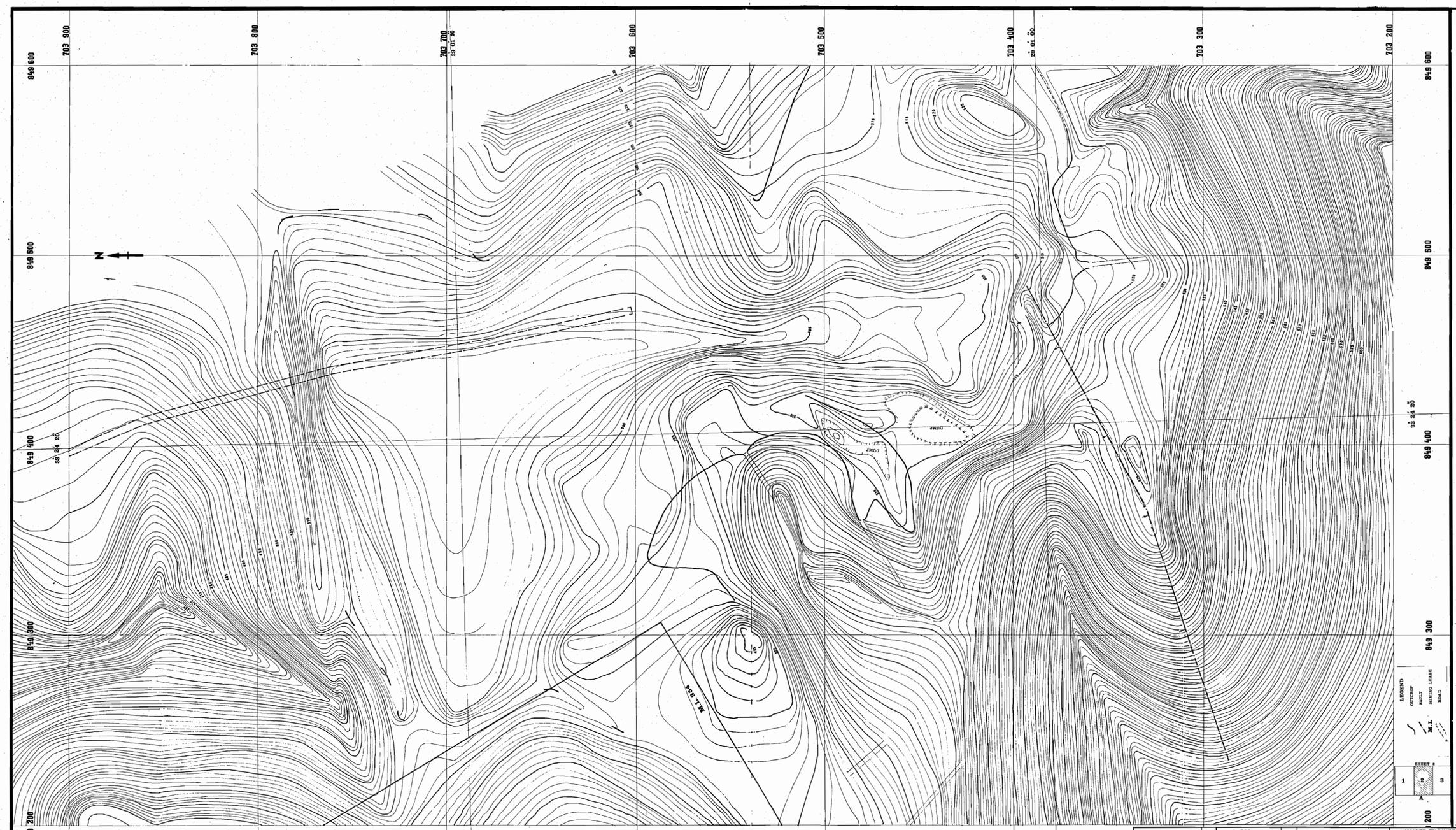
JOB No. 80012
AID No. 2630084
DWG. No. 105-1-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
EL ALLUGA M.L. 353-354A



APPROVED	DATE	SCALE 1:500	DATE
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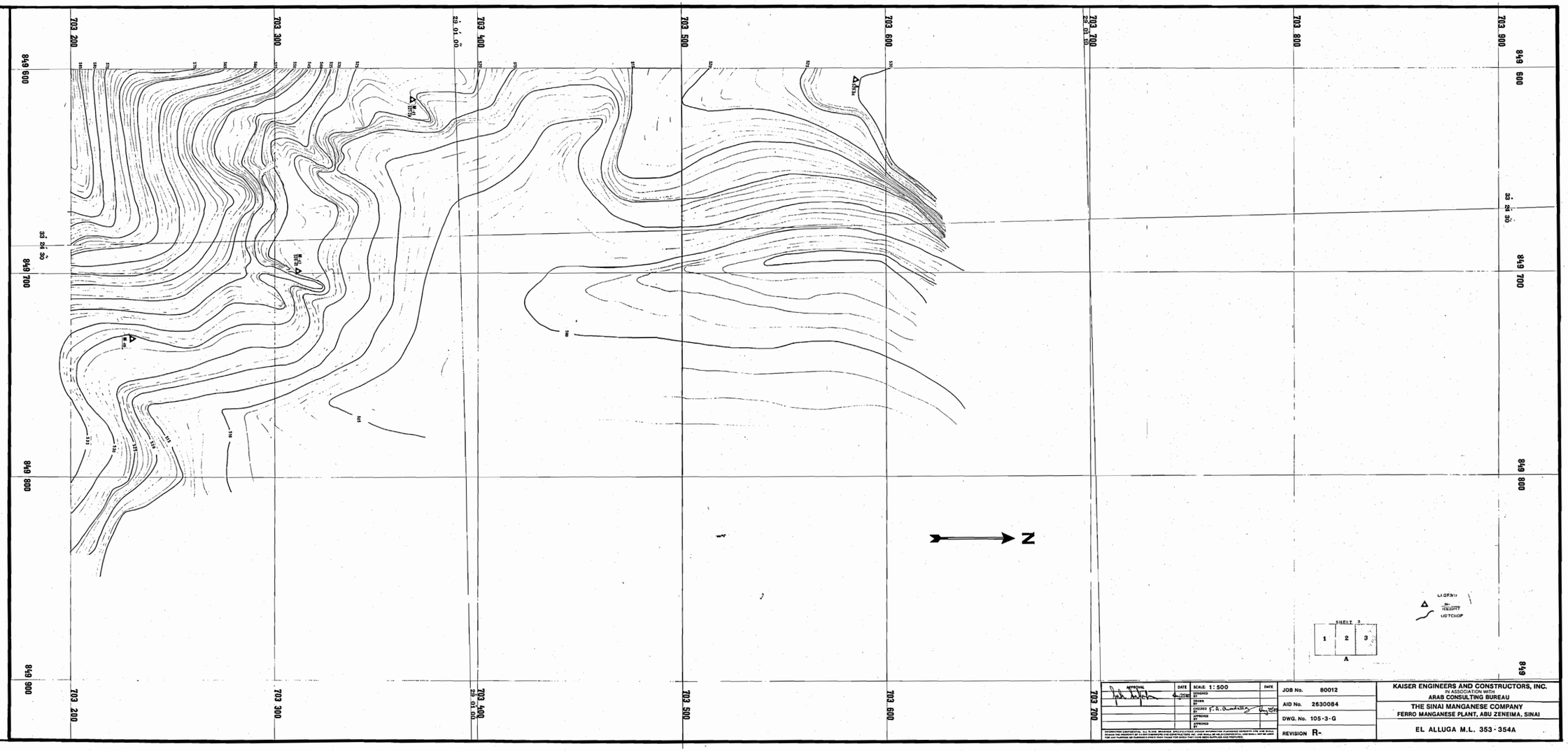
JOB No.	80012
AID No.	2630084
DWG. No.	105-2-G
REVISION	R-

KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI

EL ALLUGA M.L. 353-354A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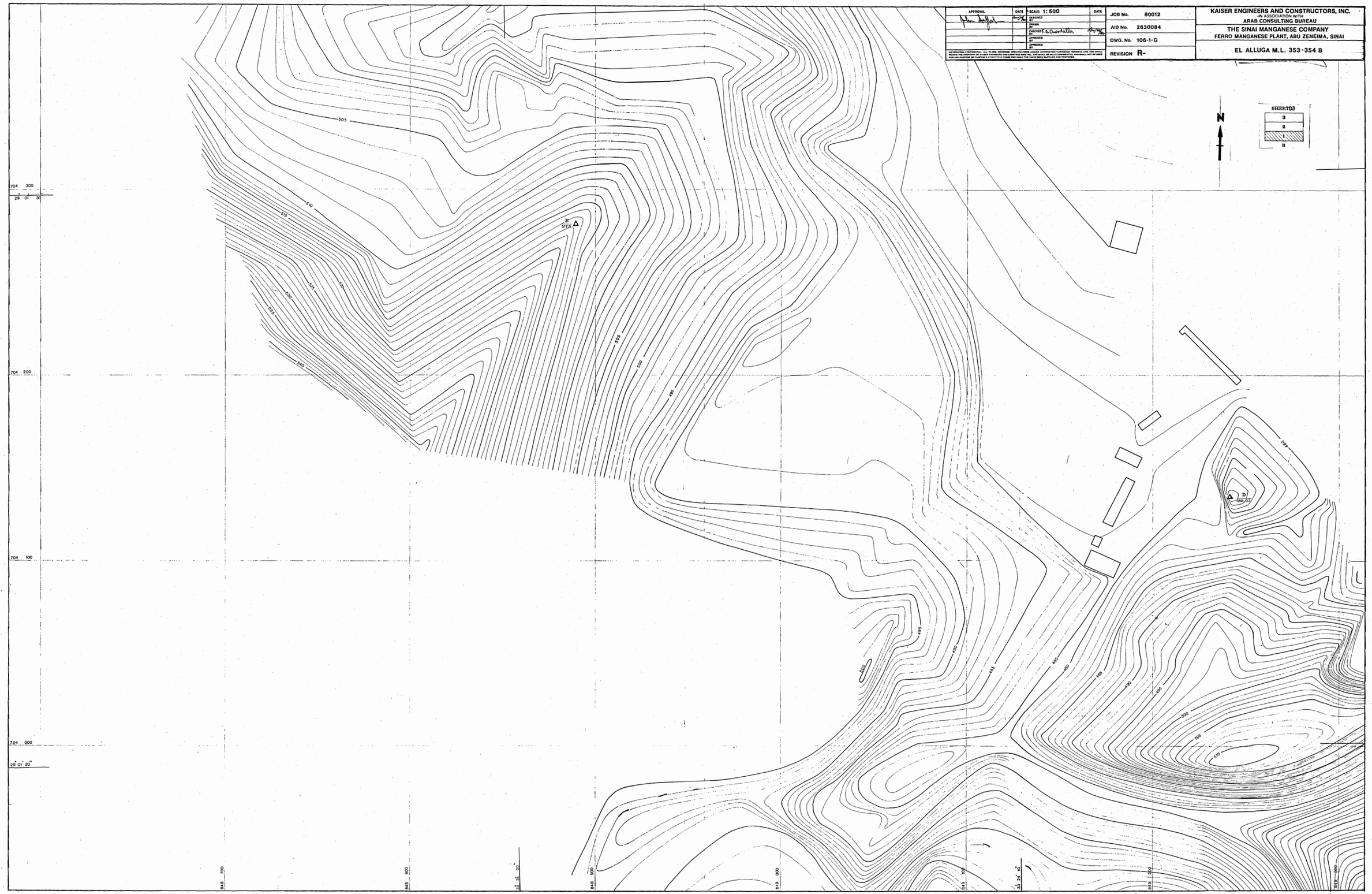
JOB No. 80012
AID No. 2630084
DWG. No. 105-3-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
EL ALLUGA M.L. 353-354A

APPROVAL	DATE	SCALE: 1:500	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. -IN ASSOCIATION WITH ARAB CONSULTING BUREAU
		DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		DRAWN BY		DWG. No. 106-1-G	EL ALLUGA M.L. 353-354 B
		CHECKED		REVISION R-	
		APPROVED BY			
		APPROVED BY			

INFORMATION CONFIDENTIAL: ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE THE SOLE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS, INC. AND ARE TO BE RETURNED UPON REQUEST. THEY SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PROVIDED.



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SCALE 1:500
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DESIGNED BY
DRAWN BY
CHECKED BY
APPROVED BY
APPROVED BY
JOB No. 80012
AID No. 2630084
DWG. No. 106-2-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
EL ALLUGA M.L. 353 - 354 B

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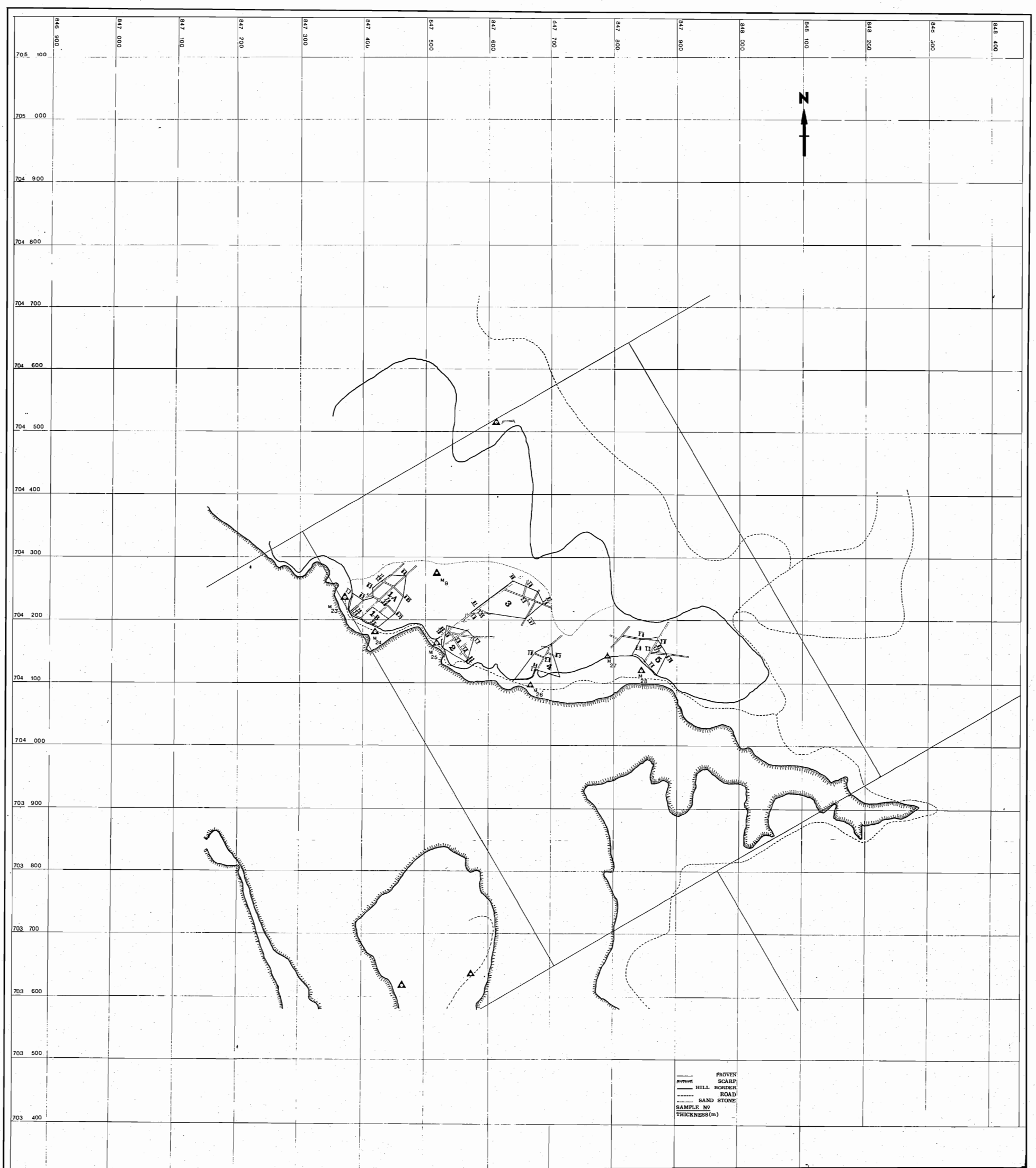
DATE
SCALE: 1:500
DATE
DESIGNED
DRAWN
CHECKED
APPROVED
JOB No. 80012
AID No. 2630084
DWG. No. 106-3-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
EL ALLUGA M.L. 353-354 B



APPROVAL	DATE	SCALE: 1:2000	DATE
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		APPROVED BY	
		APPROVED BY	

INFORMATION CONFIDENTIAL. ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PREPARED.

JOB No. 80012

AID No. 2630084

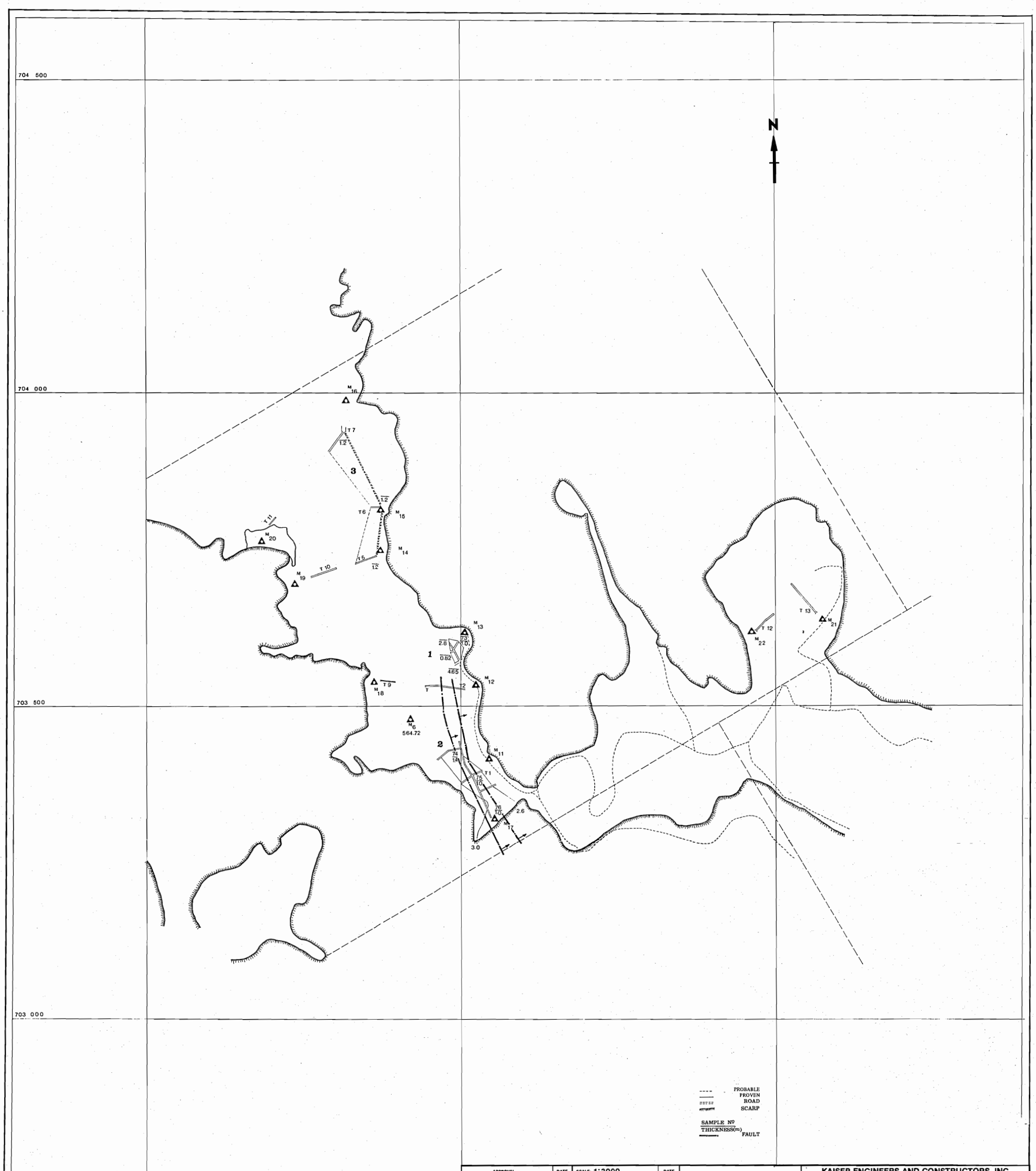
DWG. No. 107-G

REVISION R-

KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU

THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI

ABU THOR. M.L. 293



APPROVAL	DATE	SCALE: 1:2000	DATE
	Aug 27/80	DESIGNED BY	
		DRAWN BY	
		CHECKED BY	Aug 27/80
		APPROVED BY	
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INFORMATION CONFIDENTIAL. ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS, INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PREPARED.

JOB No. 80012

AID No. 2630084

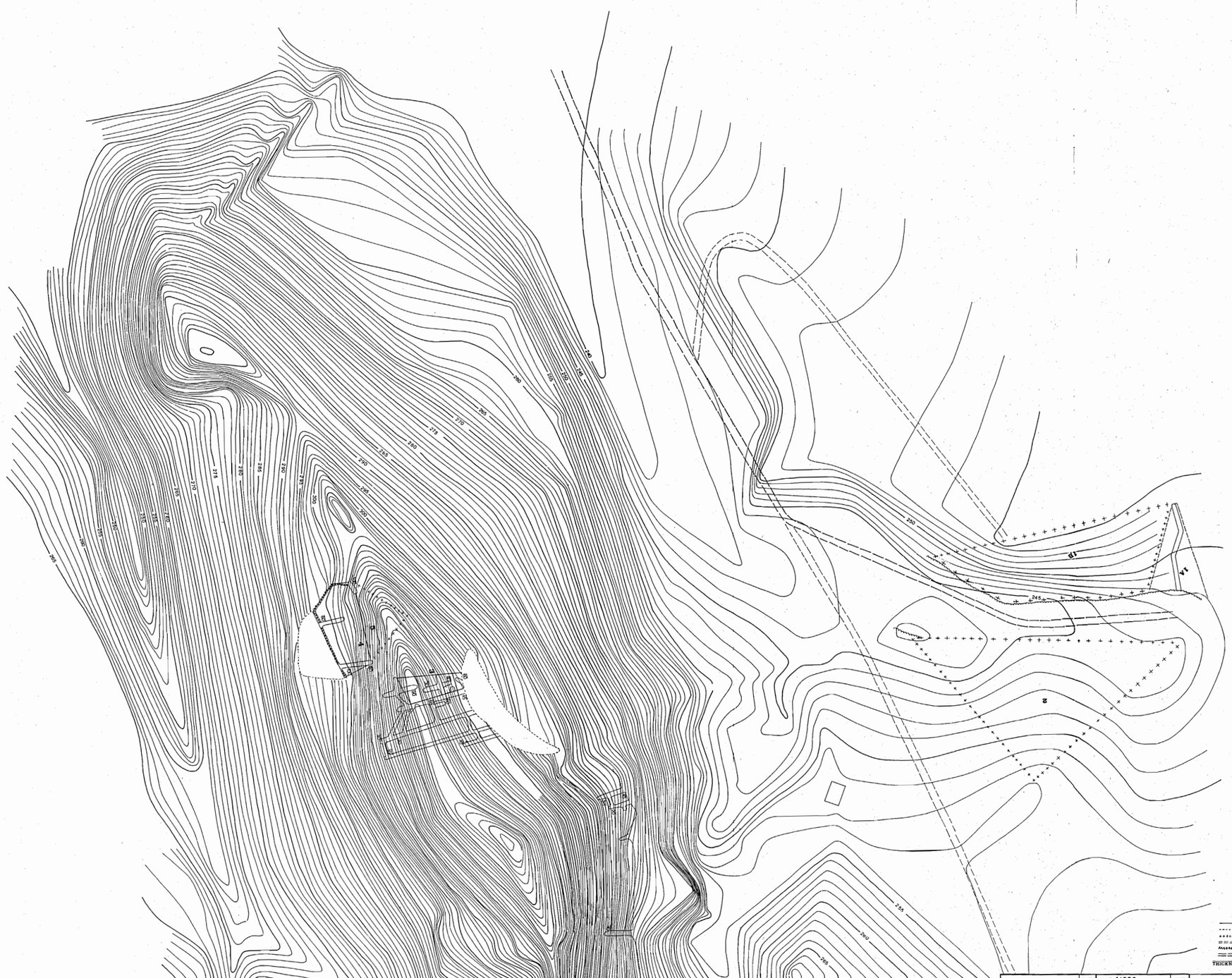
DWG. No. 108-G

REVISION R-

KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU

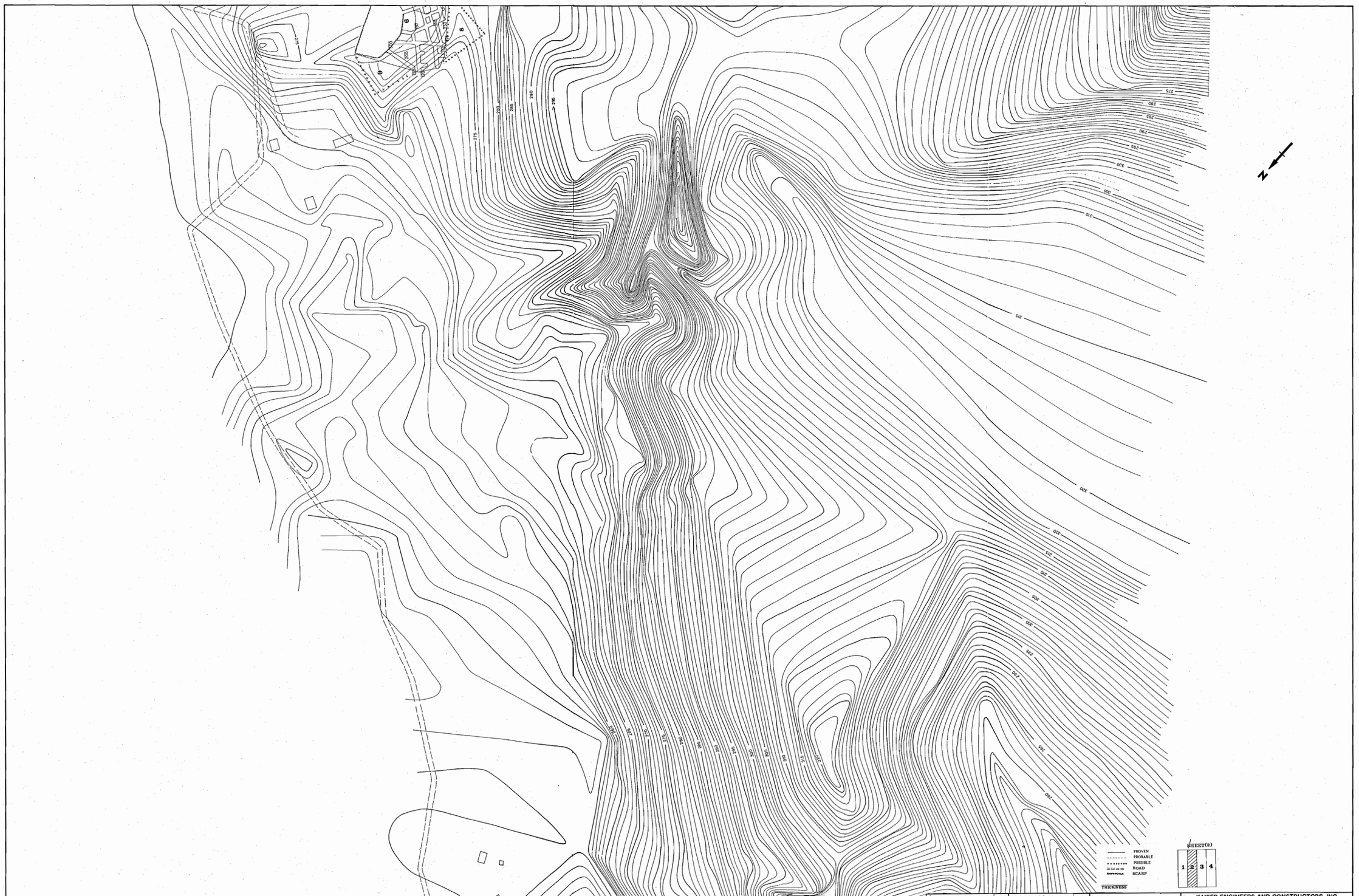
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI

ABU THOR M.L. 401-402



APPROVAL	DATE	SCALE 1:500	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. IN ASSOCIATION WITH ARAB CONSULTING BUREAU
		DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		DRAWN BY		DWG. No. 109-1-G	ABU KAFAS M.L. 266 - 267
		CHECKED BY		REVISION R-	
		APPROVED BY			
		APPROVED BY			

INFORMATION CONFIDENTIAL, ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THAT FOR WHICH THEY WERE SUPPLIED AND FURNISHED



APPROVAL	DATE	SCALE: 1:500	DATE
	Aug 1/86	DESIGNED BY	
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		APPROVED BY	
		APPROVED BY	

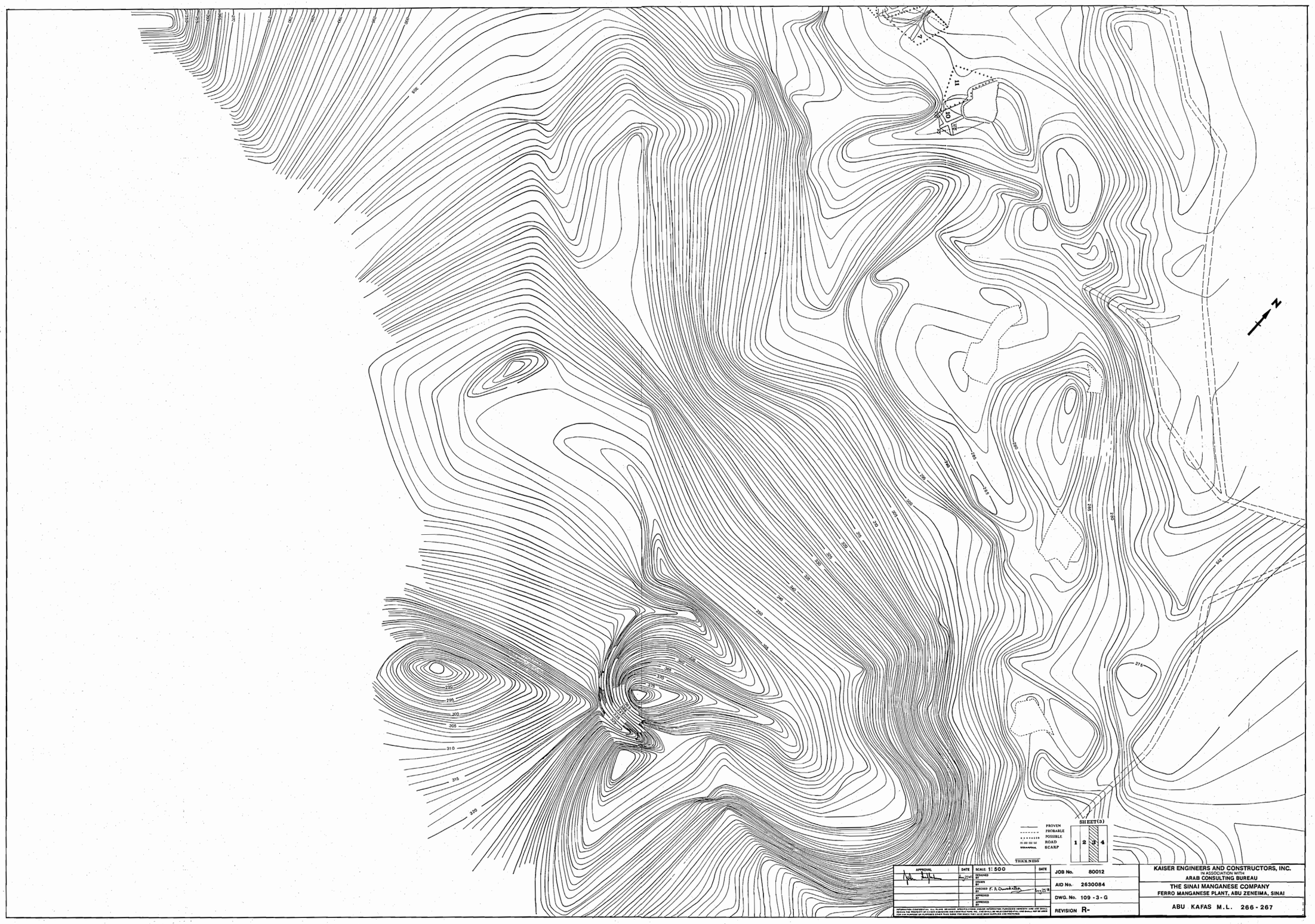
INFORMATION CONFIDENTIAL. ALL PLANS DRAWINGS SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS, INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OF PURPOSES OTHER THAN THOSE FOR WHICH THEY WERE SPECIFICALLY PREPARED.

JOB No.	80012
AID No.	2630084
DWG. No.	109 -2-G
REVISION	R-

KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU

THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI

ABU KAFAS M.L. 266 - 267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JOB No. 80012
AID No. 2630084
DWG. No. 109-3-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
ABU KAFAS M.L. 266-267

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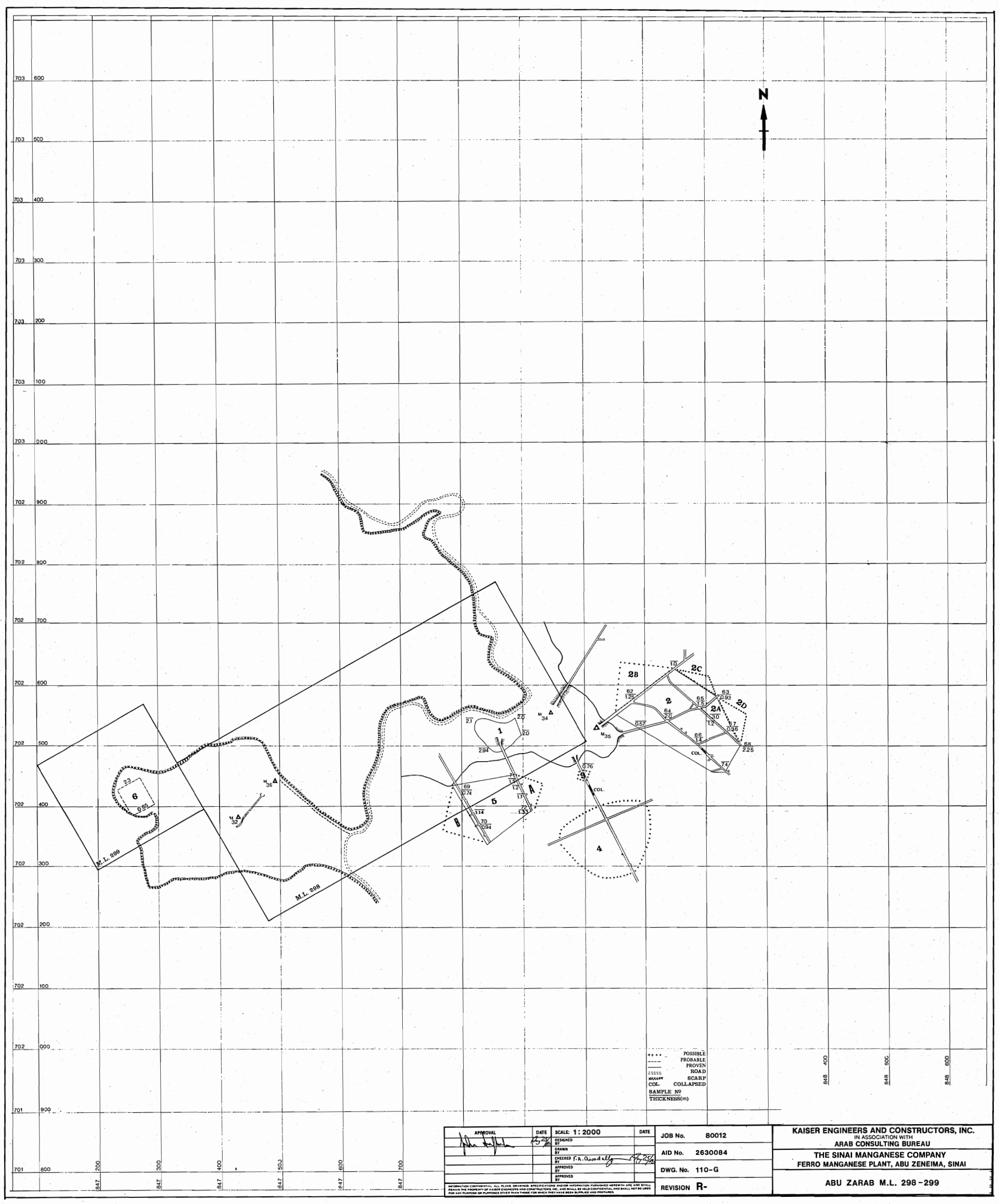
APPROVAL
JOB No. 80012
AID No. 2630084
DWG. No. 109 - 4 - G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
ABU KAFAS
M.L. 266 - 267



APPROVAL	DATE	SCALE: 1 : 2000	DATE
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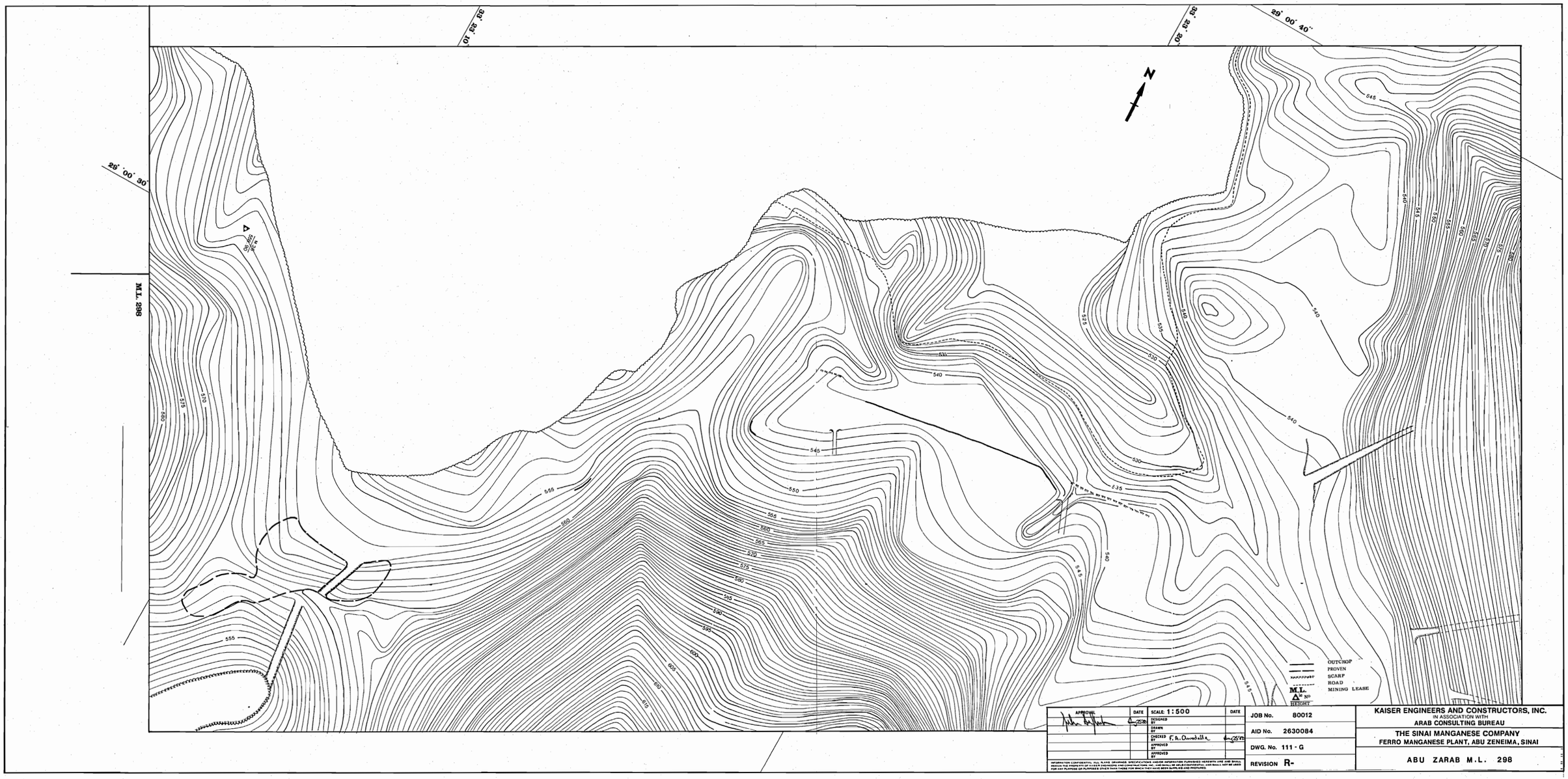
INFORMATION CONFIDENTIAL. ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS, INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PREPARED.

JOB No.	80012
AID No.	2630084
DWG. No.	110-G
REVISION	R-

KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU

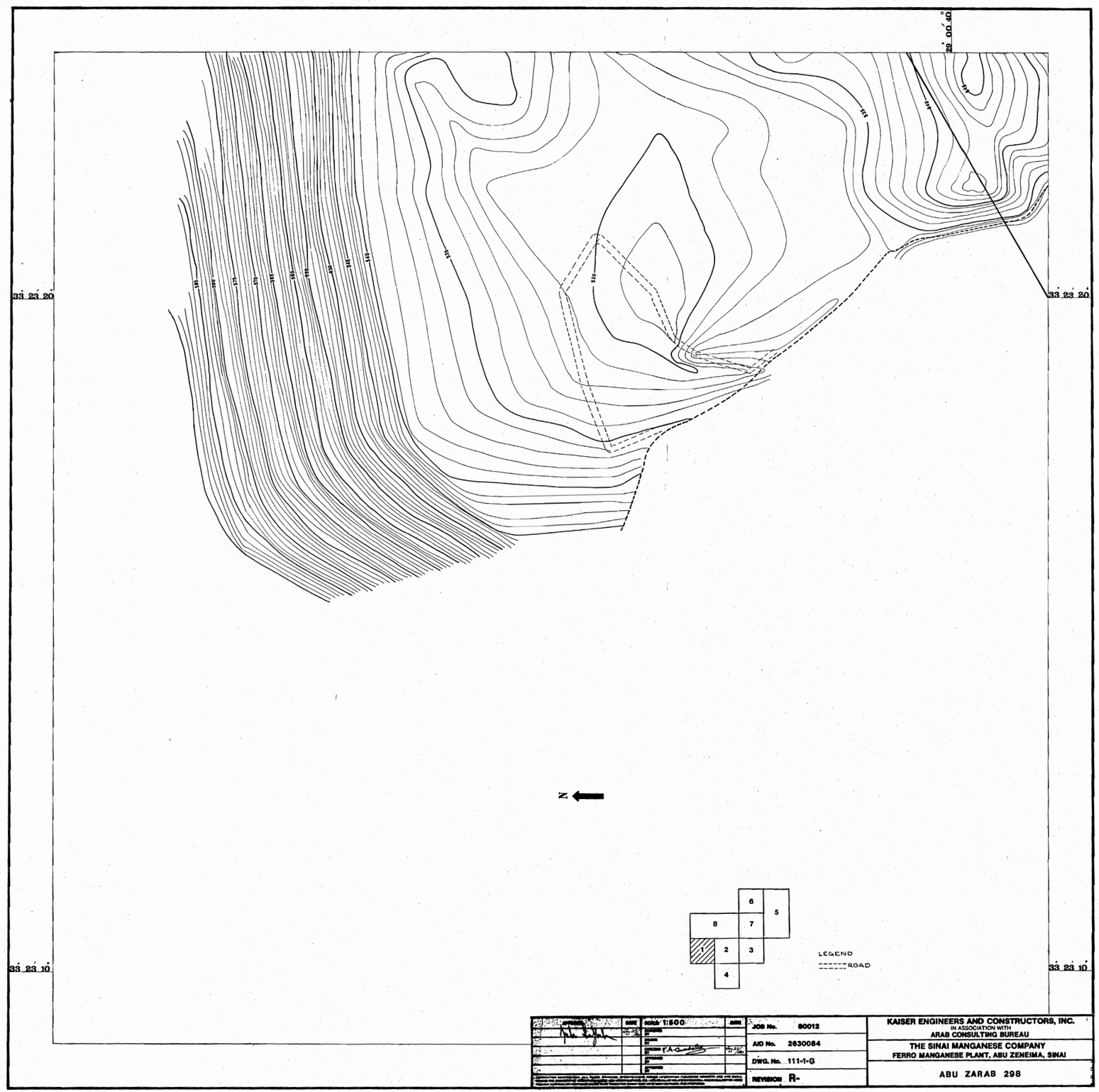
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI

ABU ZARAB M.L. 298 - 299



APPROVAL	DATE	SCALE: 1:500	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. IN ASSOCIATION WITH ARAB CONSULTING BUREAU
		DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		DRAWN BY		DWG. No. 111 - G	ABU ZARAB M.L. 298
		CHECKED BY		REVISION R-	
		APPROVED BY			
		APPROVED BY			

INFORMATION CONFIDENTIAL: ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS, INC. AND ARE TO BE RETURNED UPON REQUEST. THEY SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PREPARED.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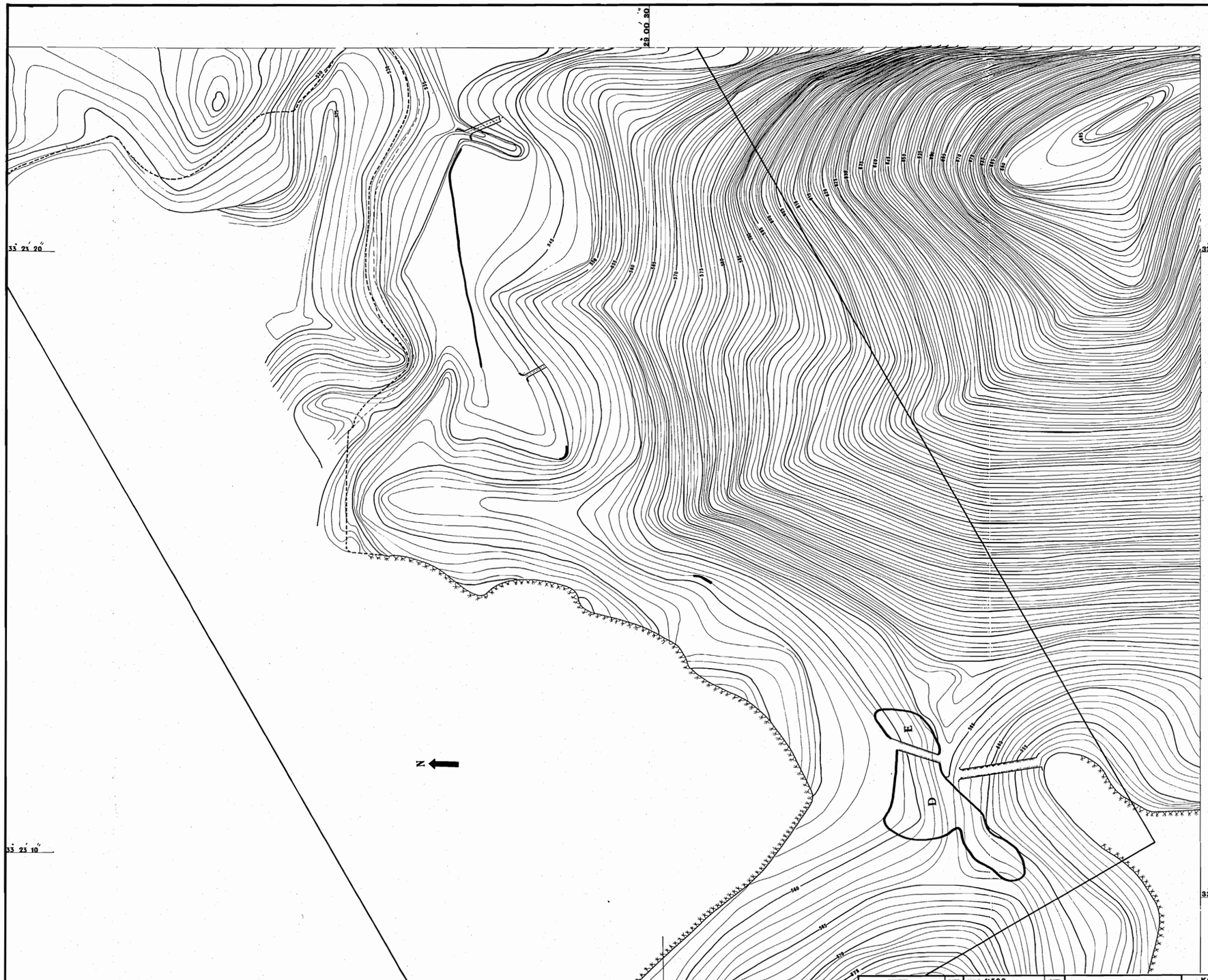
JOB No. 80012
A/O No. 2630084
DWG. No. 111-1-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
ABU ZARAB 298



APPROVED	DATE	SCALE: 1:500	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. IN ASSOCIATION WITH ARAB CONSULTING BUREAU
		DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY
		DRAWN BY		DWG. No. 111-2-G	FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		CHECKED BY		REVISION R-	ABU ZARAB 298
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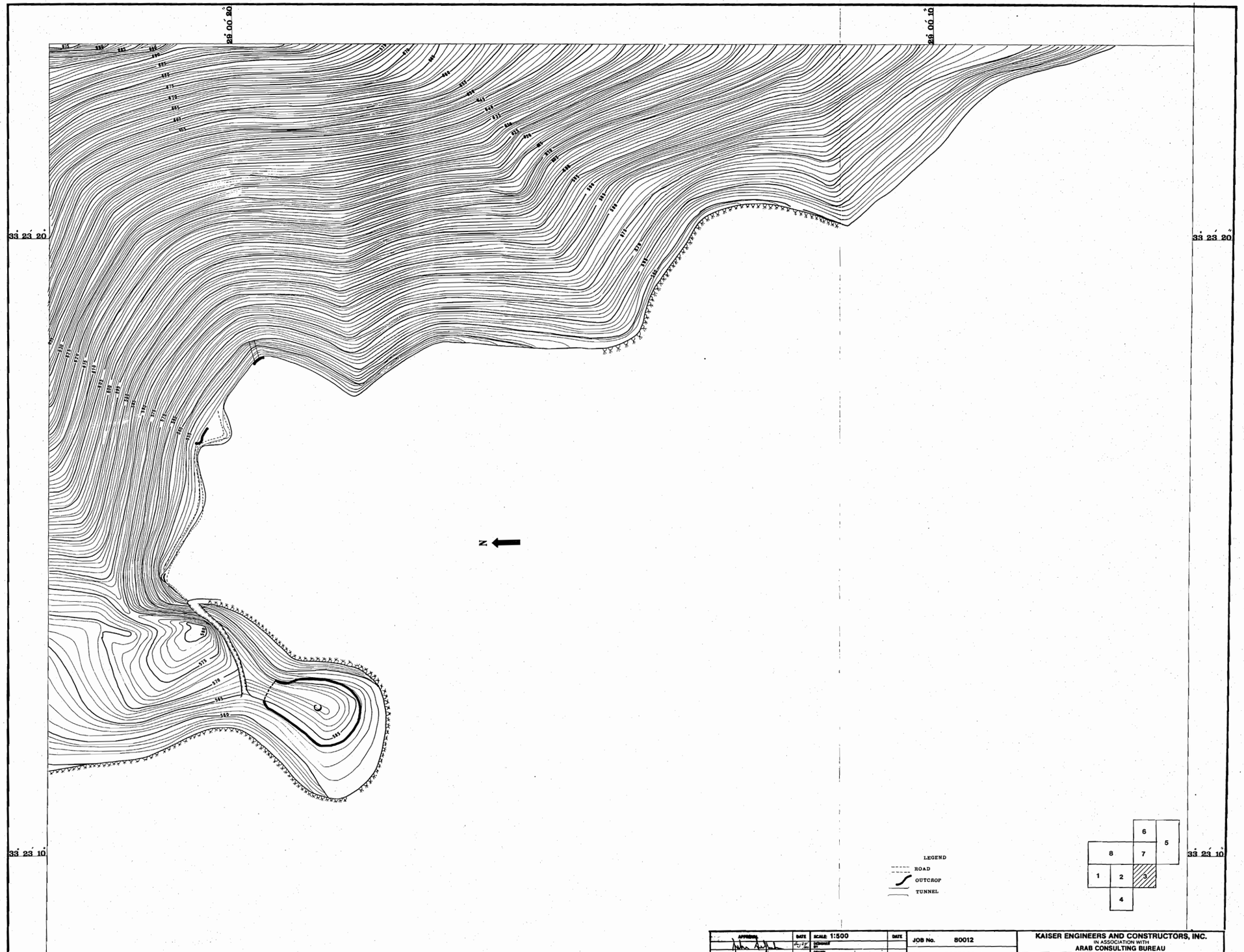
		APPROVED BY			

INFORMATION CONFIDENTIAL. ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS, INC. AND SHALL BE HELD CONFIDENTIAL. THEY SHALL NOT BE USED FOR ANY PURPOSE BY PURCHASERS OTHER THAN THOSE FOR WHICH THEY WERE WHEN SUPPLIED AND PROVIDED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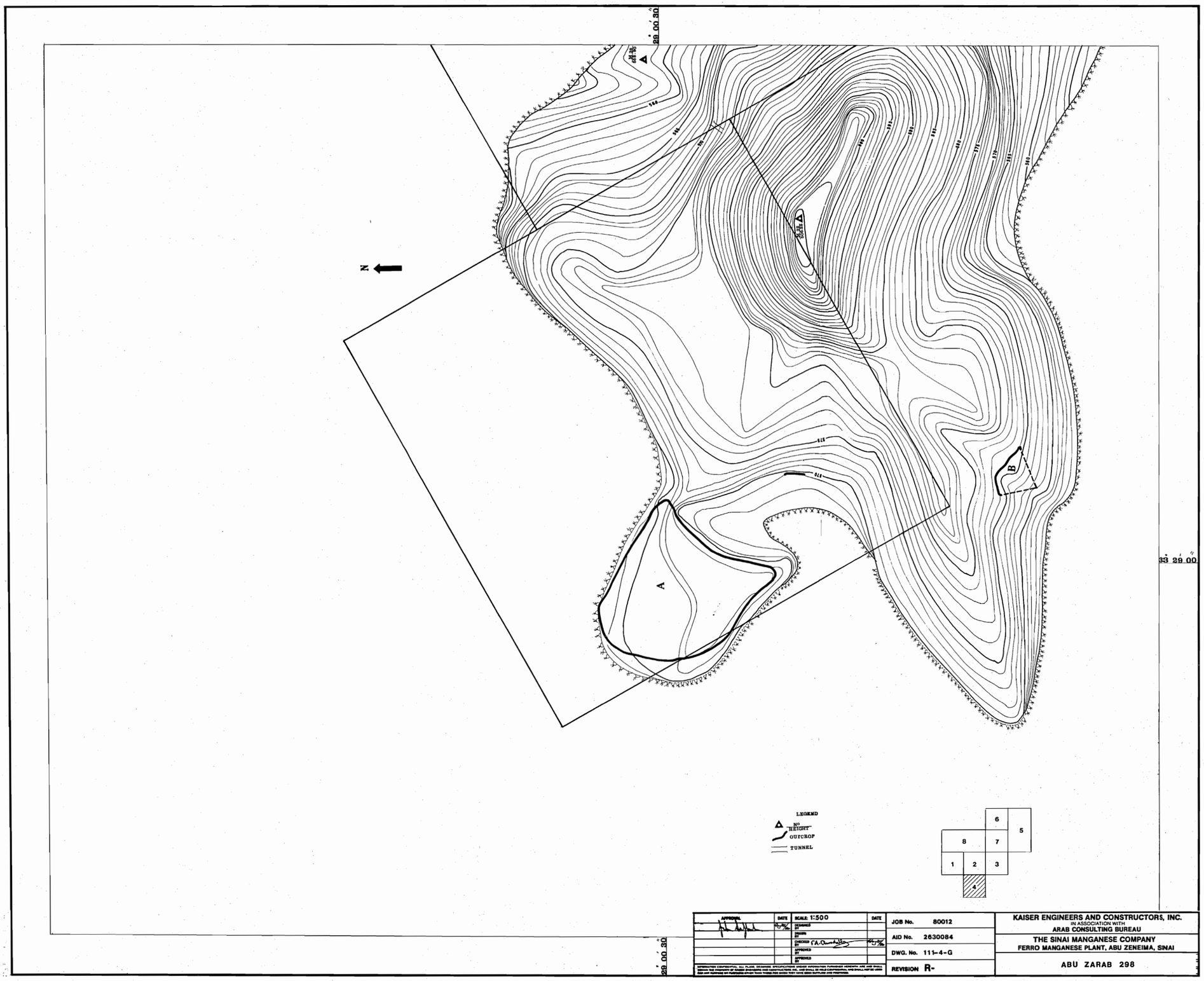
JOB No. 80012
AID No. 2630084
DWG. No. 111-3-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
ABU ZARAB 298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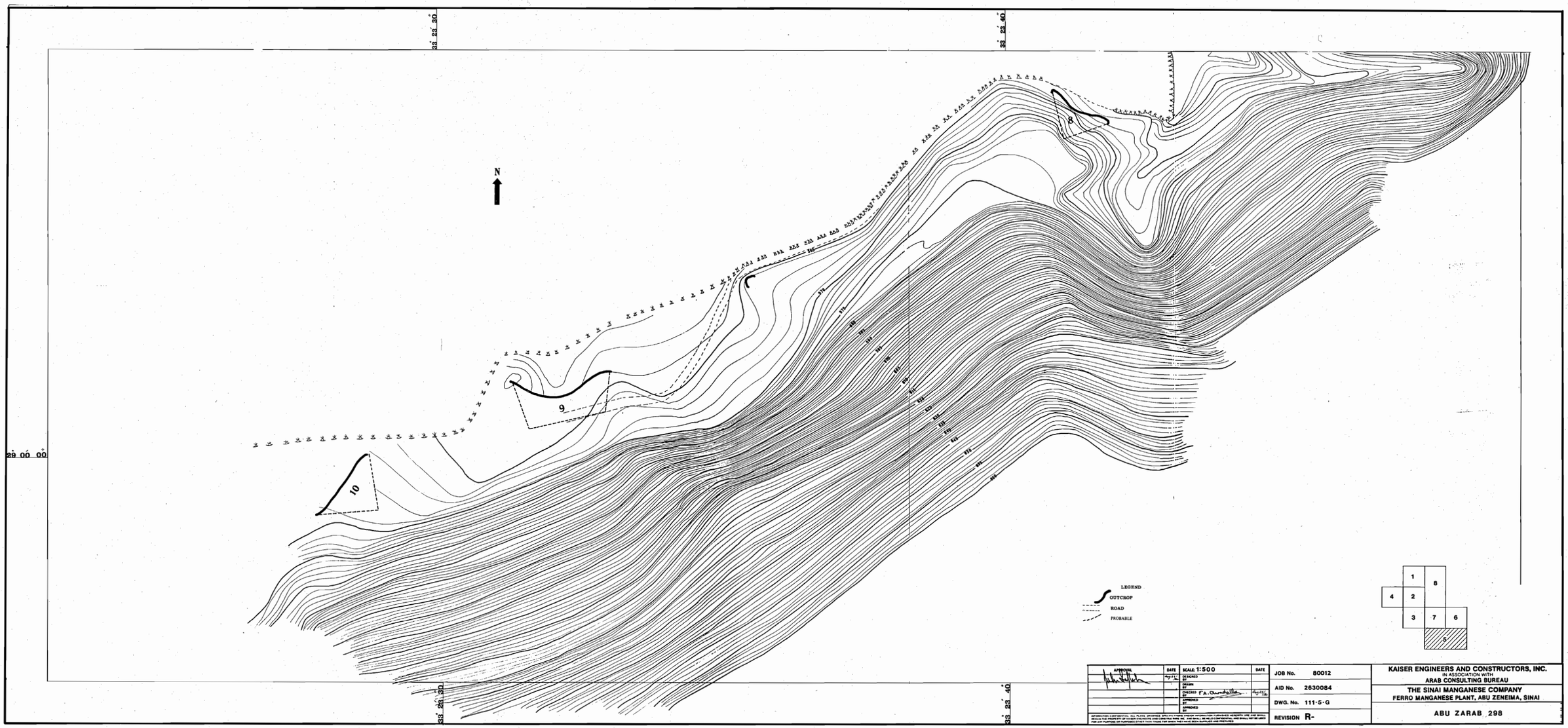
APPROVED BY
JOB No. 80012
AID No. 2630084
DWG. No. 111-4-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
ABU ZARAB 298



APPROVAL	DATE	SCALE 1:500	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. IN ASSOCIATION WITH ARAB CONSULTING BUREAU
		DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		DRAWN BY		DWG. No. 111-5-G	ABU ZARAB 298
		CHECKED BY F.A.		REVISION R-	
		APPROVED BY			
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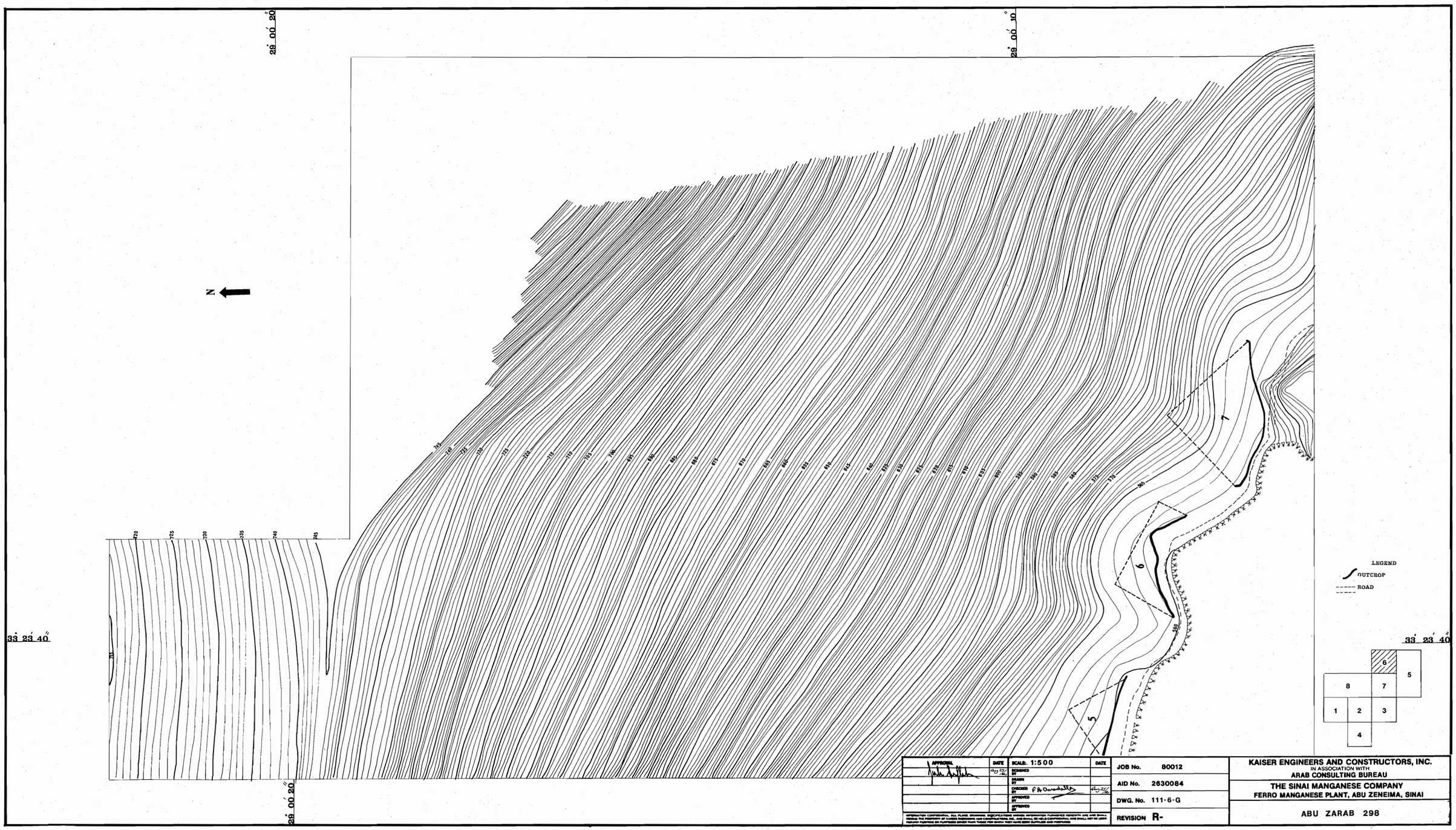
INFORMATION CONFIDENTIAL ALL PLANS, DRAWINGS, SPECIFICATIONS AND ALL OTHER INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OR FURNISHED OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PROVIDED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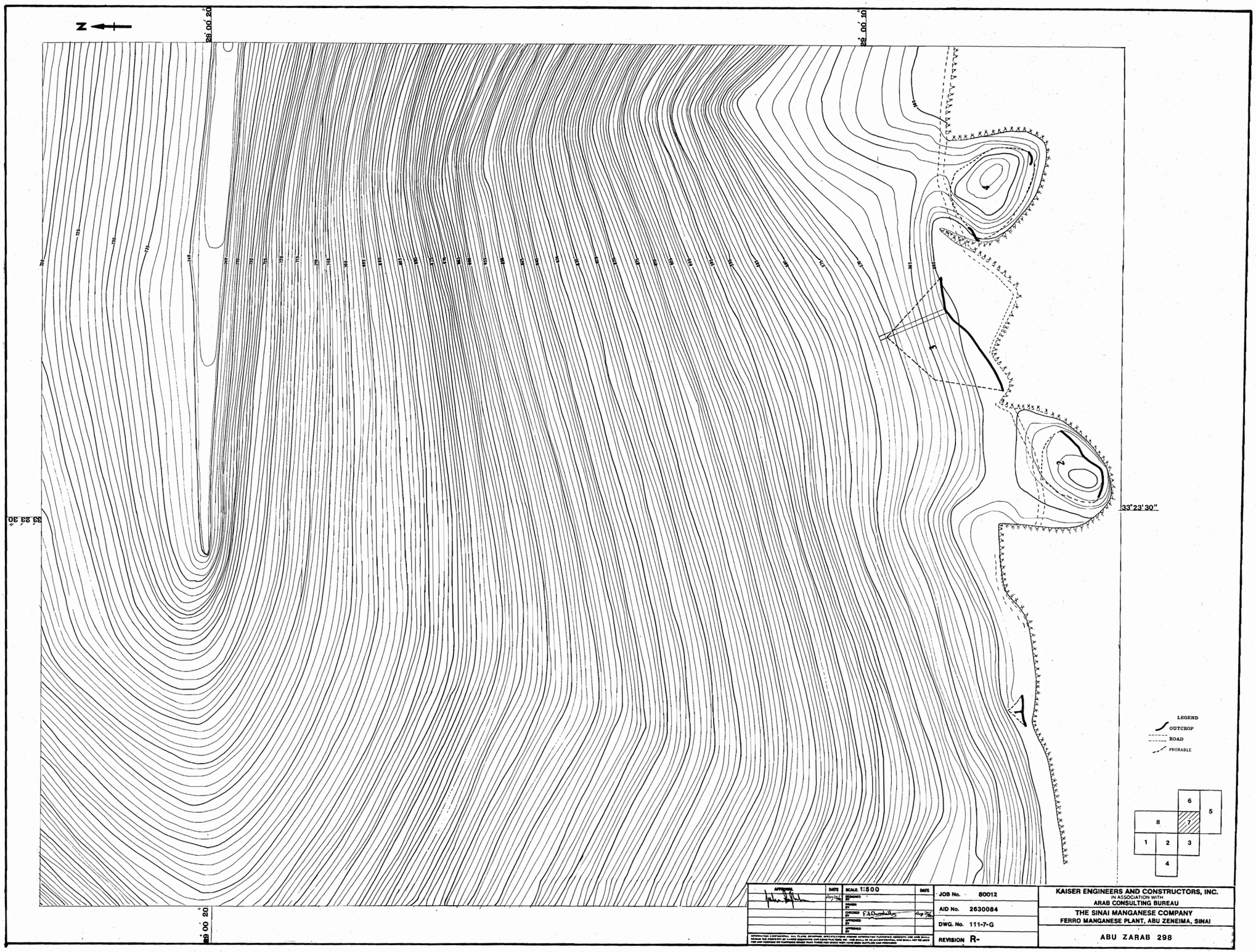
APPROVED BY
APPROVED BY
JOB No. 80012
AID No. 2630084
DWG. No. 111-6-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
ABU ZARAB 298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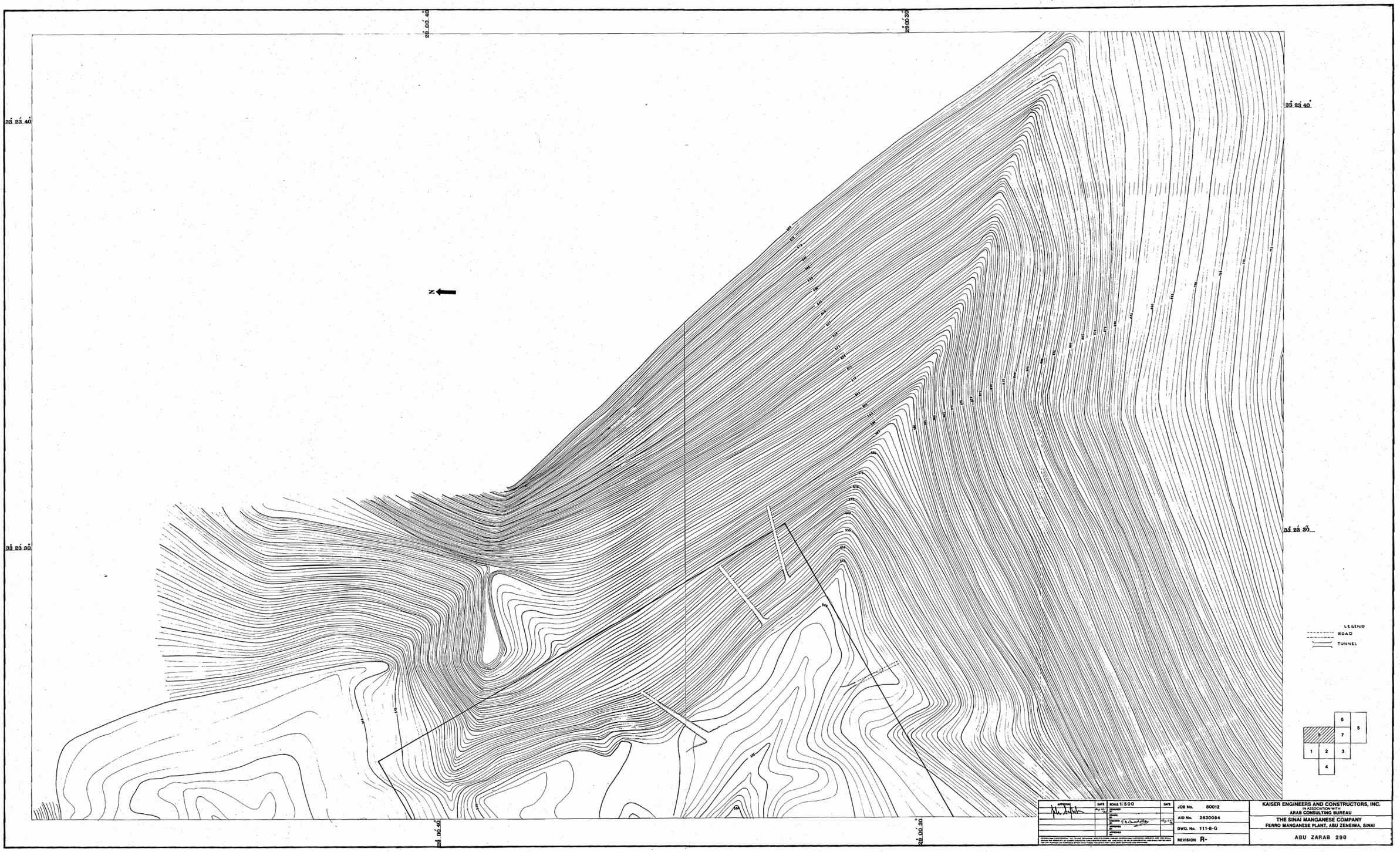
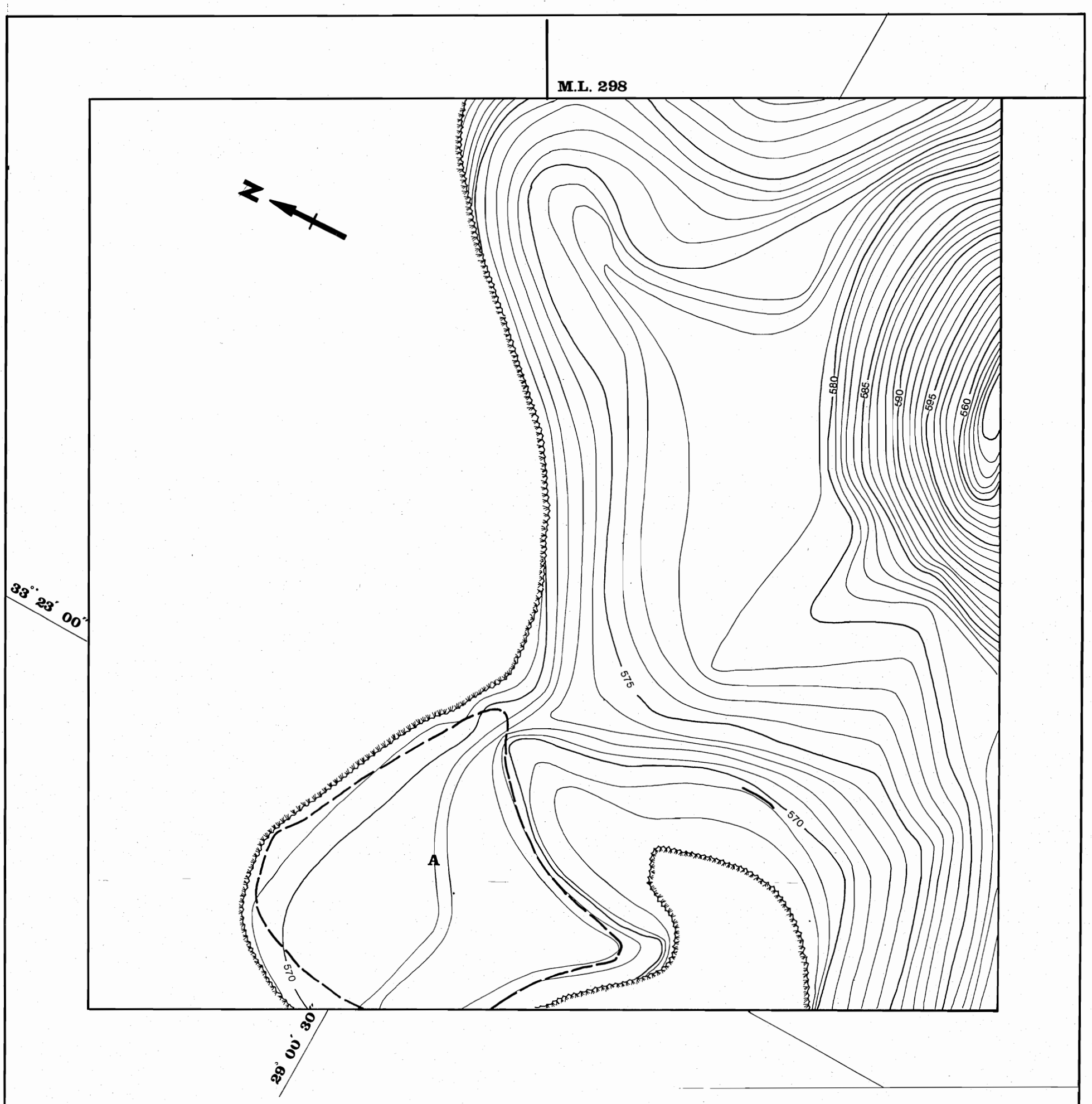
APPROVED BY
APPROVED BY
JOB No. 80012
AID No. 2630084
DWG. No. 111-7-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
ABU ZARAB 298


33° 23' 40"
33° 23' 30"
N
LEGEND
ROAD
TUNNEL
1
2
3
4
5
6
7
8
SCALE 1:500
JOB No. 80012
AID No. 2630084
DWG. No. 111-8-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
ABU ZARAB 298



M.L. MINING LEASE
OUTCROP
PROVEN
SCARP

APPROVAL	DATE	SCALE: 1 : 500	DATE
	Aug 25'80	DESIGNED BY	
		DRAWN BY	
		CHECKED BY F.A. Swodalla	Aug 25'80
		APPROVED BY	
		APPROVED BY	

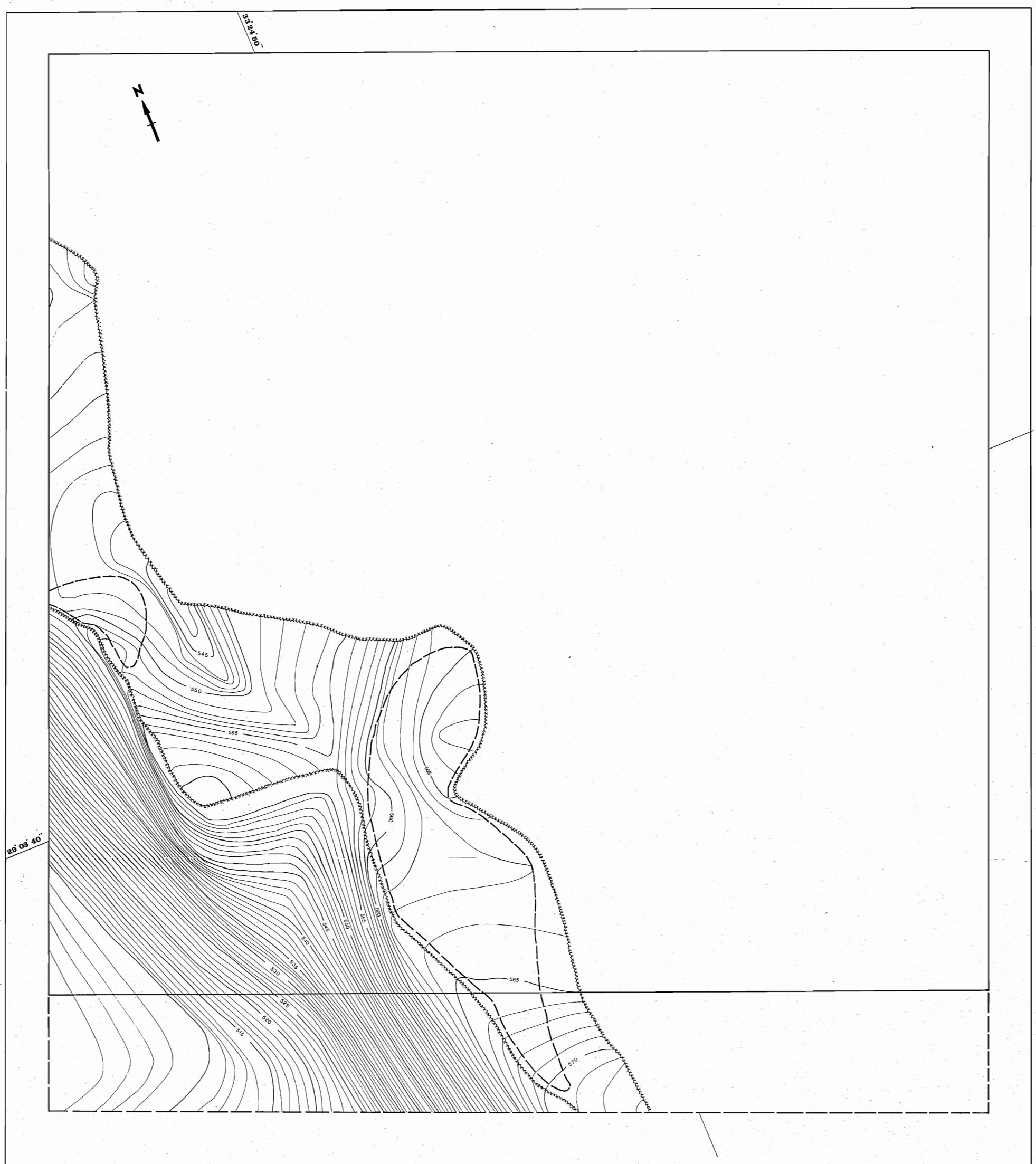
INFORMATION CONFIDENTIAL: ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS, INC., AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PREPARED.

JOB No. 80012
AID No. 2630084
DWG. No. 112 - G
REVISION R-

KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU

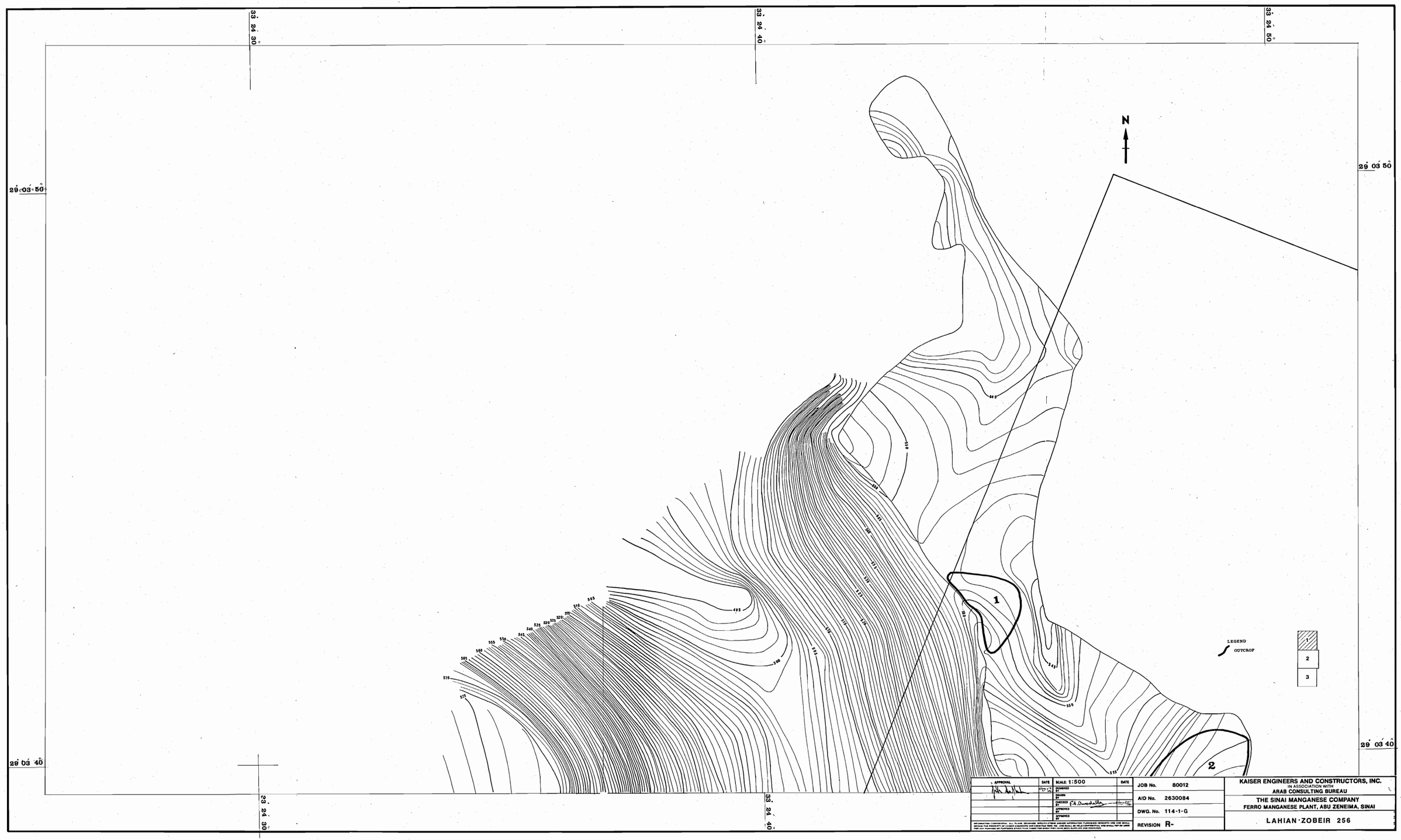
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI

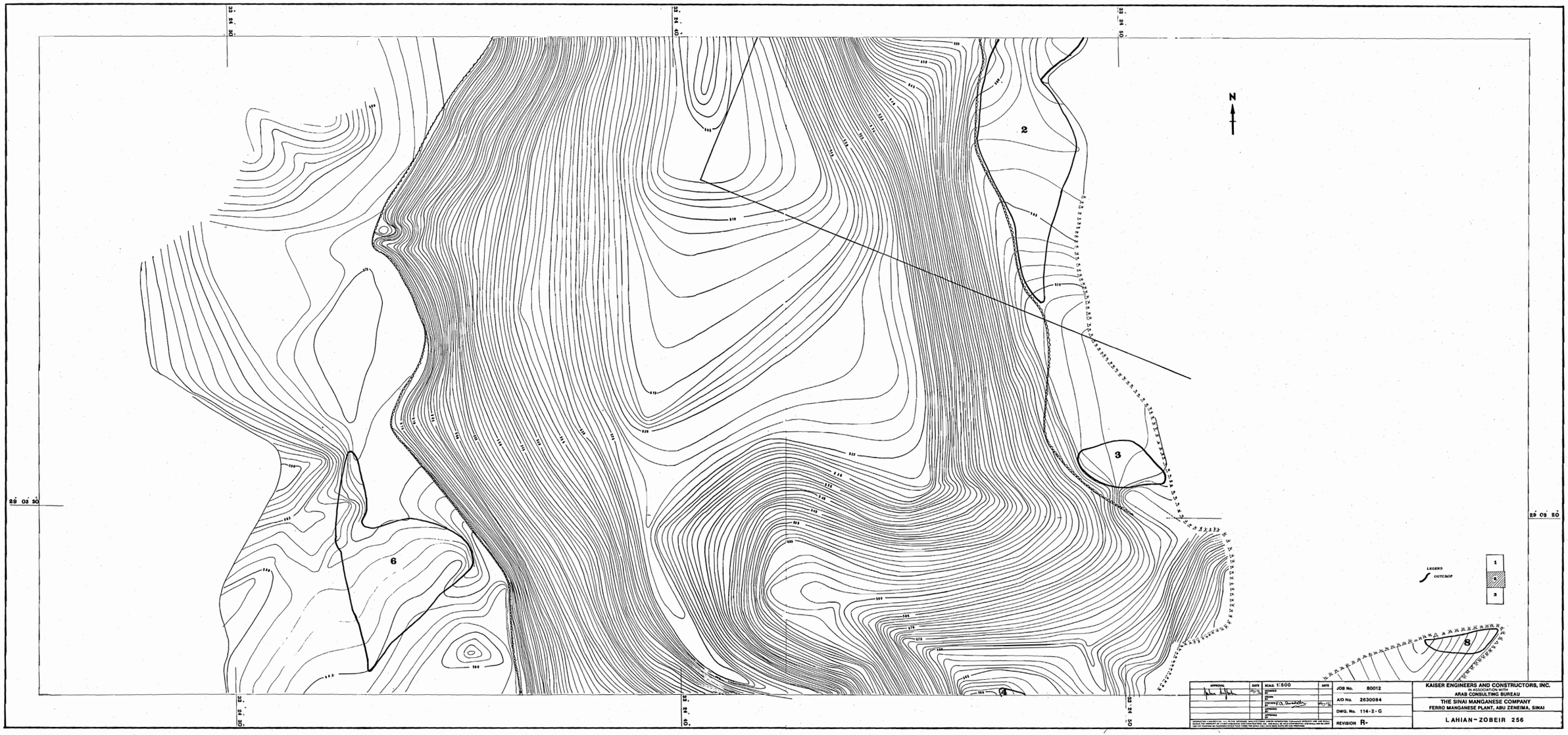
ABU ZARAB M.L. 299

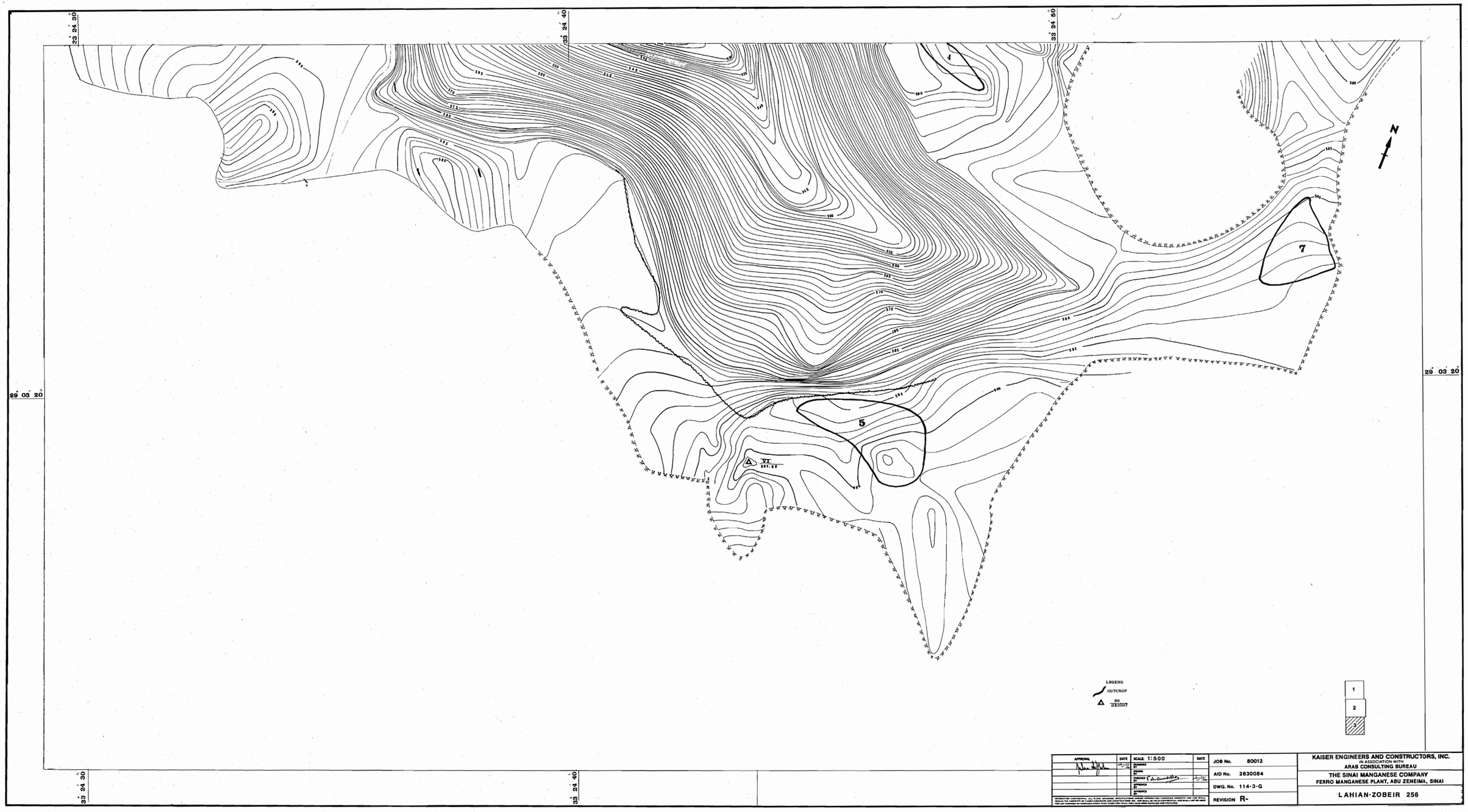


APPROVAL	DATE	SCALE: 1:500	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. IN ASSOCIATION WITH ARAB CONSULTING BUREAU
		DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		DRAWN BY		DWG. No. 113-G	
		CHECKED BY F.A. Awadallah		REVISION R-	LAHIAN ZOBIER M.L. 256
		APPROVED BY			
		APPROVED BY			

INFORMATION CONFIDENTIAL. ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PREPARED


33° 24' 30"
33° 24' 40"
33° 24' 50"
29° 03' 50"
29° 03' 40"
N
1
2
LEGEND
OUTCROP
2
3
APPROVAL
DATE
SCALE: 1:500
DATE
DESIGNED BY
DRAWN BY
CHECKED BY
APPROVED BY
APPROVED BY
JOB No. 80012
AID No. 2630084
DWG. No. 114-1-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
LAHIAN·ZOBEIR 256


N
2
3
4
6
8
LEGEND
OUTCROP
1
2
3
33° 24' 00"
33° 24' 40"
33° 25' 20"
29° 03' 30"
29° 03' 20"
APPROVAL
DATE
SCALE 1:500
DATE
JOB No. 80012
AID No. 2630084
DWG. No. 114-2-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
LAHIAN-ZOBEIR 256


33° 24' 30"
33° 24' 40"
33° 24' 50"
29° 03' 20"
N
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5
7
VT
881.00
LEGEND
OUTCROP
MB
HEIGHT
1
2
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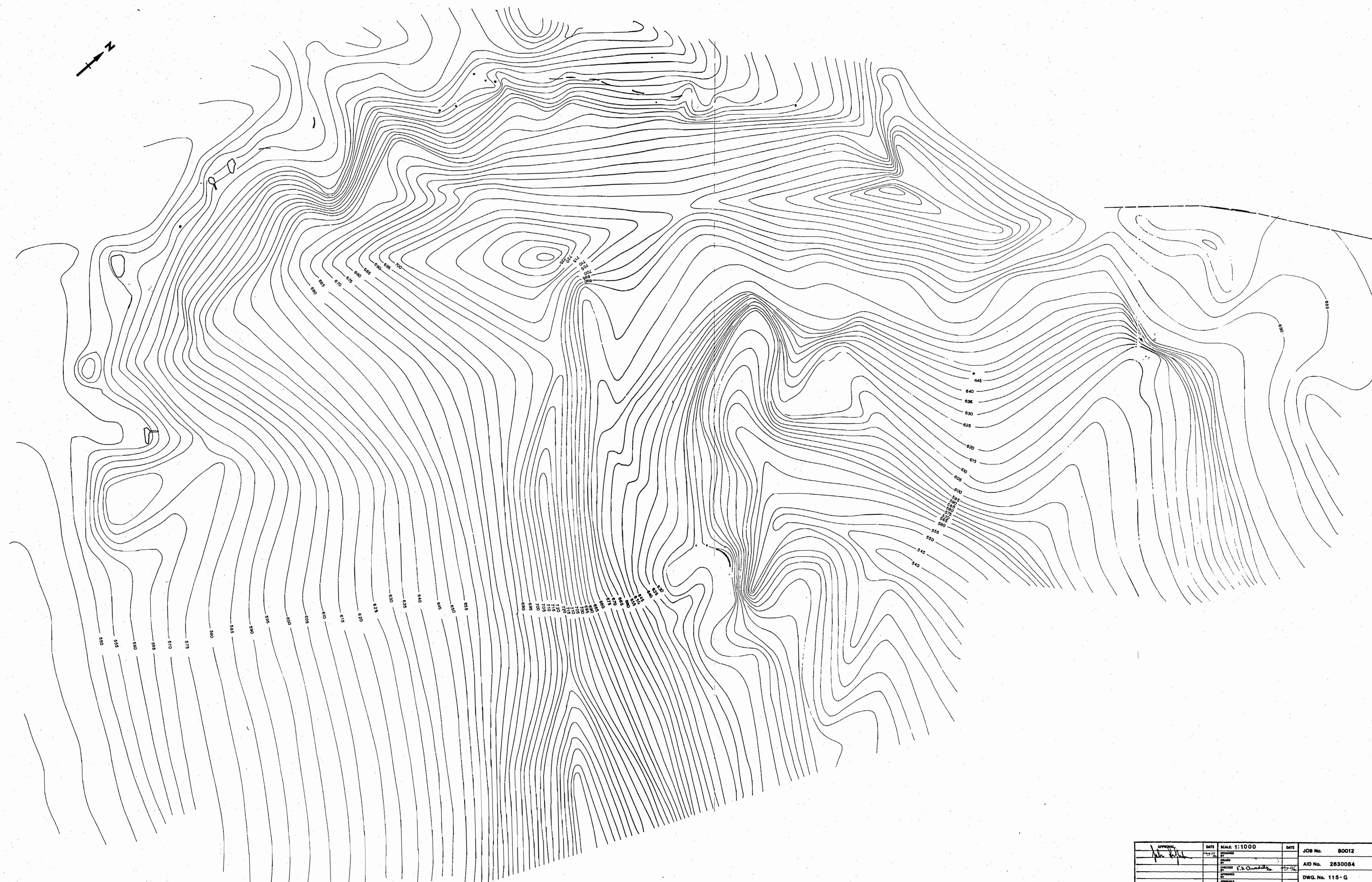
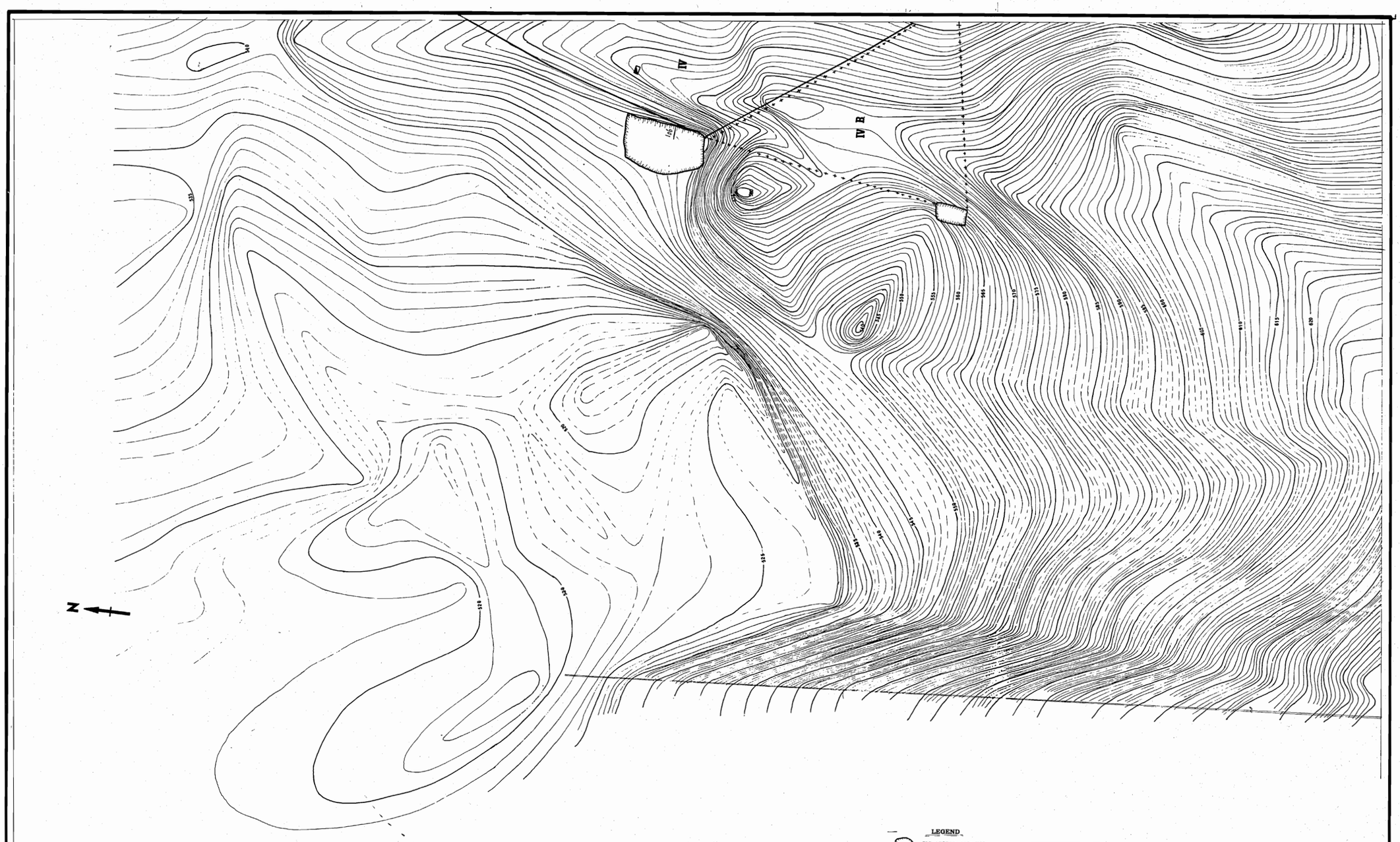
APPROVAL
DATE
SCALE 1:500
DRAWNED BY
DESIGNED BY
CHECKED BY
APPROVED BY
REVISED BY
JOB No. 80012
AID No. 2630084
DWG. No. 114-3-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
LAHIAN-ZOBEIR 256



APPROVAL	DATE	SCALE: 1:1000	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. IN ASSOCIATION WITH ARAB CONSULTING BUREAU
	Aug 25 80	DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		DRAWN BY		DWG. No. 115-G	
		CHECKED BY F.A. Quradilla	Aug 25/80	REVISION R-	OM RATAM 265
		APPROVED BY			
		APPROVED BY			



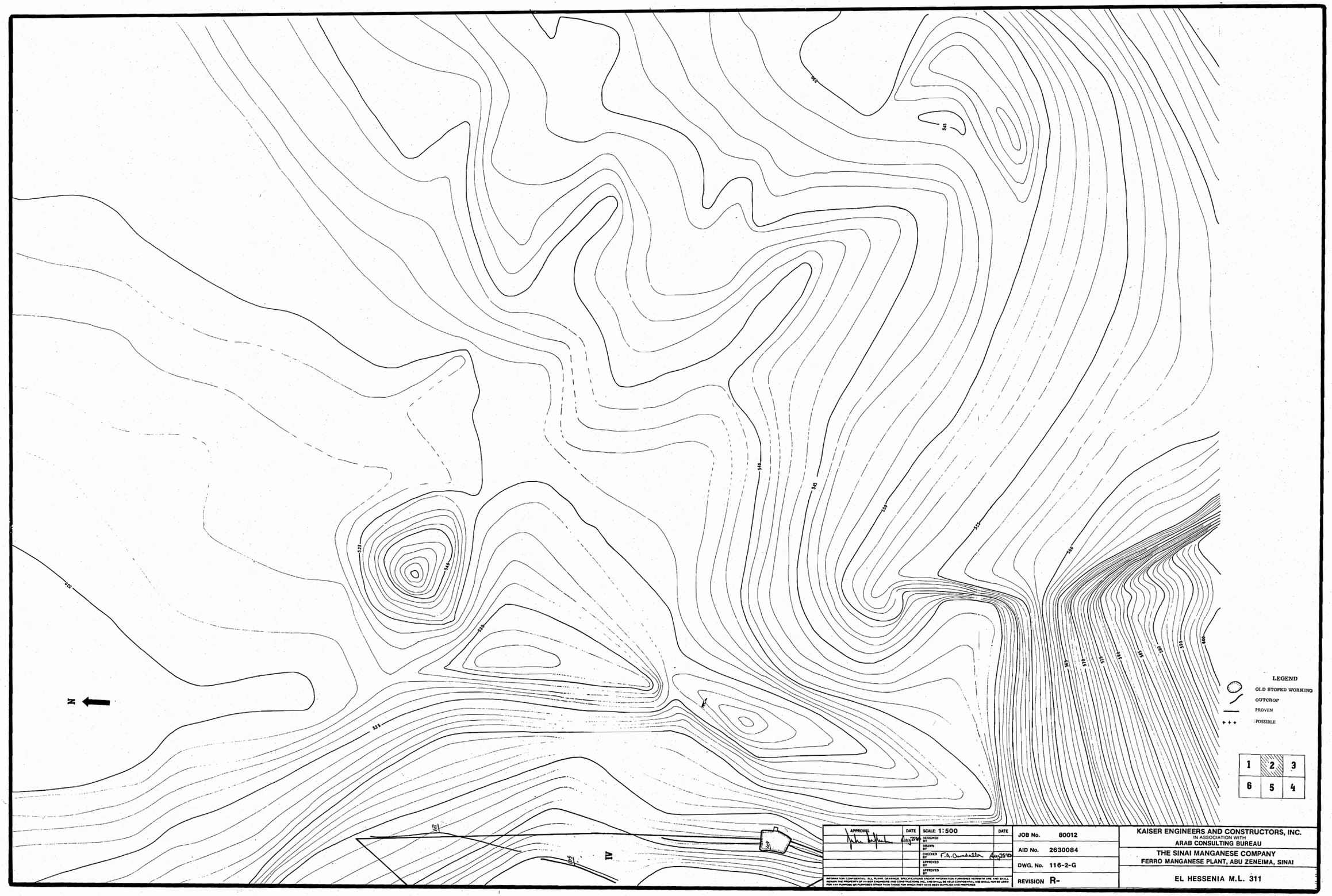
LEGEND

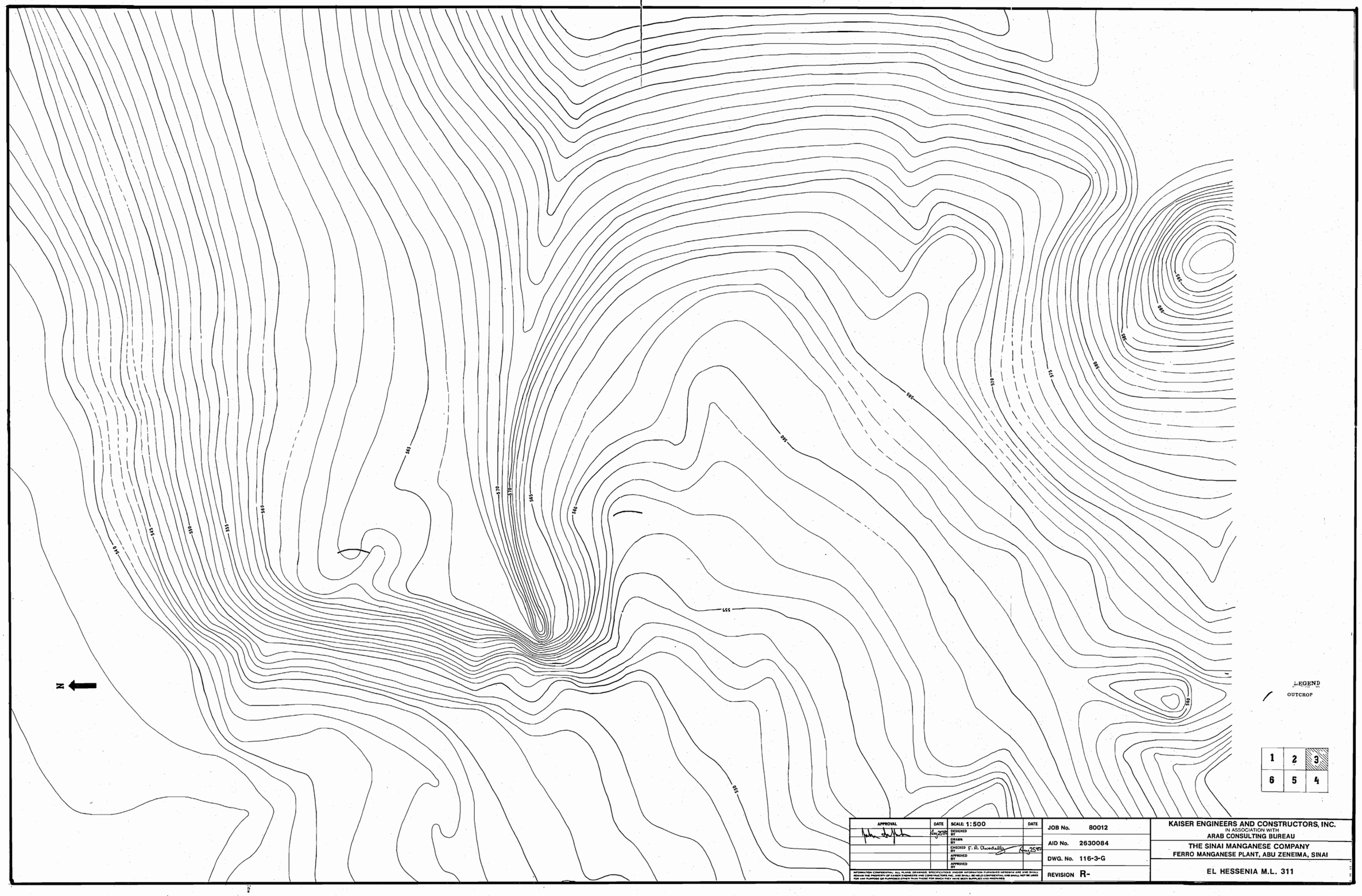
- OLD STOPED WORKING
- BUILDING
- ROPE WAY
- OUTCROP
- POSSIBLE
- PROVEN

1	2	3
6	5	4

APPROVAL	DATE	SCALE: 1:500	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. IN ASSOCIATION WITH ARAB CONSULTING BUREAU
	Aug 25/72	DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		DRAWN BY		DWG. No. 116-1-G	
		CHECKED BY C.A. Ramadan	Aug 25/72	REVISION R-	EL HESSENIA M.L. 311
		APPROVED BY			
		APPROVED BY			

INFORMATION CONFIDENTIAL. ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS, INC., AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PREPARED.


N
IV
LEGEND
OLD STOPED WORKING
OUTCROP
PROVEN
POSSIBLE
1 2 3
6 5 4
APPROVAL
DATE
SCALE: 1:500
DATE
DESIGNED BY
DRAWN BY
CHECKED BY
APPROVED BY
APPROVED BY
JOB No. 80012
AID No. 2630084
DWG. No. 116-2-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
EL HESSENIA M.L. 311



APPROVAL	DATE	SCALE: 1:500	DATE
	Aug 2584	DESIGNED BY	
		DRAWN BY	
		CHECKED BY F. A. Quadalto	Aug 2584
		APPROVED BY	
		APPROVED BY	

INFORMATION CONFIDENTIAL. ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PREPARED.

JOB No.	80012
AID No.	2630084
DWG. No.	116-3-G
REVISION	R-

KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU

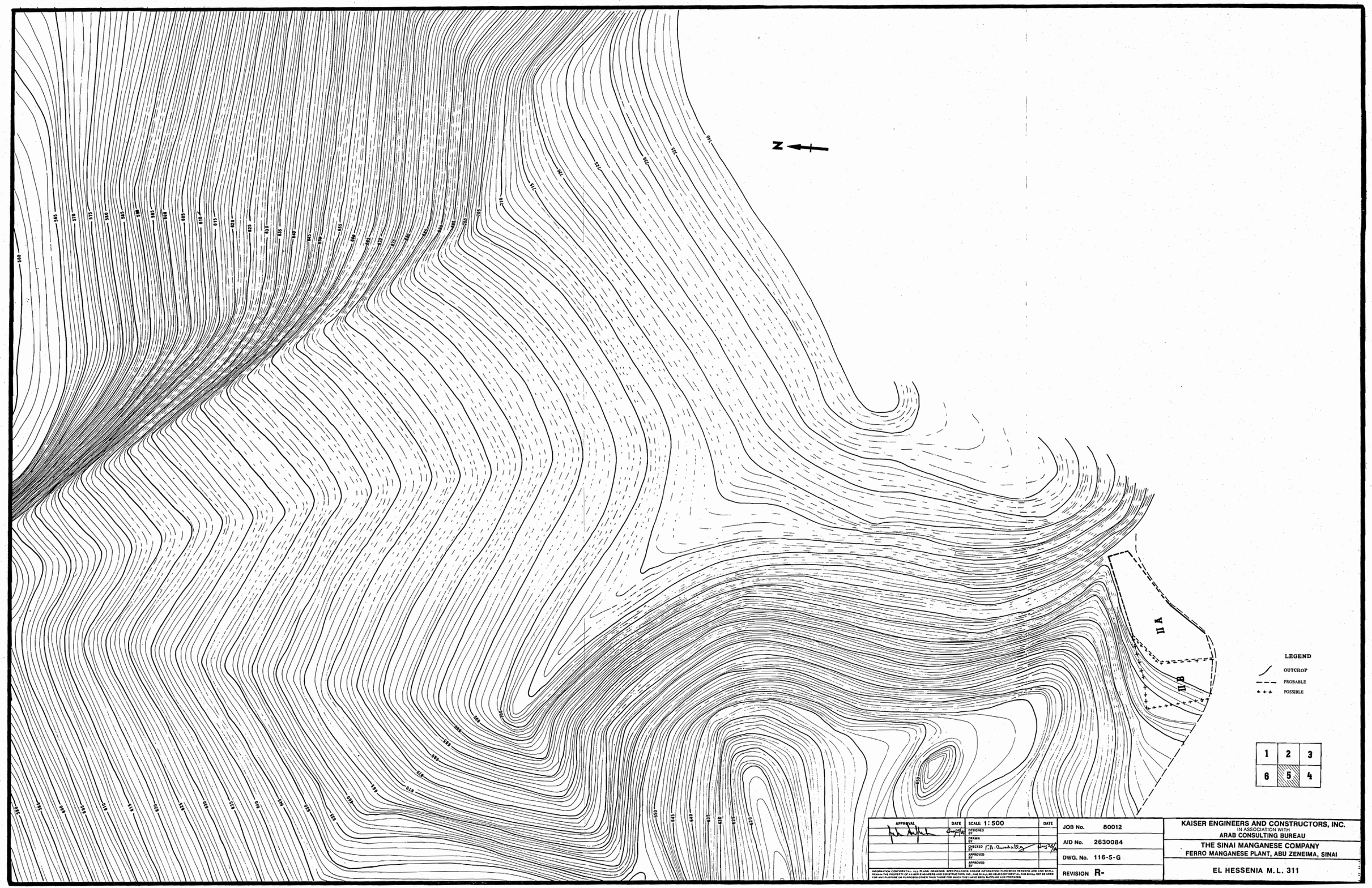
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI

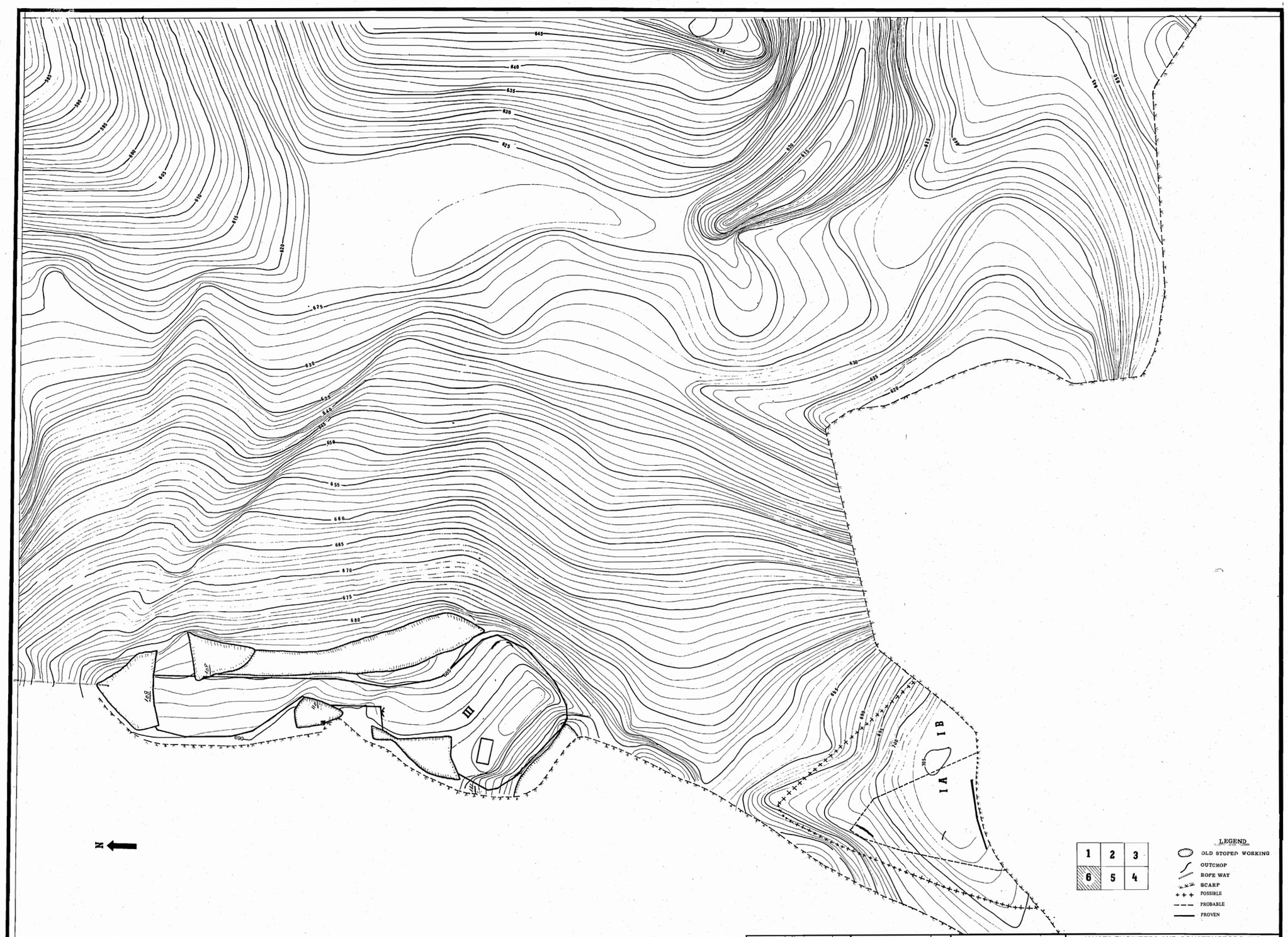
EL HESSENIA M.L. 311

1	2	3
6	5	4

APPROVAL	DATE	SCALE: 1:500	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. IN ASSOCIATION WITH ARAB CONSULTING BUREAU
		DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		DRAWN BY		DWG. No. 116-4-G	EL HESSENIA M.L. 311
		CHECKED BY F. A. Quandalla	Sep 25 '82	REVISION R-	
		APPROVED BY			
		APPROVED BY			

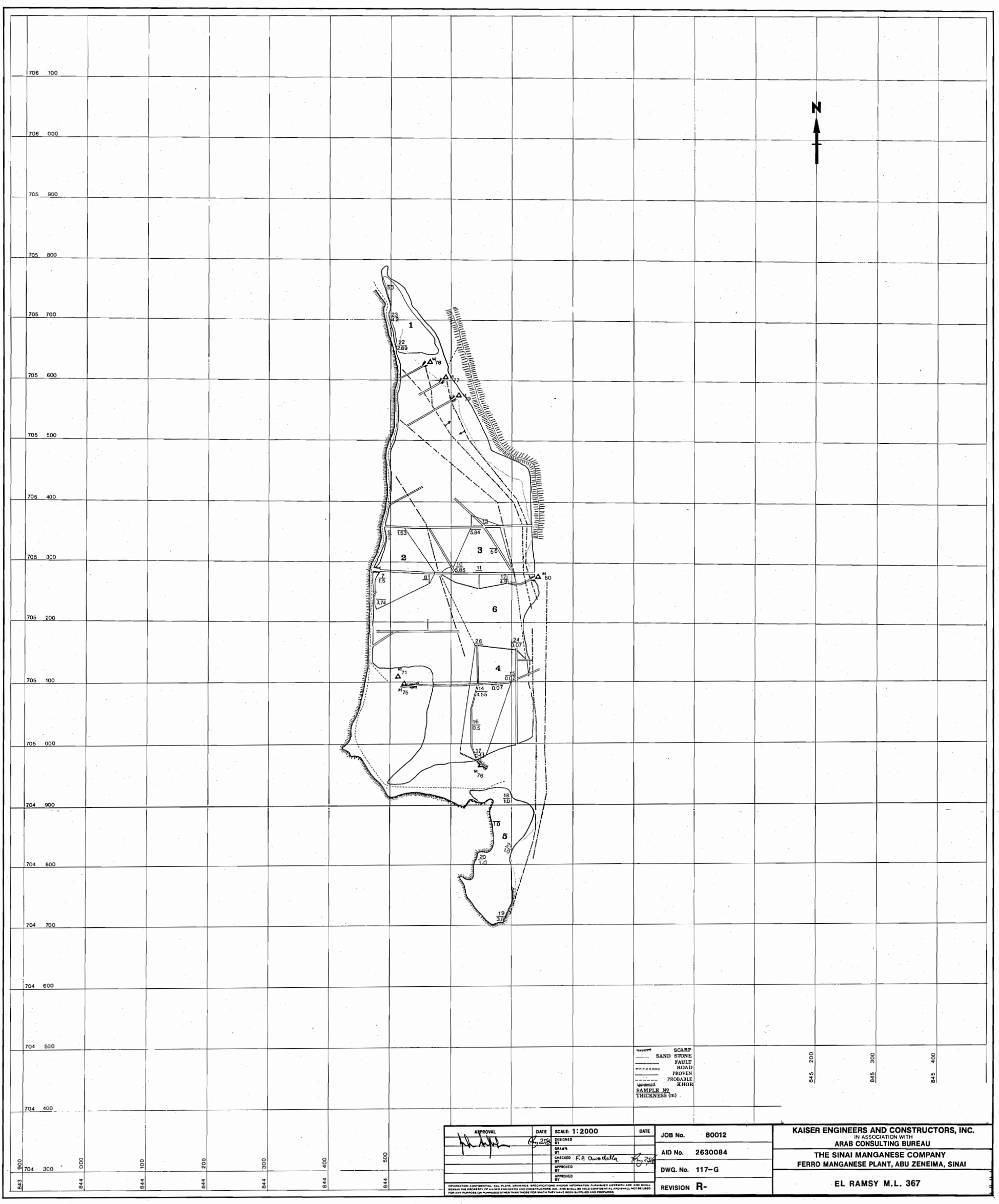
INFORMATION CONFIDENTIAL: ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS, INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PREPARED.


N
II A
II B
LEGEND
OUTCROP
PROBABLE
POSSIBLE
1 2 3
6 5 4
APPROVAL
DATE
SCALE: 1:500
DATE
DESIGNED BY
DRAWN BY
CHECKED BY
APPROVED BY
APPROVED BY
JOB No. 80012
AID No. 2630084
DWG. No. 116-5-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
EL HESSENIA M.L. 311



APPROVAL	DATE	SCALE: 1:500	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. IN ASSOCIATION WITH ARAB CONSULTING BUREAU
		DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		DRAWN BY		DWG. No. 116-6-G	EL HESSENIA M.L. 311
		CHECKED BY		REVISION R-	
		APPROVED BY			
		APPROVED BY			

INFORMATION CONFIDENTIAL, ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS, INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PREPARED.


N
706 100
706 000
705 900
705 800
705 700
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705 500
705 400
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705 200
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704 800
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843 900
844 000
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844 500
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845 300
845 400
1
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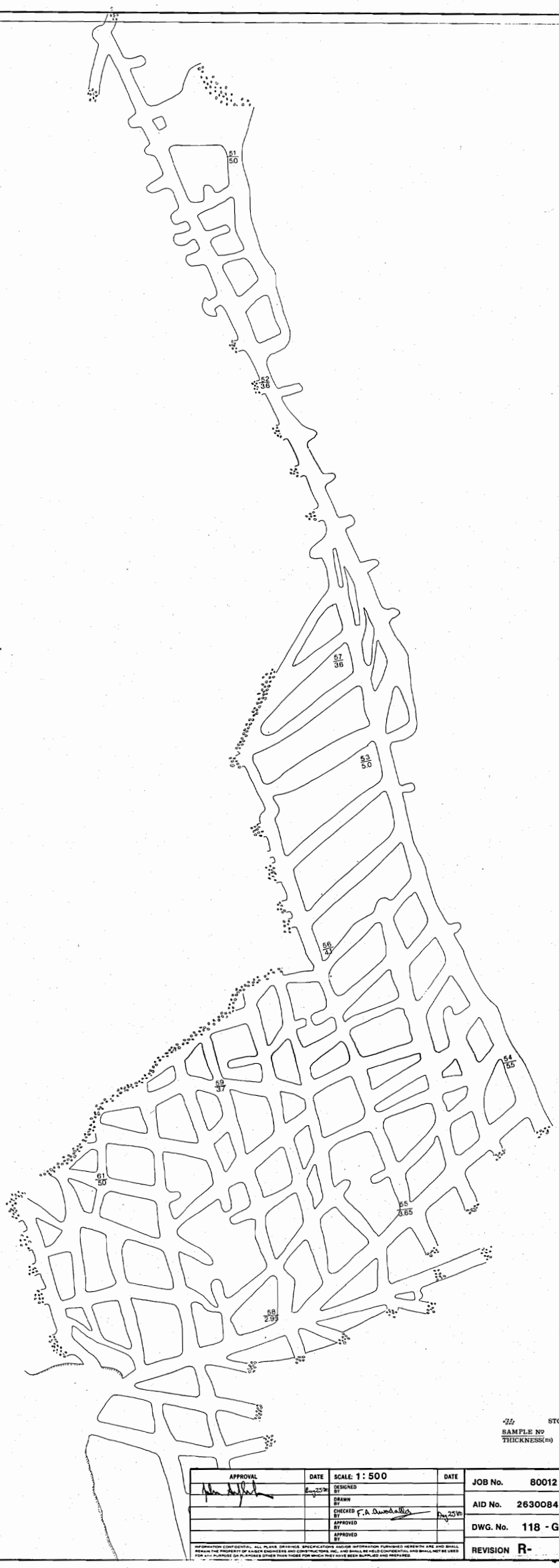
6
SCARP
SAND STONE
FAULT
ROAD
PROVEN
PROBABLE
KHOR
SAMPLE No
THICKNESS (m)
APPROVAL
DATE
SCALE: 1:2000
DATE
DESIGNED BY
DRAWN BY
CHECKED BY F.A. Awadalla
APPROVED BY
APPROVED BY
JOB No. 80012
AID No. 2630084
DWG. No. 117-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
EL RAMSY M.L. 367



APPROVAL	DATE	SCALE: 1 : 500	DATE
	Aug 25 70	DESIGNED BY	
		DRAWN BY	
		CHECKED BY F.A. Dwodallah	Aug 25 70
		APPROVED BY	
		APPROVED BY	

INFORMATION CONFIDENTIAL. ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS, INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PREPARED.

JOB No. 80012

AID No. 2630084

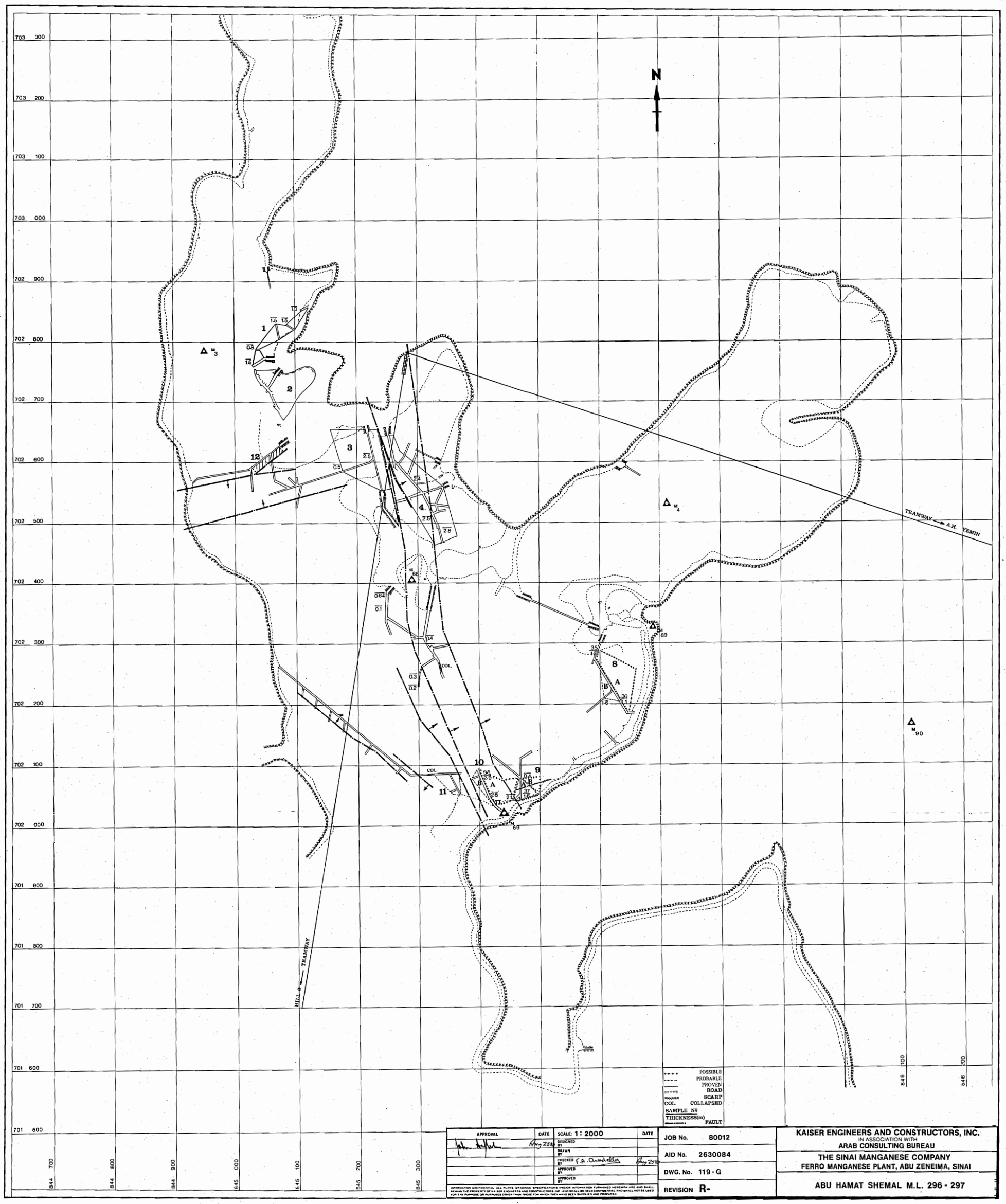
DWG. No. 118 - G

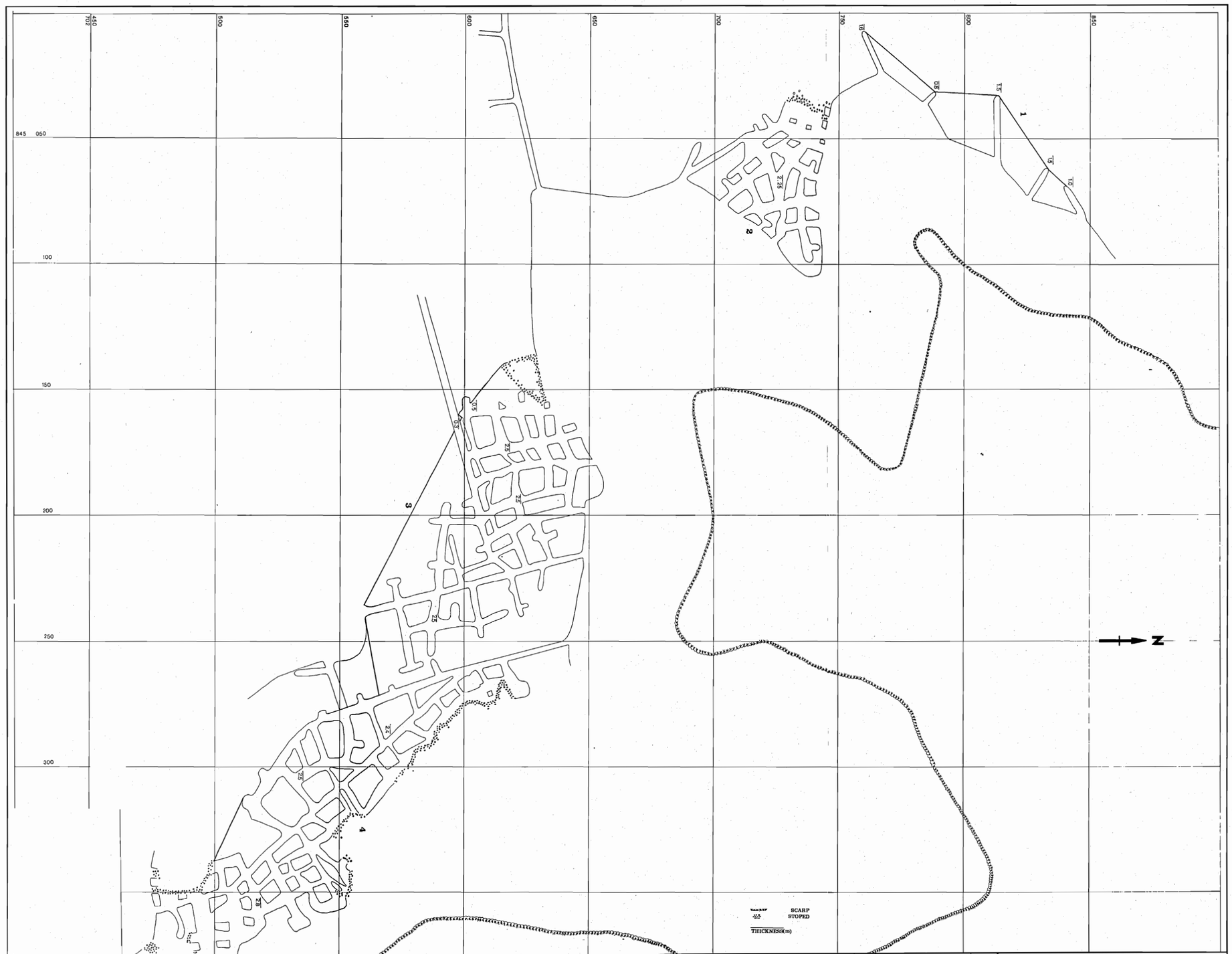
REVISION R-

KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU

THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI

AREA 8 M.L. 288


N
TRAMWAY → A.H. YEMIN
HILL 8 ← TRAMWAY
POSSIBLE
PROBABLE
PROVEN
ROAD
SCARP
COL. COLLAPSED
SAMPLE Nº
THICKNESS(m)
FAULT
SCALE: 1 : 2000
JOB No. 80012
AID No. 2630084
DWG. No. 119 - G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
ABU HAMAT SHEMAL M.L. 296 - 297



APPROVAL	DATE	SCALE: 1:500	DATE
		DESIGNED BY	
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		CHECKED BY	
		APPROVED BY	
		APPROVED BY	

INFORMATION CONFIDENTIAL. ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS, INC., AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PREPARED.

JOB No. 80012

AID No. 2630084

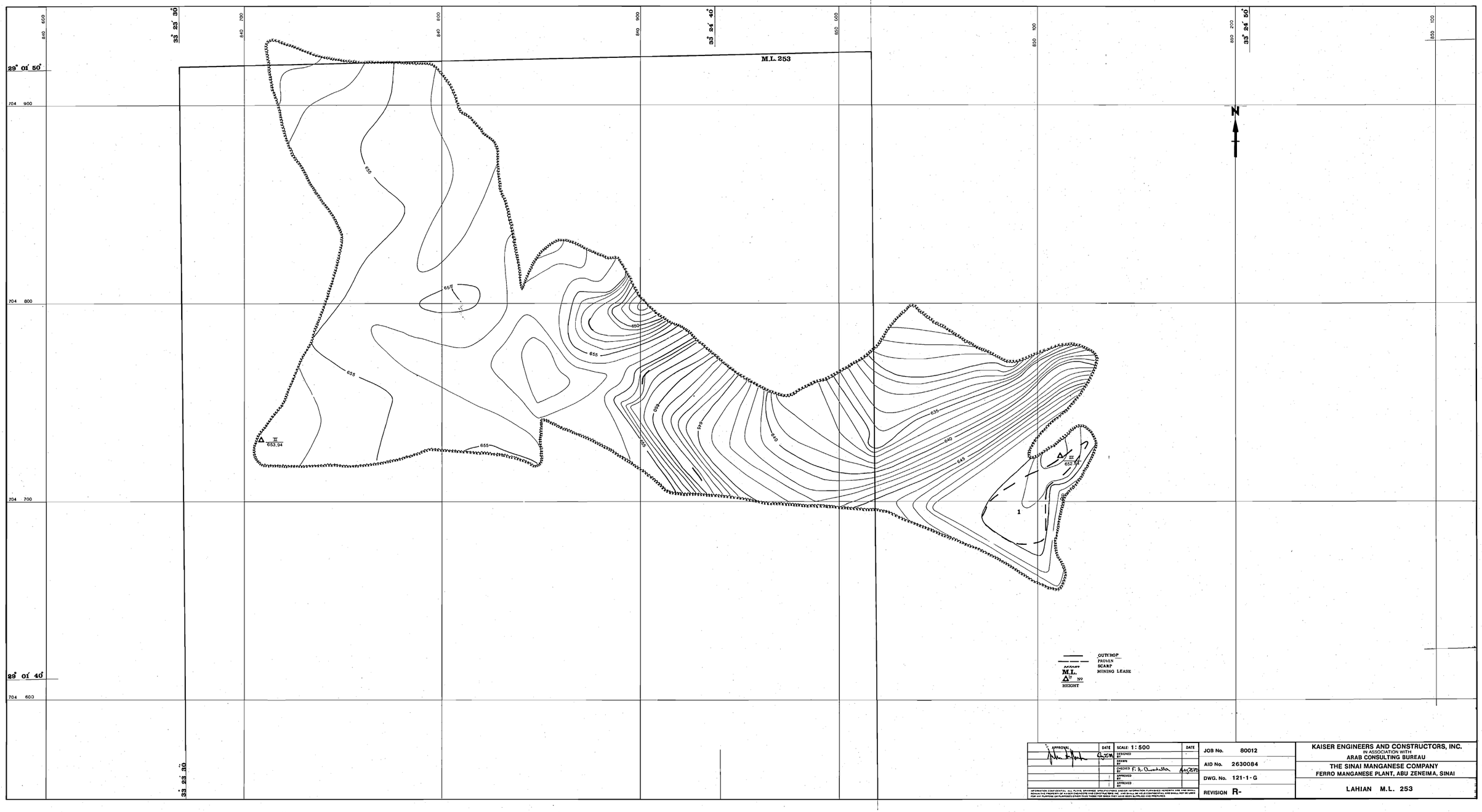
DWG. No. 120 - G

REVISION R-

KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU

THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI

ABU HAMAT SHEMAL M.L. 296 - 297


M.L. 253
29° 01' 50"
29° 01' 40"
33° 23' 30"
33° 24' 40"
33° 24' 50"
33° 23' 30"
704 900
704 800
704 700
704 600
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655
650
645
640
635
II
653.94
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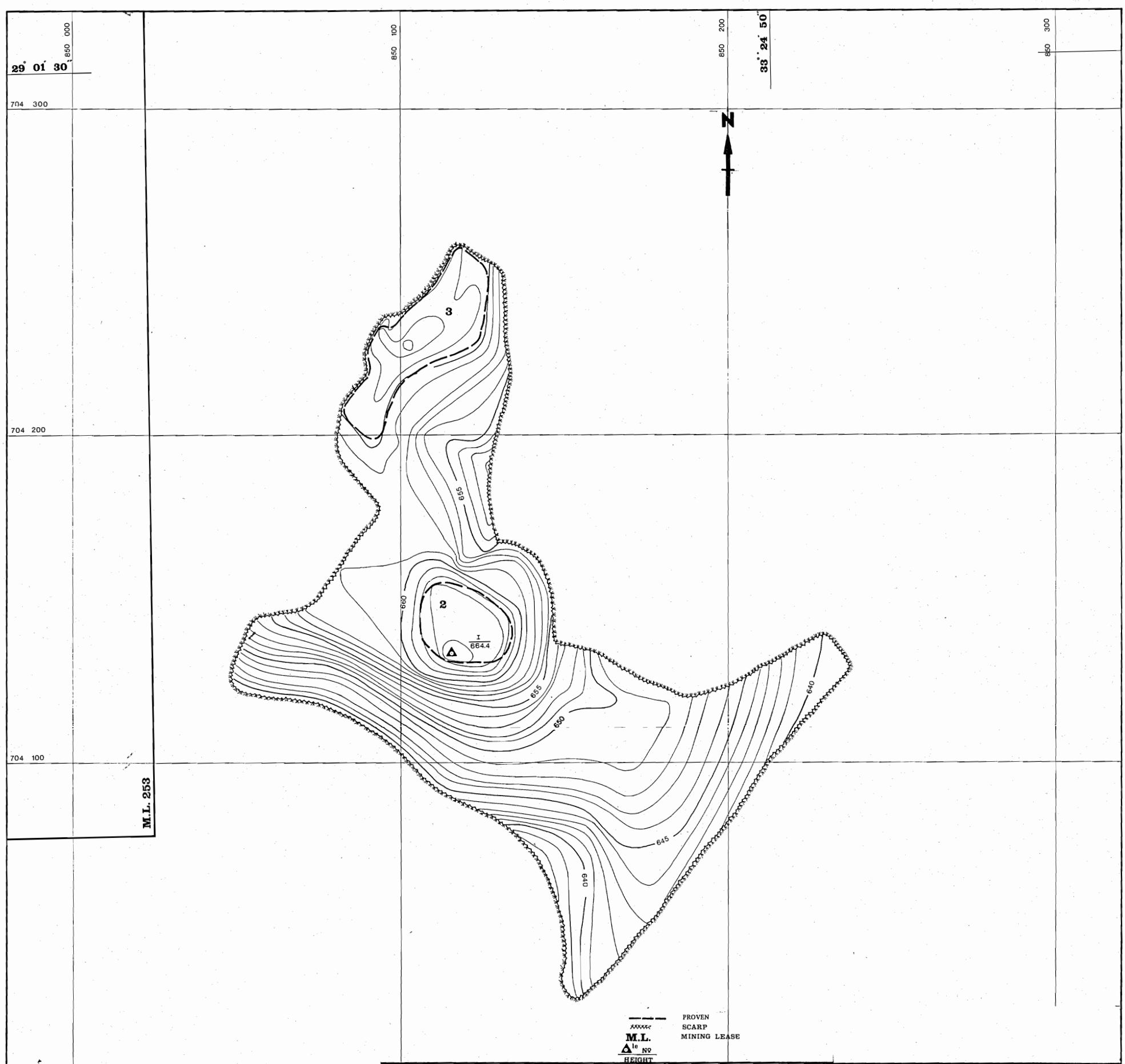
652.94
1
OUTCROP
PROVEN
SCARP
MINING LEASE
M.L.
NO
HEIGHT
APPROVAL
DATE
SCALE: 1:500
DATE
DESIGNED BY
DRAWN BY
CHECKED
APPROVED BY
APPROVED BY
JOB No. 80012
AID No. 2630084
DWG. No. 121-1-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
LAHIAN M.L. 253



APPROVAL	DATE	SCALE: 1 : 500	DATE
		DESIGNED BY	
		DRAWN BY	
		CHECKED BY F.A. Awadalla	
		APPROVED BY	
		APPROVED BY	

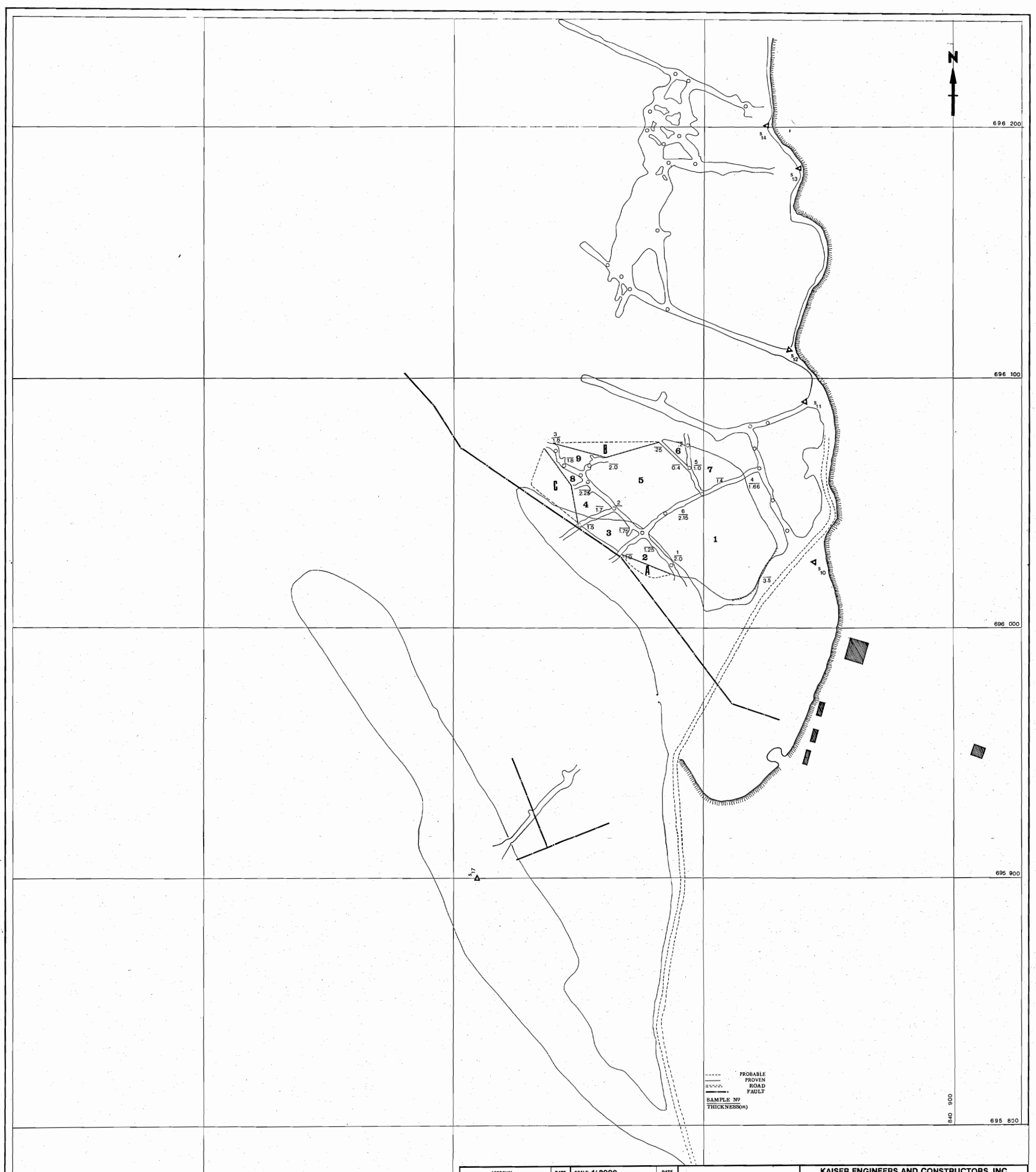
INFORMATION CONFIDENTIAL: ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS, INC., AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PREPARED.

JOB No.	80012
AID No.	2630084
DWG. No.	121-2-G
REVISION	R-

KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU

THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI

LAHIAN M.L. 253



APPROVAL	DATE	SCALE: 1:2000	DATE
		DESIGNED BY	
		DRAWN BY	
		CHECKED BY	
		APPROVED BY	
		APPROVED BY	

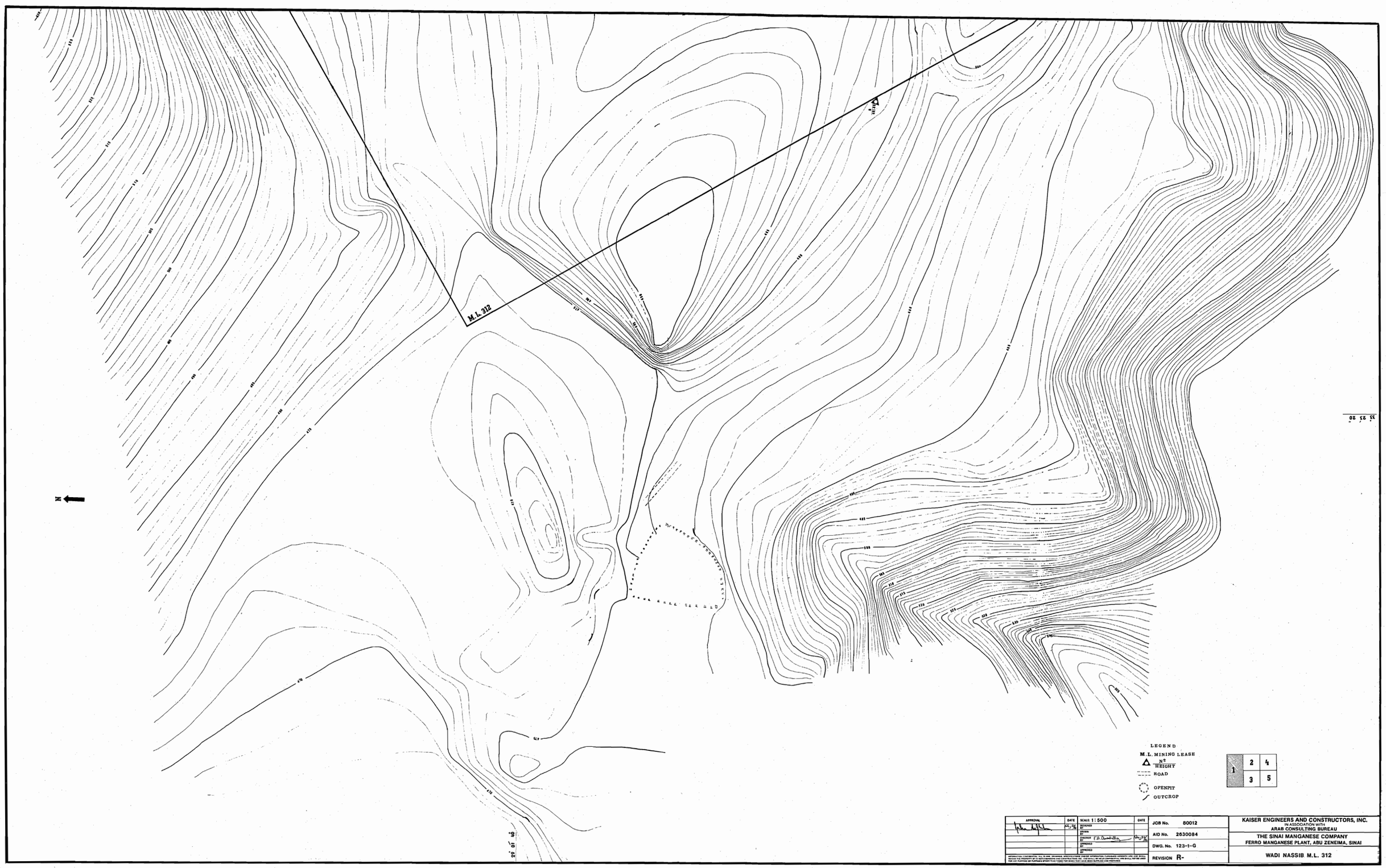
INFORMATION CONFIDENTIAL. ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS, INC. AND SHALL BE HELD CONFIDENTIAL, AND SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PREPARED.

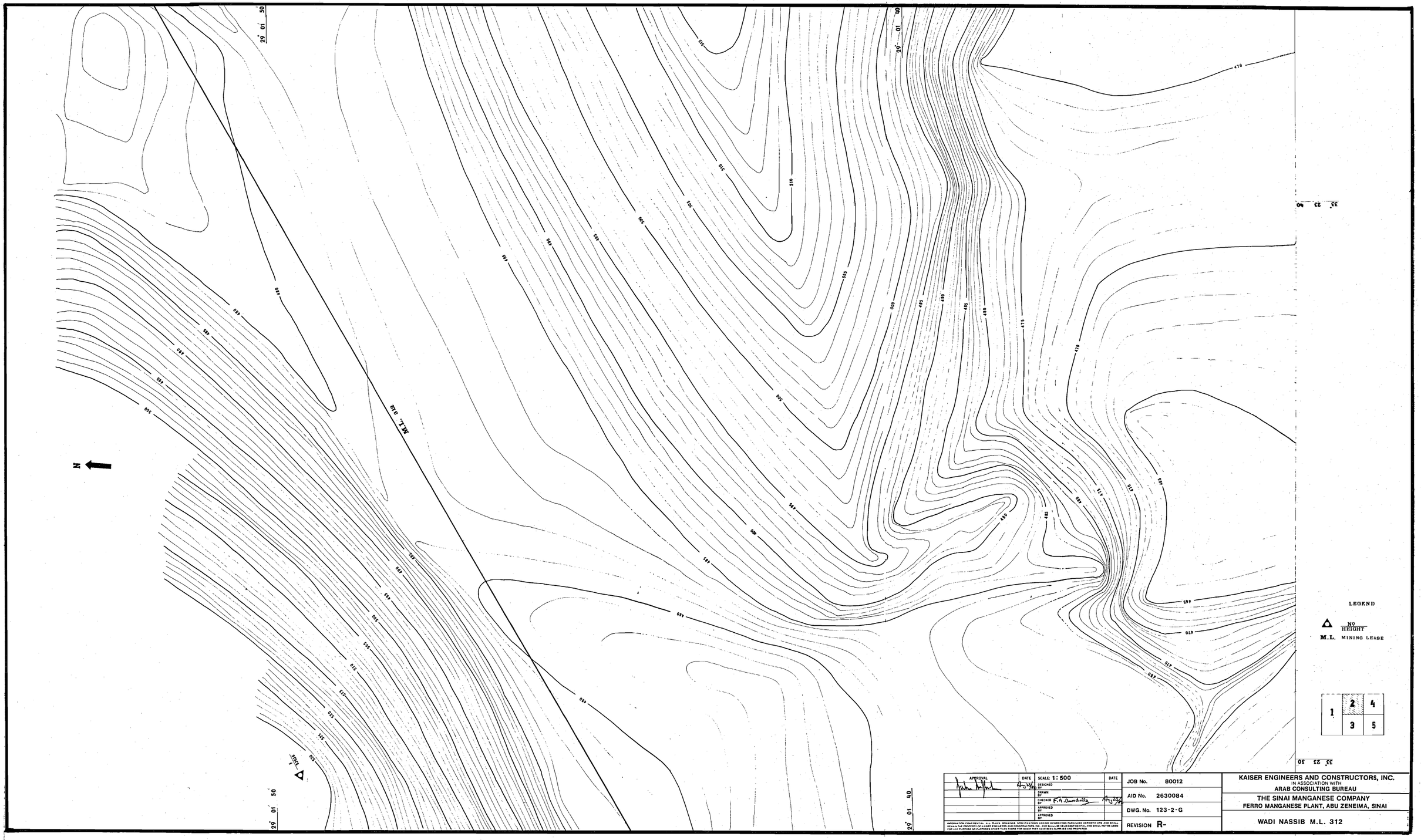
JOB No.	80012
AID No.	2630084
DWG. No.	122-G
REVISION	R-

KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU

THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI

AREA 45 M.L. 292


M.L. 312
N
LEGEND
M.L. MINING LEASE
Nº
HEIGHT
ROAD
OPENPIT
OUTCROP
1
2
4
3
5
APPROVAL
DATE
SCALE 1:500
DATE
DESIGNED BY
DRAWN BY
CHECKED BY
APPROVED BY
APPROVED BY
JOB No. 80012
AID No. 2630084
DWG. No. 123-1-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
WADI NASSIB M.L. 312



APPROVAL	DATE	SCALE: 1:500	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. IN ASSOCIATION WITH ARAB CONSULTING BUREAU
		DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		DRAWN BY		DWG. No. 123-2-G	WADI NASSIB M.L. 312
		CHECKED BY F.A. Dandashly		REVISION R-	
		APPROVED BY			
		APPROVED BY			

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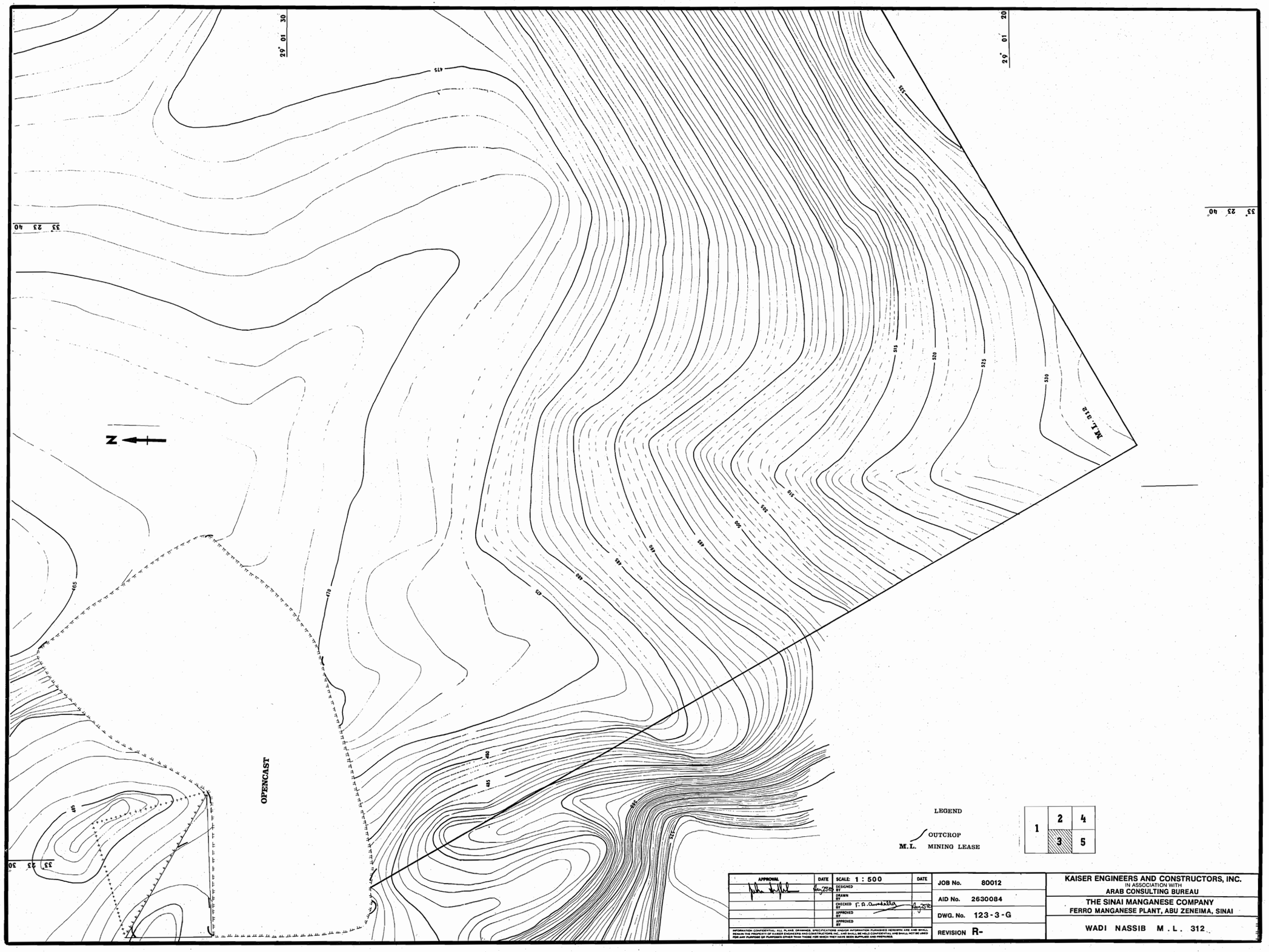
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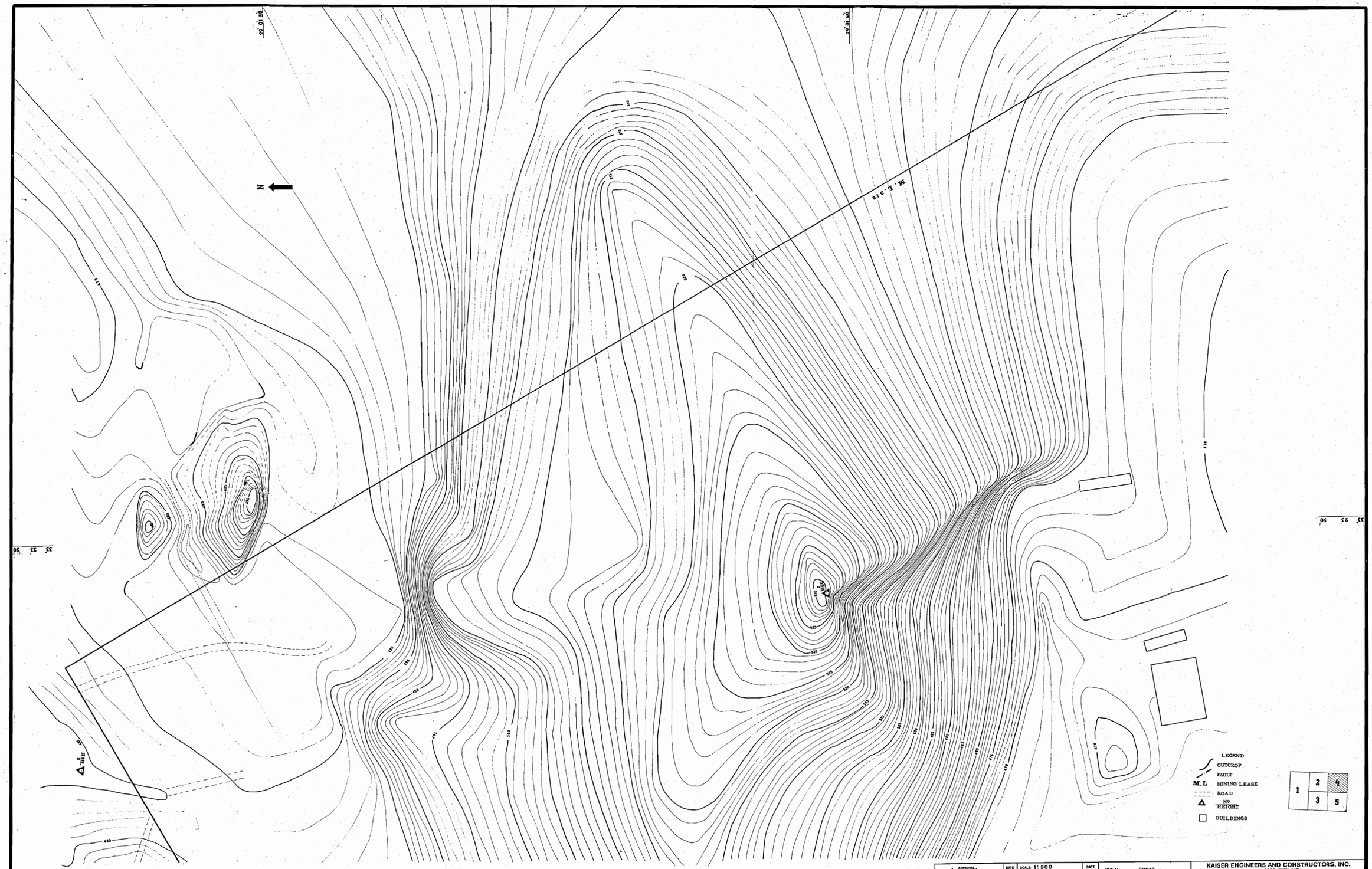
DESIGNED BY
DRAWN BY
CHECKED BY
APPROVED BY
APPROVED BY
JOB No. 80012
AID No. 2630084
DWG. No. 123-3-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
WADI NASSIB M.L. 312



APPROVAL	DATE	SCALE: 1:500	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. IN ASSOCIATION WITH ARAB CONSULTING BUREAU
		DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		DRAWN BY		DWG. No. 123-4-G	WADI NASSIB M.L. 312
		CHECKED BY F.A. Dwindell		REVISION R-	
		APPROVED BY			
		APPROVED BY			

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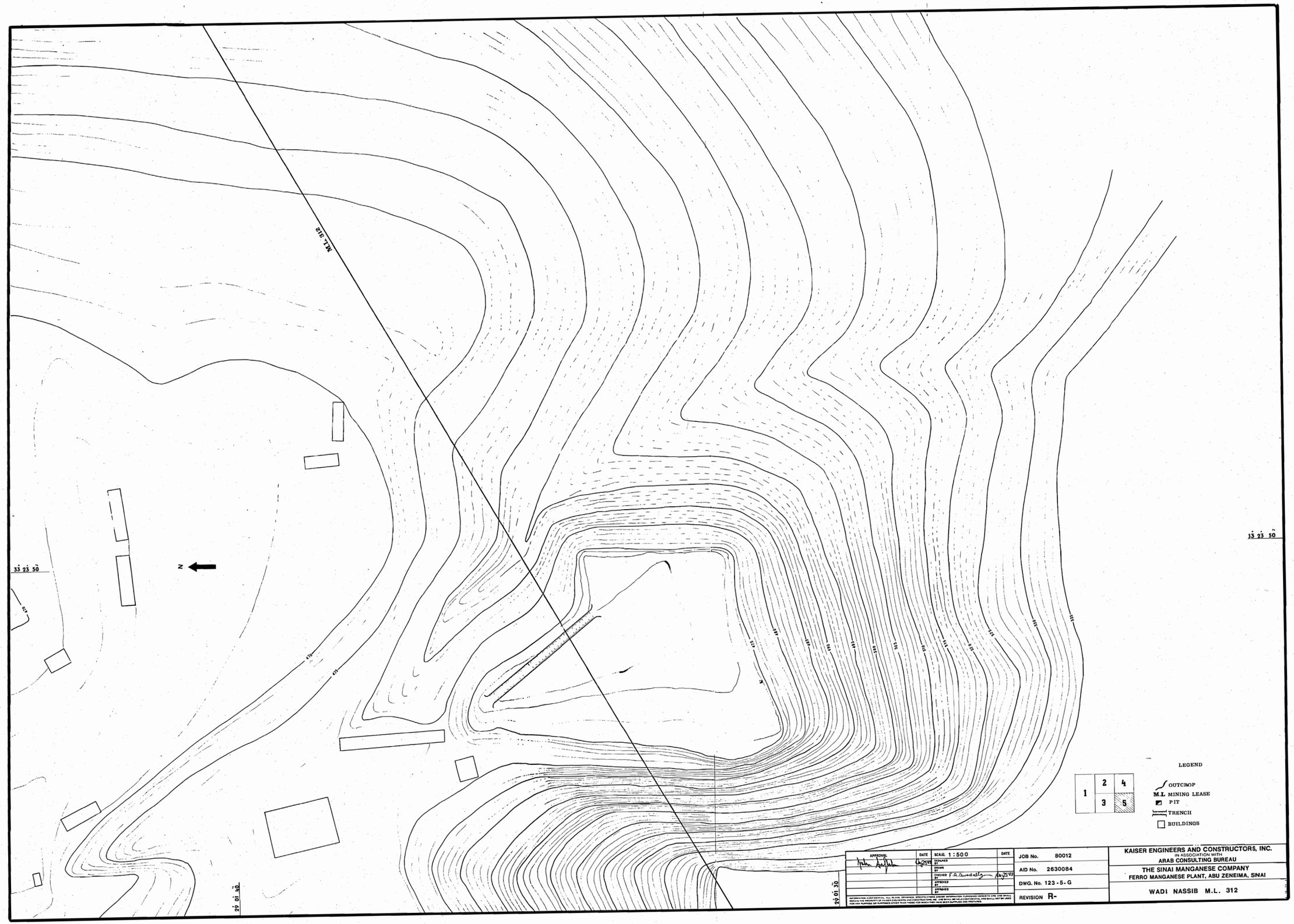
M.L. 312
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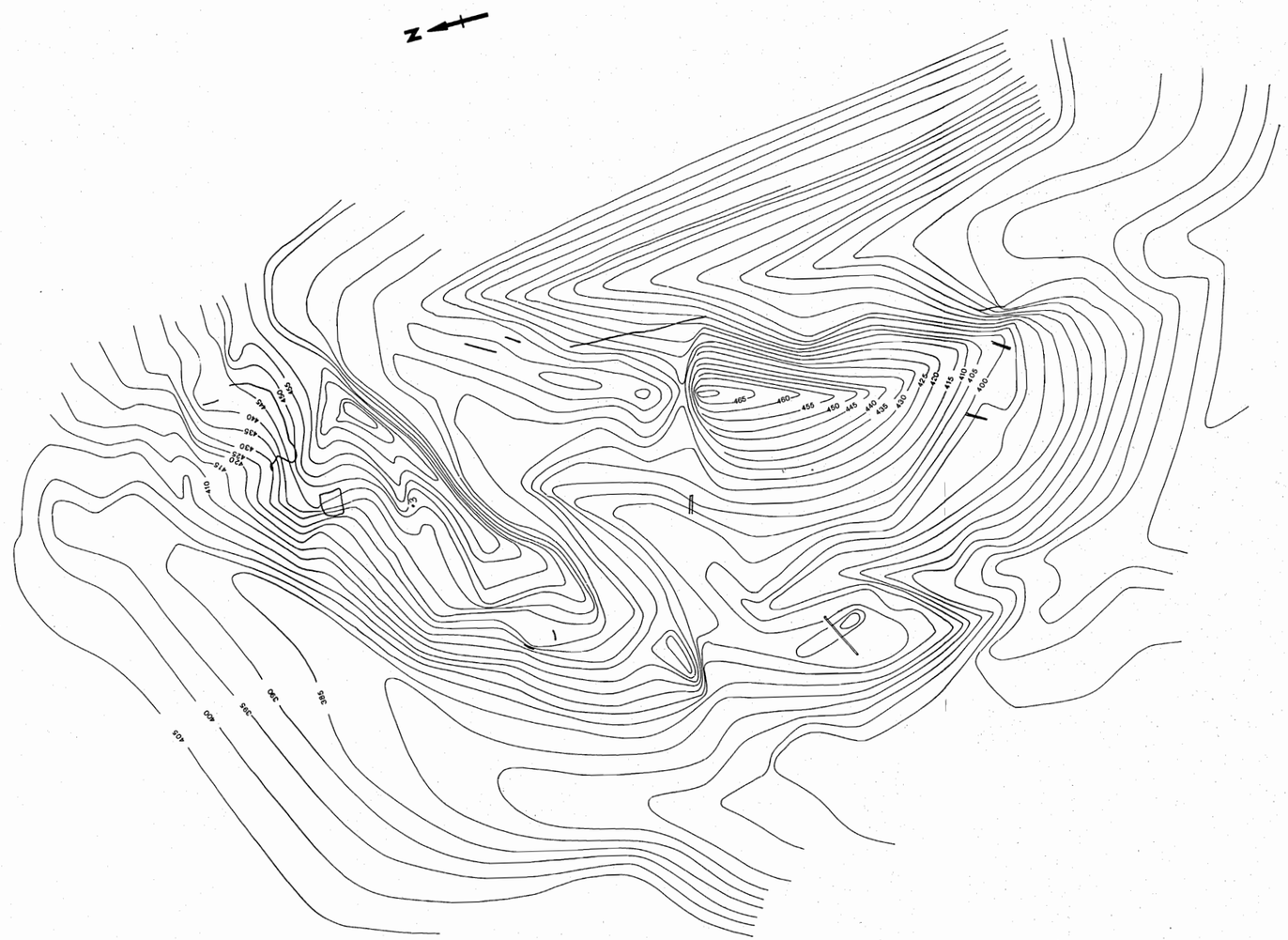
CHECKED
APPROVED
JOB No. 80012
AID No. 2630084
DWG. No. 123-5-G
REVISION R-
KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU
THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
WADI NASSIB M.L. 312



APPROVAL	DATE	SCALE: 1:1000	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. IN ASSOCIATION WITH ARAB CONSULTING BUREAU
		DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		DRAWN BY		DWG. No. 124-G	
		CHECKED BY		REVISION R-	EL HIMERA
		APPROVED BY			
		APPROVED BY			

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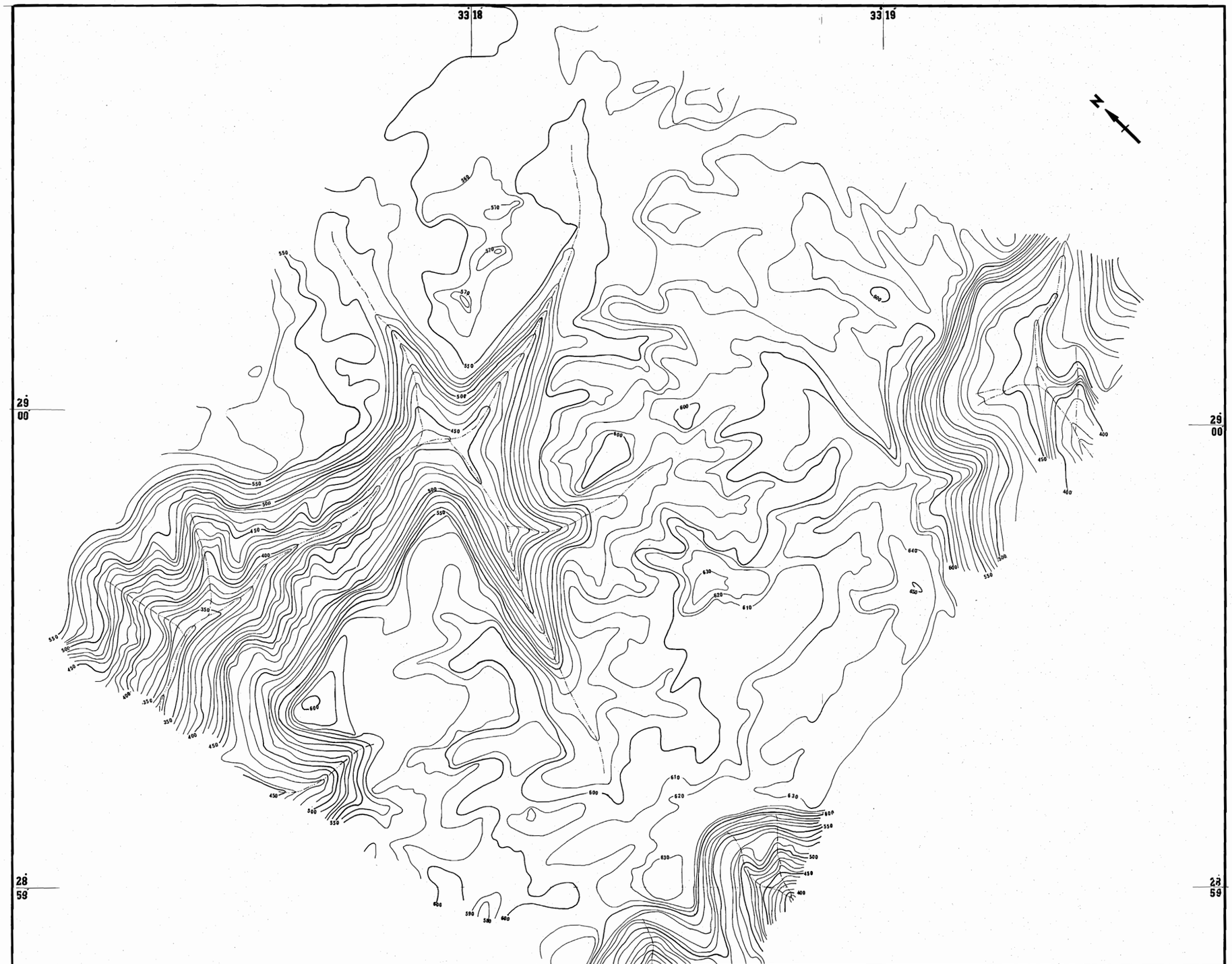


APPROVAL	DATE	SCALE: 1:5000	DATE
		DESIGNED BY	
		DRAWN BY	
		CHECKED BY	
		APPROVED BY	
		APPROVED BY	

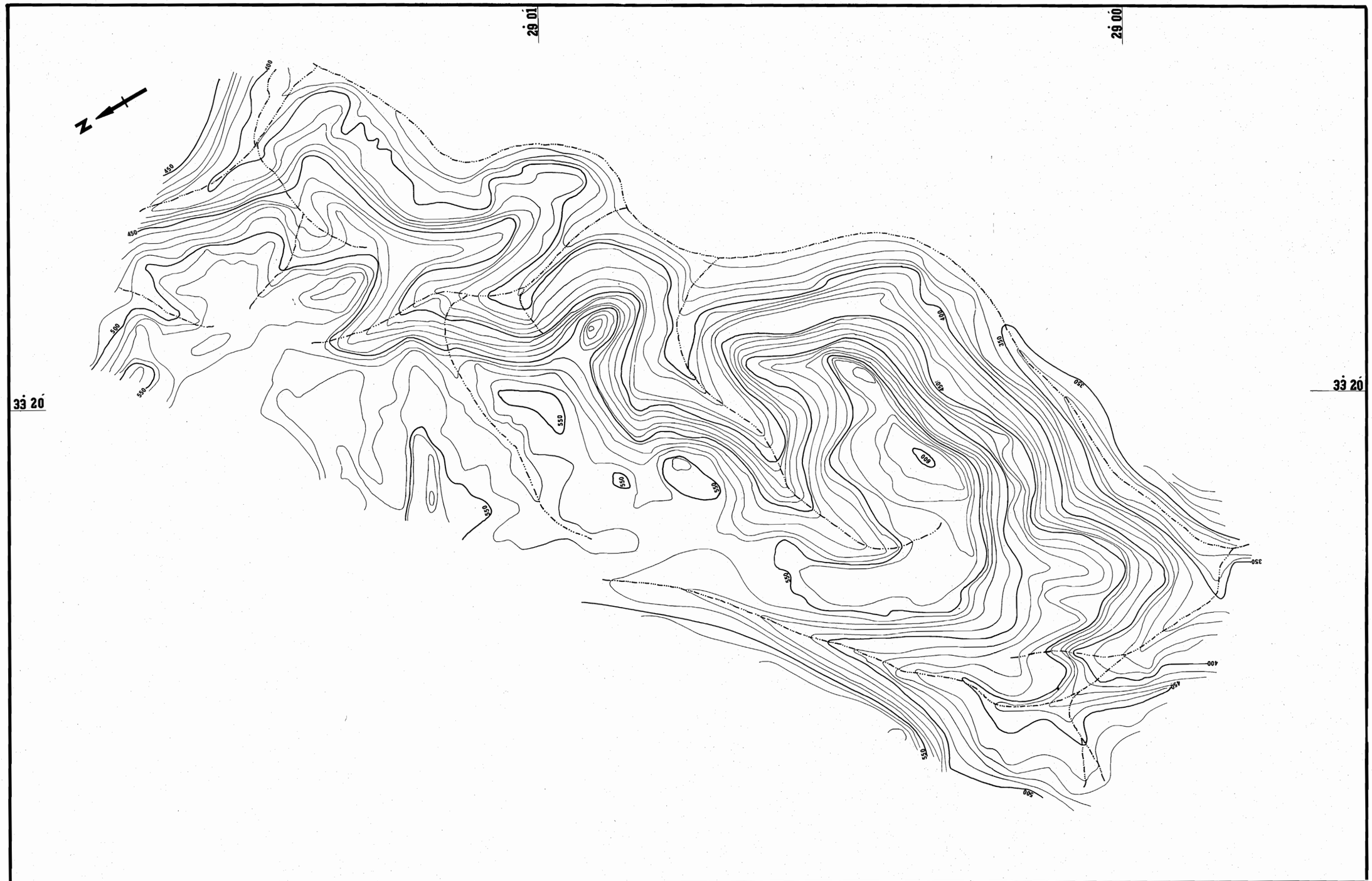
INFORMATION CONFIDENTIAL. ALL PLANS, DRAWINGS, SPECIFICATIONS AND/OR INFORMATION FURNISHED HEREWITH ARE AND SHALL REMAIN THE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS, INC. AND SHALL BE HELD CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PROVIDED.

JOB No.	80012
AID No.	2630084
DWG. No.	125-G
REVISION	R-

KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU

THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI

AREA (A)



APPROVAL	DATE	SCALE: 1:5000	DATE	JOB No. 80012	KAISER ENGINEERS AND CONSTRUCTORS, INC. IN ASSOCIATION WITH ARAB CONSULTING BUREAU
	Aug 25 80	DESIGNED BY		AID No. 2630084	THE SINAI MANGANESE COMPANY FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI
		DRAWN BY		DWG. No. 126-G	
		CHECKED BY	Aug 25 80	REVISION R-	AREA (B)
		APPROVED BY			
		APPROVED BY			

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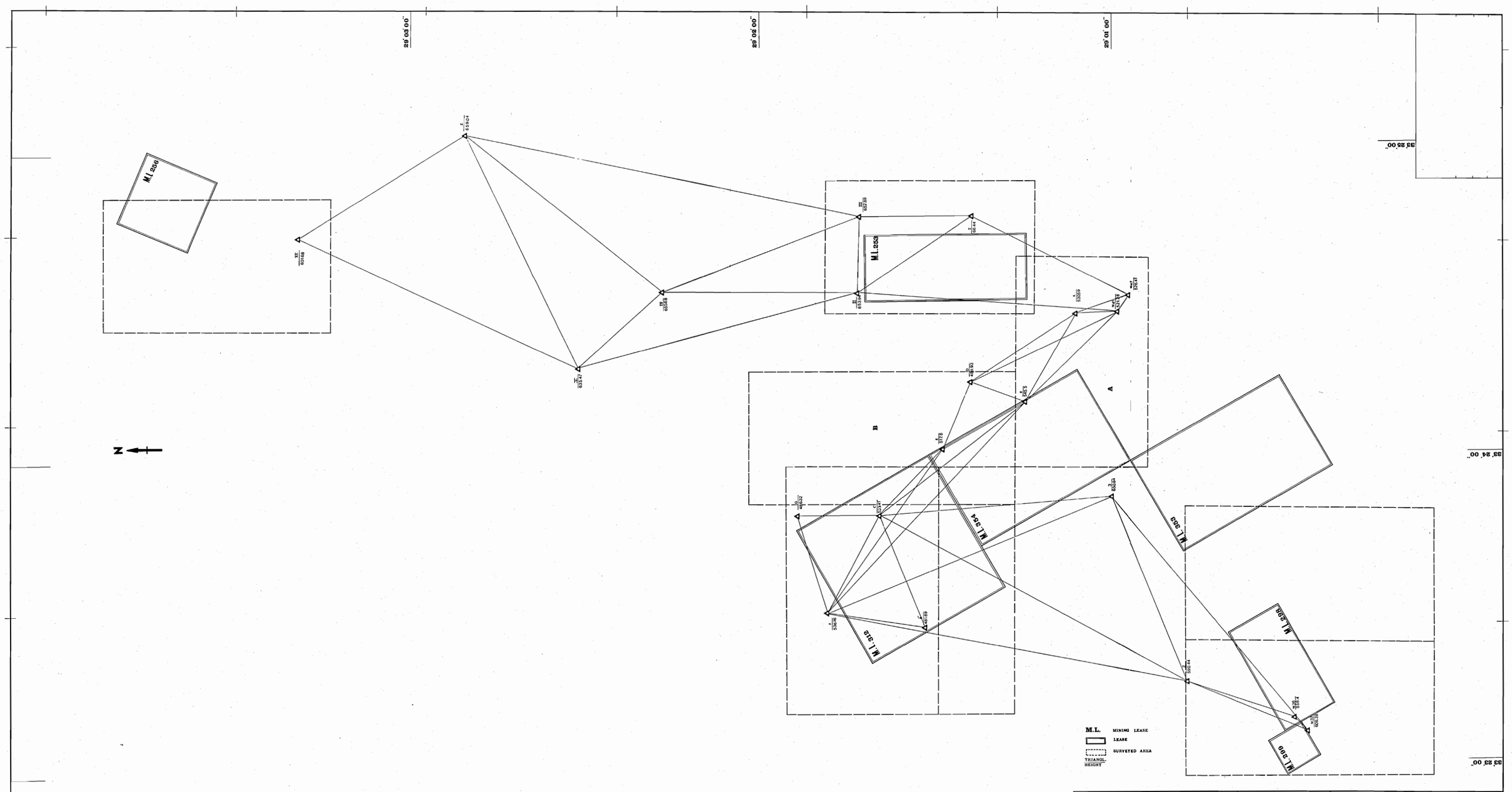

APPROVAL	DATE	SCALE: 1:500	DATE
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INFORMATION CONFIDENTIAL. ALL PLANS, SPECIFICATIONS AND INFORMATION FURNISHED HEREWITH ARE THE SOLE PROPERTY OF KAISER ENGINEERS AND CONSTRUCTORS, INC. THEY SHALL BE KEPT CONFIDENTIAL AND SHALL NOT BE USED FOR ANY PURPOSE OR PURPOSES OTHER THAN THOSE FOR WHICH THEY HAVE BEEN SUPPLIED AND PROVIDED.

JOB No.	80012
AID No.	2630084
DWG. No.	127 - G
REVISION	R-

KAISER ENGINEERS AND CONSTRUCTORS, INC.
IN ASSOCIATION WITH
ARAB CONSULTING BUREAU

THE SINAI MANGANESE COMPANY
FERRO MANGANESE PLANT, ABU ZENEIMA, SINAI

KEY SURVEY MAP

EL RAMSY M.L. 367

Quantity

Kind of Reserves	Block No.	Area m^2	Av. Thick m	Volume m^3	Cavaties m^3	Net Volume m^3	sp. gr.	Tonnage
Proven	1	5000	4.03	20150	-	20150	3	60450
	2	8000	2.125	17000	388	16662	3	49986
	3	8520	5.54	47201	1488	45712	3	137136
	4	11520	0.945	10866	439	10447	3	31341
	5	12580	1.70	21386	-	21386	3	64158
	Total							343,071
Probable	6	10,200	2.485	25,347	-	25347	3	76,041
						Grand Total		419,112

Quality of Proven Ore

The proven ore reserves chamical analysis are as follows:

Total Tonnage	Bl. No.	Block Tonnage	Sam. No.	Block Analysis Mn %	Block Analysis Fe %	Block Analysis L.O.I. %	Mean Mn %	Mean Fe %	Thick m
343071	1	60450	23	21.87	23.90	16.59	21.87	23.90	4.2
	2	49986	7	2019	19.81	15.1			1.5
			8	19.32	31.20	12.46			1.0
			9	8.55	27.74	14.26	19.35	26.25	2.0
	3	137136	11	9.88	38.84	12.99			5.35
			12	21.12	24.38	11.57			4.90
			13	43.29	14.75	6.09	24.76	25.99	5.84
	4	31341	14	13.74	39.69	8.68	13.74	39.69	4.55
	5	64158	18	29.63	27.12	13.09			1.0
			19	35.33	21.35	13.43			3.8
			20	18.84	32.20	11.86			1.0
			21	31.45	19.72	12.99	28.81	25.10	1.0
			Arthmetic Mean				23.21	26.74	A
			Geometric Mean				22.74	26.28	G

ALLUGA M.L. 353,354

Quantity

Kind of Reserves	Bl. No.	Area m^2	Thick m^3	Volume m^3	Cavaties m^3	Net Volume m^3	sp. gr.	Tonnage
Proven	1	7700	1.38	10626	363	10253	3	30759
	2	3860	0.98	3783	441	3342	3	10026
	4	8200	1.06	8692	394	8298	3	24894
	5	3620	1.08	3910	194	3716	3	11148
	6	624	0.76	474	68	406	3	1218
	7A	198	0.80	158	-	158.4	3	475.2
	Total							78,520.2
Probable	1A	1480	0.75	1110	-	1110	3	3330
Possible	1-B	625	0.6	375	-	375	3	1125
	1-C	2500	0.6	1500	-	1500	3	4500
	3-A	1598	0.8	1278	-	1278.4	3	3835.2
	4-A	1640	0.6	984.0	-	984	3	2952
	4-B	640	1.35	864	-	864	3	2592
	6-A	2134	0.60	1280.4	-	1280.4	3	3841.2
	7-B	180	0.80	144	-	144	3	432
	Total							19,277.4
						Grand Total		102,048.9

Quality of Proven Ore

Total Tonnage	Bl. No.	Block Tonnage	Sam. No.	Block Analysis Mn %	Block Analysis Fe %	Block Analysis L.O.I.	Mean Mn %	Mean Fe %	Thick m
78520	1	30759	95	34.94	22.25	14.11	34.94	22.25	1.1
	2	10026	93	26.78	31.65	9.92	26.78	31.65	1.7
	4	24894	90	21.96	36.33	9.38			1.25
			91	29.86	19.82	11.17	25.91	28.07	1.18
	5	11148	87	4.47	42.22	14.23			0.7
			89	45.50	6.22	6.22	24.98	28.72	1.1
			Arithmetic Mean				29.43	25.23	A
			Geometric Mean				30.04	25.88	G

AREA NO. 8 M.L. 288

Quantity

Kind of Reserves	Bl. No.	Area m^2	Av. Thick m	Volume m^3	Cavaties m^3	Net Volume m^3	Sp. Gr.	Tonnage
Proven	ALL AREA	11,630	4.60	53,498	-	53,498	3	160,494

Total Tonnage	Sam. No.	Block Analysis Mn %	Block Analysis Fe %	Block Analysis L.O.I.	Mean Mn %	Mean Fe %	Thick m
	51	26.75	32.44	9.1			5.00
	52	24.65	34.25	44.68			3.60
	53	20.98	38.47	9.37			5.00
	54	28.98	31.27	9.56			5.50
	55	15.92	43.31	6.35			3.65
	56	26.01	33.36	4.16			4.10
	57	28.57	15.91	14.27			3.60
	58	39.39	20.27	11.40			2.96
	59	15.27	39.68	9.92			3.70
	60	20.97	38.31	7.94			3.90
	61	34.82	20.72	12.97			5.00
		Arithmetic Mean			25.66	31.69	A
		Geometric Mean			25.72	31.64	G

ABU THOR M.L. 293

Quantity

Kind of Reserves	Block No.	Area m^2	Av. Thick m	Volume m^3	Cavities m^3	Net Volume m^3	Sp. Gr.	Tonnage
	1-A	3520	1.16	4083	365	3718	3	11154
	2	1760	1.20	2112	162	1950	3	5850
Proven	3	3760	1.50	5640	405	5235	3	15705
	4	1840	0.90	1656	81	1575	3	4725
	5	2160	0.85	1836	90	1746	3	5238
	Total							42,672
Probable	1-B	820	3.10	2542	1271	1271	3	3813
						Grand Total		183,708

Quality of Proven Ore

Total Tonnage	Bl. No.	Block Tonnage	Sam. No.	Block Analysis Mn %	Block Analysis Fe %	Block Analysis L.O.I.%	Mean Mn %	Mean Fe %	Thick m
42672	1-A	11154	77	26.01	24.88	12.83			1.2
			78	42.85	17.21	12.14			2.9
			79	24.48	24.00	10.67	31.11	22.03	2.8
	2	5850	80	29.49	27.77	8.32			1.0
			83	42.80	2.90	12.18	36.15	15.34	0.85
	3	15705	81	44.33	14.34	3.43			1.20
			82	46.98	11.34	13.22	45.66	12.84	1.00
	4	4725	84	33.98	21.29	5.81	33.98	21.29	1.4
	5	5238	85	41.99	15.50	13.38	41.99	15.50	1.27
				Arithmetic Mean			38.81	16.85	A
				Geometric Mean			39.04	16.84	G

ABU THOR M.L. 401, 402

Quantity

Kind of Reserves	Block No.	Area m^2	Av. Thick m	Volume m^3	Cavities m^3	Net Volume m^3	Sp. Gr.	Tonnage
Proven	1	640	2.32	1485	180	1305	3	3915
	2	5080	1.13	5740	220	5520	3	16560
	Total							20,475
Probable	3	5120	1.20	6144	25	6119	3	18357
						Grand Total		38,832

Quality of Proven Ore

Total Tonnage	Bl. No.	Block Tonnage	Sam. No.	Block Analysis Mn %	Block Analysis Fe %	Block Analysis L.O.I.%	Mean Mn %	Mean Fe %	Thick m
20475	1	3915	73	26.55	26.23	11.39	26.55	26.23	1.0
	2	16560	74	55.75	4.07	5.14			1.4
			75	35.74	8.37	14.58			1.0
			76	13.95	30.17	13.13	35.15	14.20	1.0
				Arithmetic Mean			33.51	16.5	A
				Geometric Mean			35.46	15.15	G

ABU HAMAT LEFT M.L. 296, 297

Quantity

Kind of Reserves	Block No.	Area m^2	Av. Thick m	Volume m^3	Cavities m^3	Net Volume m^3	Sp. Gr.	Tonnage
Proven	1	1095	1.28	1402	-	1402	3	4206
	2	820	2.25	1845	-	1845	3	5535
	3	4320	1.66	7171	-	7171	3	21513
	4	2072	2.5	5810	-	5180	3	15540
	Total							46,794
Probable	8-B	594	1.35	802	-	802	3	2406
	10-B	385	2.16	832	-	832	3	2496
	9-A	748	1.37	1025	103	922	3	2766
	11-A	520	1.50	780	-	780	3	2340
	TOTAL							10,008
Possible	8-A	961	1.10	1057	-	1057	3	3170
	10-A	1024	2.16	2212	-	2212	3	6636
	9-B	110	1.00	110	-	110	3	330
	12	236	0.70	165.2	-	165.2	3	495.6
	Total							14,721.6
						Grand Total		71,523.6

Quality of Proven Ore

Total Tonnage	Sam. No.	Block Analysis Mn %	Block Analysis Fe %	Block Analysis L.O.I.%	Mean Mn %	Mean Fe %	
46794	31	25.35	30.30	8.54			
Pillars: A sample of R.O.M. represent all mine					25.35	30.33	A + G

AREA NO. 45 M.L. 292

Quantity

Kind of Reserves	Block No.	Area m	Av. Thick m	Volume m^3	Cavaties m^3	Net Volume m^3	Sp. Gr.	Tonnage
Proven	1	1500	1.99	2985	-	2985	3	8955
	2	109	1.41	154	-	154	3	462
	3	167	1.795	300	-	300	3	900
	4	125	1.816	227	-	227	3	681
	5	885	1.378	1220	-	1220	3	3660
	6	38	0.462	18	-	18	3	54
	7	216	1.065	230	-	230	3	690
	8	45	1.95	88	-	88	3	264
	9	84	1.866	157	-	157	3	471
	Total					5,379	3	16,137
Probable	A	58	1.50	87	-	87	3	261
	B	135	1.35	182	-	182	3	546
	C	248	1.85	459	-	459	3	1377
	Total					728	3	2,184
						Grand Total		18,321

Quality of Proven Ore

Total Tonnage	Bl. No.	Block Tonnage	Sam. No.	Block Analysis Mn %	Block Analysis Fe %	Block Analysis L.O.I.	Mean Mn %	Mean Fe %	Thick m
16,137	1	8,955	1	16.62	17.22	14.88			2.00
			4	23.22	35.07	6.81			1.66
			6	52.95	3.95	14.25	30.92	18.75	
	3+4+5	5,241	2	36.59	15.39	11.85	36.59	15.39	
	6+7		5	23.92	15.38	7.53	23.92	15.38	1.0
	8+9	735	3	28.10	32.14	9.96	28.10	32.14	1.80
	2	462	1	16.62	17.22	14.88	16.62	17.22	2.00
				Arithmetic Mean			31.90	18.07	
				Geometric Mean			32.47	15.42	

ABU HAMAT RIGHT M.L. 291,300

Quantity

Kind of Reserves	Block No.	Area m^3	Av. Thick m	Volume m^3	Cavities m^3	Net Volume m^3	Sp. Gr.	Tonnage
Proven	1	1524	1.83	2789	-	2789	3	8367
	2	2489	1.20	2987	-	2987	3	8961
	3	2664	1.10	2930	-	2930	3	8790
	4	1931	1.50	2897	-	2897	3	8691
	5	1856	1.40	2598	-	2598	3	7794
	6	16500	1.30	21450	1306	20144	3	60432
	8	1596	0.89	1420	107	1313	3	3939
	Total					35,658	3	106,974
Probable	7	1200	1.05	1260	173	1087	3	3261
	16	11440	1.23	14300	210	14090	3	42270
	Total							45,531
Possible	6A	1175	0.8	940	-	940	3	2820
	6B	266	0.8	212.8	-	212.8	3	638.4
	6C	840	1.6	1344	-	1344	3	4032
	6D	731	1.5	1096.5	-	1096.5	3	3289.5
	7A	1200	0.4	480	-	480	3	1480
	9	450	0.76	344	23	321	3	963
	10	3575	1.00	3575	-	3575	3	10725
	11	300	0.8	240	-	240	3	720
	12	722	1.3	938	-	938	3	2815.8
	13	900	0.8	720	-	720	3	2160
	14	1408	0.8	1126.4	-	1126.4	3	3379.2
	15	2940	0.8	2352	-	2352	3	7056
	Total							40,078.9
						Grand Total		192,583.9

N.B. Blocks 1, 2, 3, 4 & 5 are shown on map scale 1:500.

Quality of Proven Ore

Total Tonnage	Bl. No.	Block Tonnage	Sam. No.	Block Analysis Mn %	Block Analysis Fe %	Block Analysis L.O.I. %	Mean Mn %	Mean Fe %	Thick m
106,974	1+2+	42,603	48	19.57	44.03	7.41	19.57	44.03	
	3+4+5	60,432	39	32.20	20.03	10.80			1.7
	6		40	17.99	38.38	9.67			1.12
			41	22.80	35.74	8.16			2.1
			42	22.10	38.88	8.03			1.5
			43	17.65	32.15	12.07	23.75	33.04	1.5
	8	3,939	47	38.96	3.32	15.92	38.96	3.32	
				Arithmetic Mean			22.65	36.32	A
				Geometric Mean			22.65	36.11	G

ABU ZARAB M.L. 298,299

Quantity

Kind of Reserves	Block No.	Area m^2	Av. Thick m	Volume m^3	Cavities m^3	Net Volume m^3	Sp. Gr.	Tonnage
Proven	1	2940	2.56	6644	-	6644	3	19932
	2	16280	1.41	22555	930	22025	3	66075
	5	9400	1.11	10434	313	10121	3	30363
	Total					38,790	3	116,370
Probable	2A	1200	1.54	1848	-	1848	3	5544
	6	2088	1.50	3132	-	3132	3	9396
	Total							14,940
Possible	2B	3600	1.10	3960	-	3960	3	11880
	2C	300	0.95	285	-	285	3	855
	2D	500	1.10	550	-	550	3	1650
	3	324	0.76	246	-	246	3	738
	4	11560	0.75	8670	-	8670	3	26010
	5A	900	1.30	1170	-	1170	3	3510
	5B	2750	0.94	2585	-	2585	3	7755
						Grand Total		183,708

N.B. The quantity of ore in Block No. 4 not reviewed due to the collapses blocking the entrance, considered possible.

Quality of Proven Ore

Total Tonnage	Bl. No.	Block Tonnage	Sam. No.	Block Analysis Mn %	Block Analysis Fe %	Block Analysis L.O.I. %	Mean Mn %	Mean Fe %	Thick m
116,370	1	19932	34	22.88	33.01	9.19	22.88	33.01	
	2	66075	62	21.41	31.60	8.80			1.25
			63	38.59	22.27	4.32			0.93
			64	33.44	24.33	10.00			2.00
			65	59.67	9.08	3.01			1.50
			66	46.42	16.04	10.40			1.44
			67	25.58	36.96	7.2	37.52	23.21	0.36
	5	30363	69	46.89	3.93	16.81			0.74
			70	11.02	38.03	12.88			0.94
			71	16.92	38.16	5.14			1.50
			72	6.70	46.08	7.09	20.26	31.55	1.33
				Arithmetic Mean			30.51	27.06	A
				Geometric Mean			30.87	26.69	G

ABO KAFAS M.L. 266-267

Quantity

Kind of Reserves	Block No.	Area m^2	Av. Thick m	Volume m^3	Cavities m^3	Net Volume m^3	Sp. Gr.	Tonnage
Proven	3	276	0.72	198.7			3	596.1
	4	677.5	0.86	582.7			3	1748.1
	6	975	2.0	1950			3	5850.0
	10	318.75	1.15	366.56			3	1099.68
	Total							9.293.88
Probable	1-B	500	0.70	350			3	1050
	13	14	6.0	84			3	252
	Total							1,302
Proven	1-A	2845	0.70	1991.5			3	5974.5
	2	4104	0.70	2872.8			3	8618.4
	5	370	0.86	318.2			3	954.6
	7	378.75	2.00	757.5			3	2272.5
	8	367.50	2.00	735			3	2205
	9	315	2.00	630			3	1890
	11	322.5	2.00	645			3	1935
	12	36.0	6.00	216			3	648
	Total							24,498
						Grand Total		35,093.88

Quality of Proven Ore

Total Tonnage	Bl. No.	Block Tonnage	Sam. No.	Block Analysis Mn.%	Block Analysis Fe %	Block Analysis L.O.I.%	Mean Mn %	Mean Fe %	Thick m
9293		4 blocks	167	24.84	23.66	13.04	24.84	23.66	1.18

LAHIAN AREA M.L. 253

Quantity

Kind of Reserves	Block No.	Area m^2	Av. Thick m	Volume m^3	Cavities m^3	Net Volume m^3	Sp. Gr.	Tonnage
	1	1045	1.00	1045			3	3135
Proven	2	559	1.00	559			3	1677
	3	1000	1.00	1000			3	3000
	Total							7,812

Quality of Proven Ore

Total Tonnage	Bl. No.	Block Tonnage	Sam. No.	Block Analysis Mn %	Block Analysis Fe %	Block Analysis L.O.I.%	Mean Mn %	Mean Fe %	Thick m
7812			144	27.66	16.83	12.70	27.66	16.83	1.0

OM SYLAT AREA (EL HESSENIA) M.L. 311

Quantity

Kind of Reserves	Block No.	Area m^2	Av. Thick m	Volume m^3	Cavities m^3	Net Volume m^3	Sp. Gr.	Tonnage
Proven	III	4490	1.5	6735.0			3	20205.0
	IV	7700	1.5	11550.0			3	34650.0
	Total							54,855.0
Probable	IA	1375	1.5	2062.5			3	6187.5
	IIA	1012.5	1.5	1518.75			3	4556.25
	Total							10,743.75
Possible	IB	2583.0	1.5	3874.5			3	11623.5
	IIB	600.0	1.5	900.0			3	2700.0
	IVB	4500.0	1.5	6750.0			3	20250.0
	Total							34,573.5
						Grand Total		100,172.25

Quality of Proven Ore

Total Tonnage	Bl. No.	Block Tonnage	Sam. No.	Block Analysis Mn %	Block Analysis Fe %	Block Analysis L.O.I.%	Mean Mn %	Mean Fe %	Thick m
54855	III	20205	110	18.46	34.25	9.09			2.0
			111	39.39	6.70	4.97	28.93	20.48	2.0
	IV	34650	104	35.29	22.92	11.19			5.0
			105	24.02	31.73	8.32			4.0
			106	25.13	30.06	10.73			3.5
			107	44.76	16.00	12.43	32.30	25.18	2.5
				Arithmetic Mean			31.06	23.45	A
				Geometric Mean			30.55	23.83	G

AL ZOBEIR AREA M.L. 256

Quantity

Kind of Reserves	Block No.	Area m^2	Av. Thick m	Volume m^3	Cavities m^3	Net Volume m^3	Sp. Gr.	Tonnage
Proven	1	910	1.00	910			3	2730
	2	7240	1.00	7240			3	21720
	Total							24,450

Adding the dump due to the exploitation, was done only for dioxide:

61830 tonnes
36703 tonnes

98533 tonnes

Quality of Proven Ore

Total Tonnage	Bl. No.	Block Tonnage	Sam. No.	Block Analysis Mn %	Block Analysis Fe %	Block Analysis L.O.I.%	Mean Mn %	Mean Fe %	Thick m
24450	2 blocks 1 + 2		122	29.74	29.04	4.56	29.74	29.04	
98533	dump		123	39.43	2.35	4.73			
			124	30.80	11.67	4.64			
			125	49.50	8.64	12.95			
			126	19.82	41.29	6.29	34.89	15.99	

W. NASSIB M.L. 312

Quantity

Kind of Reserves	Block No.	Area m^2	Av. Thick m	Volume m^3	Cavities m^3	Net Volume m^3	Sp. Gr.	Tonnage
Proven		1200	1.00	1200			3	3600
Possible		1300	1.00	1300			3	3900
						Grand Total		8,500

Quality of Proven Ore

Total Tonnage	Bl. No.	Block Tonnage	Sam. No.	Block Analysis Mn %	Block Analysis Fe %	Block Analysis L.O.I.%	Mean Mn %	Mean Fe %	Thick m
3600			138	42.81	1.57	10.98			
			141	20.96	33.20	11.82			
							31.89	17.39	

Inaccurate definitions are the cause of confusion and often of legal battles leading to prosecution for misleading information. Now at last, a committee culled from three organizations has formulated the definitions of various terms used for commercial evaluation of mineral deposits.

Let's Define Our Terms in Mineral Valuation

Armine F. Banfield, Behre Dolbear & Co., Inc.
John F. Havard, Kaiser Engineers

Sooner or later, we all get involved in the economic study and valuation of a mineral deposit. To communicate clearly the necessary information, we must scrupulously use various terms with specific meaning.

All these terms—such as ore, exploration, development, production, reserves, proven ore, probable ore, possible reserves, resources, as well as similar terms applying to coal—are continually on the lips of anyone who reports on the economic aspects of a mineral deposit at the exploration, development, and production stages. The meaning of these terms is even more important in feasibility studies to determine whether a deposit should be put into production. Finally, careless use of these terms in reports published for public financing may, and sometimes does, lead to prosecution of the writer for misleading information.

Some of these terms have been defined by government agencies for use in matters in which they are concerned, for example, the Internal Revenue Service, the Securities and Exchange Commission, and the Department of the Interior.

Recognizing that people in the mineral industry itself should define these terms, Dr. Banfield suggested that a joint committee representing the technical societies be established to study the subject and to make recommendations before the terms were defined by others, especially by the courts where precedence is so important. That was almost four years ago. Today, the task has been completed (see box).

In this article, we will review the work accomplished by the Joint Committee on Definitions, present some background data, and explain how and why the committee arrived at its recommended definitions. We will also review the actions taken by the three Societies that sponsored the Joint Committee: American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME); Society of Economic Geologists (SEG); and the American Institute of Professional Geologists (AIPG)—and particularly the Working Party appointed by the Society of Mining Engineers (SME) of AIME.

Previous Definitions

The terms under consideration have been defined by government agencies in the US, as well as by technical societies in the US, Canada, Australia, and England. The terms have also been defined in prominent textbooks used in teaching economic geology in colleges and universities. In most cases each definition reflects the particular interest of the definer; therefore, none is universally applicable.

In recommending a definition, considerable attention must be given to current usage in the country where the definition is to be used. For example, a widespread sampling in the US indicated that the profit aspect must be included in any definition of the term "ore;" however, according to the results of a study in England, the profit aspect is not necessarily a part of the definition of ore.

The comments that follow indicate the wide variety of existing definitions. It was this variety that prompted the attempt to arrive at nationally acceptable definitions.

United States—On May 17, 1943, the US Department of the Interior issued a new method of classifying ore reserves for use by the US Bureau of Mines (USBM) and by the US Geological Survey (USGS). The purpose in issuing these definitions was to ensure uniformity in the large number of reports being written during the wartime crash programs. Since that time, these definitions have been widely used, partly because they were issued by a government agency. One criticism by those engaged in actual mining is that the definitions of measured ore and inferred ore are too broad.

On April 15, 1974, the Secretary of the Interior released a revised set of definitions adopted by the USBM and the USGS. These definitions are discussed later in this article.

The US Securities and Exchange Commissions adopted, on September 19, 1957, definitions of the terms "ore," "proven ore," and "probable ore." The latter two are almost identical with those proposed by Herbert C. Hoover in 1909 in his book on the "Principles of Mining."

Glossaries published by the USBM and by the American Geological Institute also contain definitions of some of these terms.

"Words and Phrases," a periodic legal encyclopedia, contains some definitions that have been dictated by the courts.

Canada—In 1968, a Committee of the Canadian Institute of Mining and Metallurgy discussed ore definitions in general use in its own mining industry. In 1969, the Association of Professional Engineers of the Province of Ontario issued a booklet containing definitions approved for use by members of the association.

Australia—In April 1972, the Australasian Institute of Mining and Metallurgy and the Australian Mining Industry Council issued a "Report by Joint Committee on Ore Reserves," containing definitions of ore and related terms.

Much of the background for this article is in "Ore Reserves, Feasibility Studies and Valuations of Mineral Properties," presented by A. F. Banfield at the 1972 AIME Annual Meeting in San Francisco.

England—The Institution of Mining and Metallurgy, London, has studied the definition at various times, starting in 1901. The latest definition of "ore" was approved on April 14, 1955, and of ore reserves on January 10, 1961.

France and Other European Countries—Inquiries carried out in 1972 and 1973 did not disclose any definitions by government agencies or technical societies in France.

Johan W. Brinck of the Directorate-General for Energy and Euratom Safeguards of the Commission of the European Communities replied in December 1972 that the terminology in use by the Directorate-General follows closely the recommendations made by F. Blondel and S. G. Lasky in their report of 1956 on behalf of and approved by the international committee of SEG.

Joint AIME-AIPG-SEG Committee

At the 1969 spring meeting of the New York Section of the AIPG, in response to a request by the Institute's president, R. Dana Russell, for projects that might be undertaken by the Institute, Dr. Armine F. Banfield suggested that the Institute should begin to define those terms most used by the metallic and nonmetallic mining industry, e.g., such terms as "ore," "reserves," "ore reserves," "exploration," "development," and the categories into which ore reserves might be subdivided. Dr. Banfield pointed out that the Society of Petroleum Engineers of AIME had adopted definitions of proven reserves for evaluation of petroleum and natural gas properties in June 1965. To assure acceptance, it was recommended that the definitions should be drawn up by representatives of the most prominent societies in the mineral industry.

Dr. Russell discussed the matter with Dr. James Boyd, president of AIME, and Dr. F. S. Turneaure, president of SEG. The result was formation of a Joint Committee on Definitions. Dr. Armine F. Banfield represented AIPG, as chairman; Norman H. Donald, Jr. represented AIME, and Lowell B. Moon represented SEG as members.

Report of 1972—At the second meeting of the committee, it was decided to subdivide the investigation as follows: (a) private mining industry, including textbooks; (b) government agencies, federal and state, particularly the bureaus of mines and the geological surveys; (c) US Securities and Exchange Commission and similar state regulatory agencies; (d) Internal Revenue Service; (e) courts of law up to the Supreme Court.

The scope of the project was expanded to include definitions adopted by governments or recognized societies in Australia, Canada, England, and France.

The work was divided among the committee members and a thorough search of all sources of data begun. The committee met periodically to review progress. Comments were requested by notices in the publications of the three Societies but only a small number were received. Some of the findings were given in the paper presented by Dr. Banfield at the 1972 Annual AIME Meeting in San Francisco.

The committee submitted a set of definitions on April 24, 1972, to the presidents of the three professional Societies.

The proposed definitions were published in AIPG's "The Professional Geologist." The secretary of SEG asked for comments from its members. AIME took no action.

Definitions of Ore and Related Terms

General

Ore—A natural aggregate of one or more solid minerals which can be mined, or from which one or more mineral products can be extracted, at a profit.

Exploration—The search for a mineral deposit (prospecting) and the subsequent investigation of any deposit found until an ore body, if such exists, has been established.

Development—Work done on a mineral deposit, after exploration has disclosed ore in sufficient quantity and quality to justify extraction, in order to make the ore available for mining.

Production—The mining of ores and, as required, the subsequent processing into products ready for marketing.

Reserves

Reserves—Mineralized material in an identified deposit which may be shown by exploration to contain ore under certain economic conditions. Reserves may be described as proven, probable, or possible, depending upon the degree to which dimensions, grade, metallurgical characteristics, and continuity have been established by sampling. When used in context with ore deposits, the terms "ore reserves" and "reserves" are synonymous.

Proven Ore—An ore reserve so extensively sampled that the tonnage, grade, geometry, and recoverability of the ore within the block or blocks of ground under consideration can be computed with sufficient accuracy so that the uncertainties involved would not be a factor in determining the positive feasibility of a mining operation.

Probable Ore—An ore reserve for which sufficient continuity of dimensions and grade can be assumed for preliminary financial planning, but for which the risk of failure in continuity is greater than for proven ore.

Possible Reserves—Mineralized material of which the dimensions and grade are based on geologic correlation between samples so widely spaced or so erratic that additional exploration is required to establish whether ore reserves are present.

Coal—The above definitions of ore reserves can be applied to coal with appropriate modifications and with due regard to rank, grade, seam thickness, overburden, and recoverability.

Resources

The above definitions of reserves are recommended for the purposes of commercial evaluation.

The terminology adopted by the US Bureau of Mines and the US Geological Survey, as released to the public on April 15, 1974, is recognized terminology for the classification of mineral resources.

Report of 1973—As a result of the SEG secretary's request, thoughtful replies were received—some several pages long—from persons in industry, government, educational institutions, and from abroad.*

* Paul A. Bailly, C. L. Beaumont, James Boyd, James C. Bradbury, M. H. Brady, Robert W. Bridgman, Johan W. Brinck, A. E. Buller, W. H. Callahan, Jean-Paul Drolet, E. F. Fitzhugh, Jr., S. O. Ford, Y. O. Fortier, R. M. Grogan, R. B. Hoy, H. F. King, Lawrence Y. Marks, Sanchez P. Mejorada, Felix Mendelsohn, Kenneth M. Reim, Ora H. Rostad, H. T. Schassburger, Ward C. Smith, Robert H. Stebbins, J. A. Thomas, Edwin W. Tooker, L. L. Werts, Walter S. White, John A. Wolfe, R. J. Wright, J. Zwartendyk.

The comments figured importantly in the committee's final draft, but the variety of opinions was significant. One of the contributors, Sanchez P. Mejorada, expressed a general conclusion: "Reading the various commentaries to the definitions proposed by the. . . . Joint Committee, I realize it is almost impossible to cover every possible case with a simple, universal definition." Yet most contributors felt it worth the effort. While by no means agreeing with everything, E. F. Fitzhugh, Jr. expressed an opinion shared in different degrees by many others: "For communication between persons of seasoned judgment and good faith, the definitions are excellent and delightfully succinct."

All letters were read and discussed by members of the committee and a revised set of definitions submitted to the presidents of the three Societies on February 23, 1973.

Action by Societies on Joint Committee

The definitions were accepted by the National Board of AIPG at the Annual Meeting in New Orleans in October 1973.

At its meeting in February 1974, the Council of SEG voted to accept the report of the committee, an action similar to that of 1956 when it accepted the report of Blondel and Laskey.

The AIME referred the matter to the Society of Mining Engineers of AIME.

At the SME Board meeting in Dallas, February 1974, the chairman of the Joint Committee requested that the SME take action on the 1973 report. The president appointed Jack F. Havard as chairman of a working party to be composed of members chosen from industry, government, academic, and legal spheres, with instructions to report back to the board on September 22, 1974, at Acapulco.

Formation of SME Working Party

After appointing the members of the Working Party,* its chairman requested comments on the definitions recommended in the February 23, 1973, report by the AIME-AIPG-SEG Joint Committee on Definitions. A few of these comments are quoted below to highlight basic positions. As in all partial quotations, some of the qualifications and details included in the total statements are omitted for lack of space, with some loss of the value of the full discussions.

Dr. Stewart R. Wallace of Mine Finders, Inc., Denver, made major contributions to the final approved version of the Societies' definitions. Some of his comments not included within the definitions are thought provoking. For instance, he criticized the use of the word "viable" in an early version of the definitions. "I know that the words 'viable' and 'viability' are very much in vogue, but I consider these to be 'Madison Avenue' terms and I do not like them," said Wallace. "Viable refers to organic things and is said of some unborn or newly born (especially premature) animals that are fully enough developed to live, or of a seed capable of living and growing into a plant. I realize that viability, as used in the definition of proven ore, refers to a mining operation (which can grow in a manner of speaking) and not the orebody itself. Nonetheless, to condone its inclusion here is to further encourage the use of the term 'viable orebody' which is completely wrong as it is commonly used; an orebody 'grows' only during formation, and indeed does quite the opposite during its extraction."

John A. Hall, vice-president—mine projects for Noranda Mines Ltd., Dr. W. L. Brown, vice-president and general manager of Noranda Exploration Co., Ltd., and their associates provided the Canadian viewpoint in discussing the proposed definitions. They emphasized that "possible or inferred ore involves a high risk factor and this should be stated." Also this important point: "When quoting grades of proven ore, dilution factors should be shown and reasons for the use of these dilution factors clearly explained."

The SME Committee sought the opinion of a mining-oriented attorney to supplement the findings of other attorneys consulted by the original Joint Committee. Robert P. Davison, of Holland and Hart, Denver, suggested certain more precise wording which was incorporated in the final version of the definitions, whose brevity and simplicity should insure a uniform acceptance in commercial evaluations of solid mineral reserves. According to Davison, "There are no conflicts between the proposed definitions and the definitions adopted by the courts for similar terms. Actually, the judicial definitions vary depending upon the nature of the case in which the definition was pronounced (i.e. income tax matters, discovery under the mining laws) and the mineral involved (lead, coal, limestone, clay, petroleum). The new set of definitions should be helpful here . . . Perhaps I am over-sensitive on definitions but I have noted many times in government contests including validity of claims, that the expert witness, after having said that *ore* exists, then goes on to recommend further *exploration* although he undoubtedly meant *development*. This loose usage of language permits a hearing examiner to determine that in reality no valuable deposit had been discovered because more exploration was necessary."

J. C. Kinnear, Jr., vice-president—administration for Kennecott Copper Corp., commenting on the final draft, suggested that "the committee definitions be adopted for economic evaluation of reserves, in contrast with the federal definitions which will serve well for describing resources. This seems to be an appropriate division of the two possibly conflicting definitions."

> "I think the (committee's definitions) . . . will admirably suit the needs for commercial evaluation of reserves, and find these to be clear, concise, and readily understood."
>
> —F.C. Appleyard, United States Gypsum Co.

F. C. Appleyard, director of mining and exploration for United States Gypsum Co., believes the new definitions by the federal agencies and by the Societies both fill a need for general understanding. He also notes that: "The USBM/USGS definition of measured reserves in the April 15, 1974, news release was somewhat surprising in that it calls for a computation 'within a margin of error of less than 20% . . .' This does not seem practical, as there is no way to know how accurate the reserve forecast is until the orebody has been mined out, and it would seem that the requirements of a specific degree of accuracy would result in either no measured reserves, or in the establishment of so many qualifications that the category becomes meaningless.

* Frank C. Appleyard, US Gypsum Company; Robert P. Davison, attorney, Denver; Herbert D. Drechsler, Columbia University; Thomas V. Falkie, Director, US Bureau of Mines; Philip W. Guild, US Geological Survey; John A. Hall, Noranda Mines Ltd.; John C. Kinnear, Kennecott Copper Corp.; Hugh J. Leach, Cleveland Cliffs Iron Company; Charles B. Tillson, Jr., Kaiser Engineers; Stewart R. Wallace, Mine Finders, Inc.

Thus, any attempt to quantify the definitions should be avoided, as the committee has wisely done. I think the (committee's definitions) . . . will admirably suit the needs for *commercial evaluation of reserves,* and find these to be clear, concise, and readily understood."

H. J. Leach, vice-president—research and development for Cleveland-Cliffs Iron Co., commented: "We are satisfied with the definitions and concur in the recommendations. . ." .

The final quotation must come from the Noranda geologists: "You don't *'produce'* ore, although the term is used loosely in mining. God does that."

After lengthy correspondence and discussions, the Working Party agreed upon some minor clarifying modifications to the definitions and received concurrence in these modifications from the Joint Committee. Ten members voted for acceptance of the modified definitions. Dr. Thomas V. Falkie, USBM Director, abstained from voting on the definitions, preferring those adopted on April 15, 1974, by the Department of the Interior for use by the USBM and the USGS.

The Working Party recommended the revised definitions for approval of the Board of Directors of SME.

Mr. Havard submitted the recommended definitions of the Working Party to the SME Board of Directors at its meeting on September 22, 1974, at Acapulco. The Board voted to accept the report of the Working Party.

Position of the USBM and USGS

It is unfortunate that the AIME-AIPG-SEG Joint Committee and the government agencies did not work together to produce a set of timely definitions agreeable to all concerned. It may be, of course, that common definitions could not have been agreed upon because the needs of industry are different from those of government. While industry is more interested in reserves and practical working terms, government is more concerned with resources.

The AIME-AIPG-SEG Joint Committee and the SME Working Party believe that the definitions adopted for ore *reserves* and related terms and the categories into which ore reserves may be divided are more applicable to industry. They further believe that the definitions by the Department of the Interior should be used in discussing *resources*. The federal agencies do not agree.

Dr. Thomas V. Falkie, USBM Director, clearly expressed the agencies' viewpoint: "Until we find good reason for further change, we plan to adhere to our present classification and definitions—and hope you will find them acceptable also." He believes further discussions on terminology should take place between federal and industry people, with the inclusion of petroleum organizations.

Dr. Falkie further explained the agencies' position:

"The USGS and the USBM have jointly adopted the comprehensive classification of reserves and resources described in the enclosed news release of April 15, 1974, to which you referred. I have discussed your letter with Dr. V. E. McKelvey, Director of the Geological Survey.

"We concur in the recognition of the importance of clear and widely adopted definitions of these terms and that, in fact, is the reason for our own recent agreement. We recognize also that the differences in recently published definitions may be confusing to the public at a time when the need for understanding is reaching a new high.

"We believe the definitions in our classification conform fairly well with the sense of those in previous use, and that the classification itself helps to clarify the relationships between them. As you will recognize, the classification has had an evolutionary development, beginning with the terms introduced by the work of Blondel and Laskey under SEG auspices, and later work by McKelvey, then Brobst and Pratt, and finally joint Survey-Bureau analysis during the past year. Each of these efforts resulted in certain changes—fairly described, we think, as improvements—but we think we now have definitions and a classification that suit our needs very well. Furthermore, the resource terminology adopted by the Interior agencies is applicable to all commodities, whether metals, industrial minerals, chemical elements, or mineral fuels, and will provide a credible basis for comparisons between these diverse commodities.

> **"Until we find good reason for further change, we plan to adhere to our present classification and definitions—and hope you will find them acceptable also . . . We believe the definitions in our classifications conform fairly well with the sense of those in previous use, and that the classification itself helps to clarify the relationships between them.**
>
> **—Dr. Thomas V. Falkie, US Bureau of Mines**

"As was mentioned when the Survey and the Bureau adopted new terms in 1943, our needs for a classification may be somewhat different from the traditional needs of industry, for we are concerned not just with known deposits of minerals that can be mined now, but with the whole spectrum of deposits that may eventually be usable. Some of the terms in your attachment suggest that industry also needs a broader terminology than the three P's of former days. At the same time, though, industry still has need for such terms, for most of its work focuses on known currently workable deposits."

Dr. Falkie's position is amplified by Sheldon P. Wimpfen, Assistant Director—Mineral Supply, USBM.

". . . we prepared our terms to apply to all gaseous, liquid, or solid mineral resources and also in such a way that they might be understood by those not familiar with the mineral industry. Further, the terms we developed for resources and reserves in the November 1973 release represent an umbrella under which coal resource, petroleum, or any other special type of terminology could be developed that might be required.

"The (Societies') definitions do not fit these principles but appear to be restricted to solid minerals and would have to be strained to apply to many nonmetallic minerals. As an example, the term 'grade' could hardly apply to sand and gravel, nor would 'dimensions' apply to saline resources such as those being extracted from the Great Salt Lake. Further, the terminology such as 'grade' as opposed to 'quality', 'tonnage' as opposed to 'quantity,' and material within the block or blocks of 'ground' as opposed to 'location' makes sense to minerals but may not convey the same concept to others.

"I think an understanding of reserve-resource terms by those not working in the industry is more important now than ever before. We in the minerals industry are guilty, and have been for a long time, of talking largely to ourselves. Also we have failed to get our message across to the rest of the world in part by not having terminology understandable to laymen. The set of terms (by the agencies) represents some progress toward creating some understanding of terms on the part of legislators and others within government as well as that vast body of Americans that fail to realize the vital importance of minerals to our way of life."

Evaluation For Electric Power Research Institute

John J. Schanz, Jr., senior research associate for Resources for the Future, Inc., Washington, D.C., has just completed an examination of the resource classification by the US Department of Interior referred to above. The examination was sponsored by the Electric Power Research Institute. Mr. Schanz explains that the objective was not to develop new terms or methodology for resource estimation, but to "evaluate personally the usefulness of Interior's proposal and to address specifically the problem of its application to energy resources and, in particular, the newer energy forms."

In the course of this work, Mr. Schanz evaluated the usefulness of the new definitions adopted by SME, SEG, and AIPG.

He makes seven specific basic recommendations, mostly directed to the government agencies' definitions. Later in his paper, Mr. Schanz also makes recommendations on details of the Interior terminology and on energy resource terminology, both of which are outside the scope of this paper. But his first recommendation, directed to the Societies' definitions, is quite pertinent because it states: "That the proposal of the SME Committee on Definitions that there should be two sets of definitions, one for commercial use with respect to investment and property appraisals and the other for expressing broad geologic knowledge concerning resources, be endorsed. The terminology and definitions employed by the engineers have become too ingrained in practice to change and are too limited in scope to satisfy the need for resource assessments used in national planning. The real problem will be to keep these two sets of terms confined to their own arenas of communication. It would be helpful, because engineering data do contribute to the estimation of resources, if the pairs of terms—proven and measured, probable and indicated, and possible and inferred—could be kept as nearly comparable as is practicable. Since both sets of terms require application within established limits of either engineering or geologic certainty, this should be possible."

The authors of this paper agree with this recommendation.

About the Authors

Armine F. Banfield is president of Behre Dolbear & Co., Inc. (299 Park Ave., New York, NY 10017). He joined the firm in 1948 and became president in 1972. Dr. Banfield graduated from McGill Univ. with a B.Sc. in geology and later obtained a M.Sc. and Ph.D. from Northwestern Univ. His specialty is the estimation of ore reserves, particularly for senior financing, including the copper deposits of Lornex, Bouganville, Pickwe-Selibe(Botswana), and the five mines of former Roan Selection Trust in Zambia; potash deposits in Saskatchewan, Congo, Utah, and New Mexico; iron deposits in Labrador, Iran, Liberia, Ontario, and California; and molybdenum in New Mexico. He is a member of AIME and other professional organizations in the US and abroad. Dr. Banfield is a prolific writer and a contributing author of the **SME Mining Engineering Handbook.**

John F. Havard is senior vice-president of Kaiser Engineers, Div. of Kaiser Industries Corp. (Kaiser Center, 300 Lakeside Drive, Oakland, Calif. 94666). Before joining Kaiser, he was vice-president for Fibreboard Paper Products Corp. and Pabco Products Inc., chief engineer of mines for US Gypsum Co., and assistant resident manager for Potash Co. of America. He began his career in mining and minerals in 1929 while attending Montana School of Mines and the Univ. of Wisconsin, and was awarded two degrees in geology and two in mining engineering. A member of several professional organizations, Mr. Havard is President-Elect of the Society of Mining Engineers of AIME.

VII. CHEMICAL AND PHYSICAL CHARACTERISTICS

A. Introduction

The analysis carried out by the National Research Center in Cairo includes the following data:

1. Chemical Analysis

   - Complete analysis for manganese ores including SiO_2, Al_2O_3, TiO_2, MnO_2, MnO, Fe_2O_3, CaO, MgO, Na_2O, P_2O_5, AS_2O_3, ZnO, H_2O^+, CO_2 and H_2O^-, in 51 samples.
   - Partial analysis for manganese ores including total manganese, total iron and L.O.I., in 139 samples.
   - Complete analysis for gypsum and anhydrite including: SiO_2, TiO_2, Al_2O_3, MnO, MgO, CaO, Na_2O, CO_2, H_2O^+, H_2O^-, SO_3 and Cl in 12 samples.
   - Partial analysis for gypsum and anhydrite including CaO, MgO, SO_3, Cl, L.O.I. and H_2O^- in 18 samples.
   - Complete analysis for limestone and dolomite including: SiO_2, Al_2O_3, TiO_2, Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O, CO_2, H_2O^+ and H_2O^- in 4 samples.
   - Partial analysis for limestone and dolomite including: CaO, MgO, and L.O.I. in 11 samples.
   - Complete analysis for clays and kaolin including: SiO_2, Al_2O_3, TiO_2, Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O, CO_2, H_2O^+ and H_2O^- in 16 samples.
   - Complete analysis for glass sand including: SiO_2, Al_2O_3, TiO_2, Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O, CO_2, H_2O^+ and H_2O^- in 5 samples.

2. X-ray analysis of 30 samples of manganese ore, 12 samples of gypsum and anhydrite, 16 samples of clays and kaolin and 4 samples of limestone and dolomite.

3. Differential thermal and thermogravimetric analysis of manganese ores (30 samples).

4. Ore microscopic study of polished sections for manganese ores (50 samples).

5. Petrographic study in thin sections of manganese ores (30 samples), gypsum (12 samples), limestone and dolomite (4 samples), clays and kaolin (16 samples) and the heavy mineral constituents in glass sands (5 samples).

6. Vickers hardness test, and specific gravity of 30 samples of manganese ore, 12 samples of gypsum and anhydrite and 4 samples of limestone and dolomite.

7. Compressive strength of 50 samples of manganese ore.

8. Mechanical grain size analysis of 15 samples of glass sands.

B. Methods of Analysis

1. Chemical Analysis

The methods of analysis of manganese ores, limestone-dolomite-gypsum, and kaolin-glass sand are given in the following three flowsheets.

2. X-ray Powder Diffraction Analysis

The X-ray diffraction patterns for powdered manganese samples were carried out using iron target - manganese filter. Other samples (limestone, dolomite, gypsum and kaolin) were carried out using CuK_x radiation.

For kaolin samples in addition to the diffraction pattern of the bulk sample, three patterns for the oriented clay fraction (untreated, glycolated and heated at 550°C for 2 hours) were carried out.

For all patterns: 20 = 2°/min and the paper speed was 1 cm/min.

3. DTA Procedure

The samples subjected to thermal analysis were fine enough to pass sieve meshes. They were admitted in the apparatus by being placed in platinum or fused alumina cups during the thermal runs. The sample weight was approximately 100 mg. Heating was performed from room temperature up to the limit temperature, which could reach 1000°C at ambient conditions. Heating rate was 20°C/min. Two different sensitivities were used for each sample. The plot was a retrace having downward and upward deflections representing endothermic and exothermic reaction, respectively, whose peaks were at definite temperatures.

4. Thermogravimetric Investigation

The powdered samples were analyzed with an automatic thermoblanace provided by Gebruder Netzsch, W. Germany. For each experiment, a one-gram sample was analyzed, with a balance sensitivity within one mg. An appropriate heating rate of 5°C/min was always applied whereby the analysis was continued from room temperature up to 1000°C.

5. Determination of Compressive Strength

The compressive strength was carried out using a uniaxial loading machine. The samples were prepared in cubic form. The sample was loaded until crushing occurred. The compressive strength was calculated by dividing the maximum load at failure by the area of the bearing surface.

6. Determination of Hardness

The macro-hardness was carried out using a Vickers hardness tester. For manganese samples, a 20 kg load was used because it gives suitable indentation. For dolomite, limestone and gypsum samples, different loads were used, according to the softness of each sample.

7. Determination of Specific Gravity

In all samples of manganese ore, dolomite, limestone and gypsum, the specific gravity was carried out using the pycnometer, according to the ASTM standard C 135-47. For gypsum samples, benzene was used instead of water because gypsum is soluble in water.

C. Results

The data below summarize as well as comment on the obtained results.

1. Manganese Ore

a. Partial Analyses

The results indicate a high degree of variability in the manganese and iron contents. Manganese ranges between 0.78 and 59.67 and iron ranges between 0.34 and 59.74. The L.O.I. is much less variable, ranging between 3.01 and 33.05. This variance is due to the fact that the main contributor to the value of L.O.I. is the water of hydration in the hydrated manganese and iron oxides which form the main bulk of the analyzed samples, whereas the CO_2 content (in carbonates) is the principal ingredient responsible for the range of variation in the values of L.O.I. Only a minor effect is expected from other mineral constituents, such as gypsum. Refer to Table 2-10.

b. Complete Analyses

The main variability in the results is expressed in the contents of manganese (Mn, MnO and MnO_2) and iron. Less prominent variations are noticed in the values of CO_2, CaO, and SiO_2, which correspond to the contents of carbonates and free silica. Minor variations in Al_2O_3 and MgO would correspond to variability in clay and dolomite

TABLE 2-10

PARTIAL ANALYSIS OF MANGANESE ORE SAMPLES

Sample	% Fe	% Mn	% L.O.I		
1F	37.24	18.20	9.55		
2F	38.77	15.50	9.57		
3F	38.53	14.20	8.29		
4F	37.97	16.10	9.22		
5F	36.87	17.40	9.86	No. 1F-10F	From fines stockpile at Abu Zeneima.
6F	37.96	18.05	9.34		
7F	37.74	13.50	9.72		
8F	37.47	15.40	10.64		
9F	37.65	16.90	8.65	No. 1B-5B	From main ROM bunker at Abu Zeneima.
10F	35.83	15.30	9.66		
1B	42.71	14.10	8.04		
2B	26.72	23.90	9.81		
3B	39.53	16.80	8.17	No. 1 & 2	From fines stockpile at Abu Hamat Shemal (Om Bogma).
4B	26.31	31.10	12.75		
5B	29.86	23.30	9.55		
1	43.03	6.60	7.44		
2	40.27	9.68	8.19		

TABLE 2-10 (Cont)

PARTIAL ANALYSIS OF MANGANESE ORE SAMPLES

Sample No.	% Mn	% Fe	% L.O.I
1	16.62	17.22	14.88
2	36.59	15.39	11.85
3	28.10	32.14	9.96
5	23.92	15.38	7.53
6	52.95	3.95	14.25
7	30.19	19.81	15.10
9	8.55	27.74	14.26
10	1.76	30.72	13.13
11	9.88	38.84	12.99
13	43.29	14.75	6.09
14	13.74	39.69	8.68
15	1.75	0.65	28.58
17	2.67	4.18	41.39
18	29.63	27.12	13.09
19	35.33	21.35	13.43
21	31.45	19.72	13.00
22	2.56	16.67	28.79
23	21.87	23.90	16.59
25	5.25	31.28	10.70
26	36.15	21.07	9.13
27	42.59	14.74	13.10
29	24.36	33.12	8.71
31	25.35	30.33	8.54
32	22.73	30.80	9.53
33	51.64	8.18	9.73
34	22.88	33.03	9.20
35	8.74	51.17	7.30
37	12.90	42.72	12.20
39	38.20	20.03	10.80
40	17.99	38.38	9.66
41	22.80	35.74	8.16
130	38.26	6.63	12.98
131	34.61	12.15	17.79
132	36.27	5.66	18.20
133	13.22	28.08	11.61
135	34.69	15.76	10.54
136	25.03	5.87	7.91
138	42.81	1.57	10.98
139	17.40	39.13	9.13
141	20.96	33.20	11.82
142	42.58	11.57	14.66
144	27.66	16.84	12.70
145	38.04	1.31	13.53
147	37.18	6.60	18.72
149	15.50	28.28	23.56
151	37.20	14.93	17.73
156	44.02	3.49	19.54

TABLE 2-10 (Cont)

PARTIAL ANALYSIS OF MANGANESE ORE SAMPLES

Sample No.	% Mn	% Fe	% L.O.I
42	22.10	38.88	8.03
44	4.36	42.37	6.28
45	32.48	26.98	10.05
46	52.91	0.34	16.55
47	38.96	3.32	15.92
48	19.57	44.03	7.41
49	2.45	52.28	6.17
50	20.82	37.60	8.97
51	26.75	32.44	9.10
53	20.98	38.47	9.37
54	28.98	31.27	9.56
55	15.92	43.31	6.35
57	28.57	15.91	14.27
58	39.39	20.27	11.40
59	15.23	39.68	9.92
60	20.97	38.31	7.94
61	34.82	20.71	12.97
62	21.41	31.60	8.86
64	33.44	24.33	10.00
65	59.67	8.08	3.01
66	46.42	16.04	10.40
67	25.58	36.96	7.23
68	36.79	19.98	13.53
69	46.89	3.93	16.81
70	11.05	38.03	12.88
72	6.20	46.08	7.09
73	26.55	26.23	11.39
75	35.74	8.37	14.58
76	13.95	30.17	13.13
77	26.01	24.88	12.83
78	42.85	17.21	12.14
79	24.48	24.00	10.67
80	29.49	27.77	8.32
82	46.98	11.34	13.22
83	42.80	2.90	12.18
85	41.99	15.50	13.38
86	0.97	59.74	3.94
87	4.47	42.22	14.23
88	16.91	31.08	12.58
90	21.96	36.33	9.38
91	29.86	19.82	11.17
92	7.76	38.02	0.91
93	26.78	31.65	9.92
95	34.94	22.25	14.11
96	2.13	59.74	5.09
97	19.59	27.34	9.01
98	1.16	1.73	38.38

TABLE 2-10 (Cont)

PARTIAL ANALYSIS OF MANGANESE ORE SAMPLES

Sample No.	% Mn	% Fe	% L.O.I.
99	4.45	33.12	8.02
100	1.07	15.46	14.57
102	34.01	28.39	8.86
103	11.02	46.30	0.27
104	35.29	22.92	11.19
105	24.02	31.73	8.32
106	25.13	30.06	10.73
107	44.76	16.00	12.43
108	3.29	58.78	3.22
110	18.46	34.25	9.09
112	59.77	10.69	13.50
114	28.91	31.09	10.59
115	26.78	27.22	8.66
116	52.85	5.88	12.20
118	35.76	20.64	12.84
119	39.19	9.67	15.91
121	34.59	19.38	14.81
123	39.43	2.35	11.73
125	49.50	8.64	12.95
126	19.82	41.29	6.29
127	0.78	52.98	6.78
155	48.35	3.10	17.25
157	44.09	0.65	19.57
158	23.06	13.97	22.99
161	26.53	11.21	26.92
162	13.45	17.10	26.87
163	13.15	20.91	26.45
164	13.86	20.04	26.59
165	22.69	21.65	20.15
166	19.26	38.04	10.50
167	24.84	23.66	13.04
168	21.22	33.06	11.78
170	38.02	20.72	11.00
171	53.05	4.21	15.68
173	19.14	23.13	9.09
174	49.85	5.66	13.53
176	53.93	2.76	15.58
177	19.84	15.71	22.30
178	23.15	22.46	19.95
179	29.02	14.71	22.88
180	10.18	8.98	33.05
181	28.93	19.13	19.93
185	22.41	18.92	22.44
187	32.98	19.32	13.69
188	28.95	11.40	18.85

contents. Most constant are the values of Na_2O, K_2O, ZnO, P_2O_5 and As_2O_3. The combined water content is directly related to the mineralogical composition. It is higher in the samples containing more hydrated manganese and iron oxides (e.g. goethite and psilomelane versus hematite and pyrolusite). Refer to Table 2-11.

c. X-ray Powder Diffraction Analysis

The results of X-ray powder diffraction analysis indicates that the mineral ingredients of the examined samples include the following:

(1) Manganese Minerals

- Principal constituents: Pyrolusite, psilomelane and hausmannite.
- Minor constituents: Manganite, todorockite, hallowdite and rhodocronite.

(2) Iron Minerals (Goethite and Hematite)

(3) Gangue Minerals

- Of frequent occurrence: Montmorillonite, quartz, calcite and dolomite.
- Of infrequent occurrence: Gypsum, kaolinite, illite and halite.

Table 2-12presents the mineral constituents of each of the analyzed samples as identified from the X-ray powder diffraction analysis.

d. DTA and TGA

The results of DTA and TGA indicate that the analyzed manganese ore samples are formed principally of manganese and iron oxides and hydrated oxides, with smaller amounts of hausmannite and rhodochrosite. The gangue minerals include clays, carbonate (calcite and colomite) and gypsum. However, it is also clear that these thermal analyses give much less precise results than the X-ray diffraction analysis in our study case.

In Table 2-12 the mineral composition of the analyzed samples, as deduced from the differential thermal analyses, is presented.

TABLE 2-11 - COMPLETE CHEMICAL ANALYSIS OF MANGANESE ORE SAMPLES

Sample No	% Mn tot.	% MnO_2	% MnO calc.	% SiO_2	% Al_2O_3	% Fe_2O_3 tot.	% CaO	% MgO	% Na_2O	% K_2O	% TiO_2	As ppm	% ZnO	% P_2O_5	% CO_2	% H_2O^+	% H_2O^-	SO_3
4	23.22	31.43	4.33	3.32	1.44	50.10	1.01	0.64	0.40	0.22	0.27	40	0.31	0.09	0.81	5.26	0.74	0.7I
8	19.32	24.39	5.04	1.48	2.46	44.57	3.73	4.89	0.33	0.09	0.22	3	0.24	0.06	4.61	6.23	1.62	2.08
12	21.12	27.63	4.72	13.93	3.56	34.83	2.60	0.89	0.32	0.51	0.41	nil	0.25	0.03	4.35	5.86	1.36	I.48
16	2.85	2.61	1.55	11.64	3.07	67.17	nil	1.56	0.30	0.49	0.33	1	0.14	0.03	4.15	3.91	1.06	5.20
20	18.84	21.91	6.44	1.77	1.03	46.00	3.00	2.28	0.90	0.16	0.47	2	0.17	0.05	4.36	6.21	1.29	4.02
24	25.57	22.52	14.63	3.57	2.10	42.06	2.85	1.78	0.17	0.05	0.56	10	0.47	0.03	5.04	2.60	0.65	0.8I
28	50.42	64.92	12.11	1.64	1.53	8.85	nil	1.17	0.22	0.21	0.43	4	2.23	0.04	0.61	3.71	0.49	I.39
30	10.88	14.38	2.31	4.71	2.59	68.63	nil	0.61	0.24	0.25	0.22	2	0.21	0.05	0.54	3.49	0.61	3.70
36	10.30	9.35	5.66	1.60	1.39	37.11	8.69	7.98	0.25	0.15	0.80	3	0.10	0.38	17.66	2.64	0.92	3.II
38	23.97	27.93	8.51	2.98	1.19	46.10	2.21	1.63	0.27	0.22	0.43	30	0.74	0.04	0.36	3.23	0.86	I.64
43	17.65	7.85	16.37	7.48	4.55	50.30	2.52	2.58	0.18	0.05	0.37	15	0.30	0.12	8.16	2.73	1.18	4.64
52	24.65	32.55	5.71	2.53	1.89	49.79	nil	0.33	0.16	0.06	0.18	10	0.50	0.02	0.74	3.67	0.27	2.0I
56	26.01	38.69	2.01	2.42	2.34	47.66	nil	0.59	0.31	0.07	0.45	3	0.20	0.05	0.45	2.86	0.85	3.35
63	38.59	48.33	10.38	1.94	1.61	31.82	nil	0.61	0.26	0.61	0.19	3	1.11	0.13	0.68	3.65	0.45	0.74
71	16.92	22.88	3.17	5.65	2.75	54.51	nil	1.27	0.70	0.49	0.36	15	0.25	0.03	0.72	3.61	2.32	2.08
74	55.75	37.89	43.60	2.98	1.02	5.82	nil	1.49	0.28	0.08	0.19	2	0.52	0.05	0.49	4.22	0.43	3.I5
81	44.33	63.91	5.08	3.52	0.90	20.49	nil	0.68	0.29	0.17	0.71	10	0.32	0.04	0.96	2.47	0.49	3.07
84	33.98	45.62	6.64	4.79	2.86	30.41	nil	0.80	0.11	0.39	0.25	3	0.45	0.04	0.47	4.88	0.46	2.48
89	45.50	40.74	25.48	2.34	1.97	21.75	1.35	0.67	0.36	0.06	0.27	5	1.25	0.14	1.34	4.23	0.65	2.54
94	3.06	3.40	1.18	2.42	1.95	82.98	1.27	0.53	0.23	0.15	0.39	20	0.08	0.15	0.50	2.47	0.67	2.I4
101	9.17	8.41	4.99	8.21	4.34	68.44	nil	0.81	0.24	0.13	0.33	10	0.11	0.03	0.41	2.27	0.69	2.48
109	36.77	55.01	2.58	0.93	0.72	33.26	nil	0.31	0.39	0.19	0.20	2	1.05	0.07	1.35	3.81	0.44	3.I2
111	39.39	59.90	1.97	16.35	3.95	9.57	1.20	1.24	0.34	0.06	0.54	5	0.26	0.06	0.87	3.45	0.65	0.7I
113	27.64	38.04	4.65	2.29	1.04	42.76	1.71	1.02	0.93	0.46	0.21	2	0.37	0.12	1.03	5.61	2.12	0.79

TABLE 2-11 - COMPLETE CHEMICAL ANALYSIS OF MANGANESE ORE SAMPLES

Sample No.	% Mn tot.	% MnO_2	% MnO calc.	% SiO_2	% Al_2O_3	% Fe_2O_3 tot.	% CaO	% MgO	% Na_2	% K_2O	% TiO_2	As ppm	% ZnO	% P_2O_5	% CO_2	% H_2O^+	% H_2O^-	SO_3
117	36.48	56.21	1.23	7.73	2.63	23.94	2.17	0.80	0.14	0.08	0.40	9	0.25	0.07	0.51	3.35	0.40	3.06
120	36.74	52.86	4.30	5.91	3.57	22.52	1.69	1.13	1.96	0.13	0.73	20	0.22	0.04	1.22	5.65	0.88	I.69
122	29.74	44.41	2.16	1.85	1.49	41.49	nil	0.63	0.26	0.47	0.31	2	0.47	0.04	0.45	3.62	0.49	3.37
124	30.80	40.28	6.89	13.69	4.15	16.67	1.63	6.14	0.37	0.44	0.26	2	0.61	0.11	0.80	6.42	0.57	0.69
128	30.52	39.83	6.90	1.15	2.95	35.34	2.95	1.01	1.02	0.29	0.37	1	0.27	0.12	1.88	5.71	1.17	I.63
129	32.38	44.65	5.37	3.30	1.21	33.42	nil	1.34	1.09	0.33	0.49	4	0.67	0.07	0.45	6.96	1.28	2.7I
134	26.75	35.77	5.35	23.89	3.26	14.84	1.52	1.05	2.50	0.84	0.37	2	0.25	0.08	1.31	4.16	1.12	I.94
137	37.74	52.31	6.04	2.28	1.88	30.57	nil	0.98	0.24	0.32	0.28	12	0.55	0.14	0.75	3.28	0.51	I.5I
140	26.10	23.73	14.32	2.77	1.75	24.88	10.90	4.12	0.58	0.15	0.25	5	0.26	0.22	10.69	4.70	1.04	0.98
143	17.51	22.60	4.16	3.63	1.42	60.86	nil	0.94	0.39	0.27	0.49	15	0.18	0.04	0.88	2.59	0.69	2.84
146	55.68	71.52	13.52	0.68	0.60	3.63	nil	0.85	0.48	0.67	0.25	4	1.02	0.08	0.79	3.77	0.51	2.27
148	28.05	32.56	9.64	23.12	2.43	21.04	0.98	1.01	0.50	0.97	0.38	2	1.20	0.10	0.92	4.20	1.40	2.85
150	34.08	45.43	6.93	3.29	2.84	18.92	4.36	2.49	0.91	0.32	0.56	1	0.83	0.09	3.83	6.53	2.21	4.29
152	22.33	28.74	5.37	2.91	2.99	35.44	4.94	4.74	0.92	0.20	0.15	1	0.75	0.04	1.02	7.19	1.45	6.78
153	22.91	32.05	3.42	14.41	2.18	35.62	1.36	0.65	0.47	0.15	0.42	15	0.75	0.14	1.02	4.82	0.51	2.85
154	50.20	71.90	6.14	1.35	1.83	8.55	nil	0.82	0.96	0.15	0.32	7	0.29	0.28	0.79	4.85	0.89	2.42
159	16.68	24.85	1.40	2.27	1.60	31.80	8.51	8.65	0.68	0.16	0.41	nil	0.47	0.07	9.86	6.71	0.95	5.5I
160	26.76	33.50	7.20	2.23	4.62	31.43	4.50	1.40	0.61	0.30	0.19	nil	0.85	0.03	4.68	6.56	1.34	0.79
169	28.46	36.19	7.21	3.75	2.75	41.34	nil	0.63	0.55	0.45	0.24	4	1.12	0.02	0.72	3.92	0.52	I.43
172	17.05	16.66	8.42	1.76	1.14	66.87	nil	0.45	0.25	0.24	0.20	7	0.20	0.10	0.63	2.88	0.40	0.83
175	41.70	64.50	1.20	1.29	1.04	26.67	nil	0.27	0.19	0.12	0.11	7	0.23	0.08	0.77	2.61	0.59	2.74
182	11.70	13.98	3.70	5.61	1.19	15.24	13.8	10.66	0.47	0.32	0.21	3	0.19	0.03	26.93	3.42	0.65	3.2I
183	25.08	34.01	4.63	1.63	3.62	36.94	2.04	0.93	1.12	0.19	0.10	1	1.62	0.04	5.84	6.30	1.59	2.43
184	0.62	0.25	0.60	54.28	0.76	40.24	nil	0.41	0.11	0.06	0.28	4	0.07	0.09	0.64	0.88	0.06	0.83
186	25.63	37.54	2.46	2.35	4.08	31.72	5.11	2.07	0.90	0.60	0.25	1	1.15	0.02	3.15	5.30	1.25	2.2I
189	20.36	26.39	4.75	3.74	2.30	27.33	6.93	7.57	0.69	0.75	0.15	nil	0.70	0.13	8.21	4.19	0.91	4.80
X	28.42	41.42	2.89	4.22	2.57	27.47	3.11	2.40	0.47	0.44	0.12	nil	0.50	0.10	[illegible]	7.12	0.83	2.92

TABLE 2-12
MINERAL CONSTITUENTS

Sample No.	Manganese Minerals							Iron Min.		Gangue Minerals						
	Pyr.	Holl.	Psil.	Haus.	Mang.	Tod.	Rhod.	Goe.	Hem.	Mont.	Kaol.	Ill.	Cal.	Dol.	Gyp.	Qz.
4	+		+					+	+	+						
8						+		+	++	+			+	+	+	
16								++	++	+						+
28	+		++	+					+	+						
30			+					++	++	+						+
38			+						++	+						
43			+				++		++	+						
56	++							+	+	+						+
63	+		+	+	+			+	+	++						
74			+	++					+	+						
81	++							+	+	+						+
89			+	++				+	+	+						
101	+		+					+	++	+						+
109	+		+					+	+	+						
113	+		+					++	+	+		+				+
122	+		+					+	+	++						
128			+			+		+	++	++						
129			+			+		++	+	+						
134			+						+	+	+					++
140				+				+	+	++			+	+	+	
146	+		++	++					+	+						
148		+	+	+					+	+						++
153	+		+					+	+	+	+					+
154	+		++					+	+	+		+				
160						+		+	+	++			++			
169			+						++	+						
175	++		+					+	+	+						
183	+		+				+	++	+	+		+	+		+	
186			++			+		+	+	+				+		+
189			+					+	+	+				+		

e. Ore Microscopic Study

The study of opaque mineral constituents under reflected light in polished sections for the manganese ore samples has revealed that the most common constituents are psilomelene, pyrolusite, goethite and hematite. Hausmannite and manganite are only of secondary importance. These results are highly conformable with those obtained by X-ray powder diffraction analysis and by thermal analysis, taking into consideration the limitations of mineral identifications by optic methods compared to that by X-ray analysis.

Table 2-13 shows the results of microscopic examination for identification of opaque mineral constituents in the studied samples.

f. Petrographic Study in Thin Sections

The gangue transparent constituents of 30 samples of manganese ores have been studied in thin sections. In general, the main components of the gangue in the studied ore samples include clay minerals, quartz, calcite, dolomite, gypsum and microcrystalline silica.

Table 2-14 summarizes the components of the gangue in the studied samples as deduced from the studies in thin sections.

g. Physical Properties: Compressive Strength, Vickers Hardness and Specific Gravity

The compressive strength is a measure of the maximum load borne by the examined sample per unit area of failure.

The Vickers hardness is a reflection of the mineral composition. It can be noticed that samples with relatively high content of psilomelane (a relatively hard mineral) give the highest values of Vickers hardness.

From the results of the specific gravity measurements, it can be noticed that samples richer in gangue constituents show lower values than those poor in gangue. Refer to Table 2-15.

2. Clays and Kaolin

Sixteen clay and kaolin samples have been subjected to the following analyses.

a. Complete Chemical Analysis

The results indicate that the alumina content ranges from 11.70 to 36.16 with an average of 31.27 while silica

TABLE 2-13
MINERAL CONSTITUENTS

Sample No.	Manganese Minerals				Iron Minerals	
	Psil.	Py.	Haus.	Mang.	Goe.	Hem.
4	+	+			+	+
8	+	+			++	+
12	+	+			++	++
16	+				++	+
20	+	+	++			+
24	++				++	+
28	++	+	+			+
30	++	+			+	+
36	++				+	+
38	+	+			+	+
43	+				+	++
52	++	+			+	+
56		++			+	+
63	+	+	+	+	+	+
71	++	+	+			
74	+		++			+
81		++			+	+
84	++				+	+
89	+		++			+
94	++	+		+	+	
101	+	+	+		+	+
109	++	+			+	+
111	++	+				
113	++	+	+		++	+
117	+	+	+		+	
120	+	+	++		+	
122	+	+	+			++
124	+	+	+		++	+
128	+	+	+			
129	++				++	+
134	+					+
137	++					
140	+		++			+
143	+		++		+	+
146	+	+	++		+	
148	+	+	++	+		
150	++			+	+	+
152	+				+	+
153	+	+	+		++	+
154	++	+			+	+
159	++	+	+		++	
160	++				+	+
169	++	+			++	+
172	++	+		+	++	
175	++	++			+	+
182	++	+			++	+
183	++	+			++	+
184	+	+				
186	+				+	+
189	+	+			+	

TABLE 2-14

MINERAL CONSTITUENTS

Sample No.	Clay	Quartz	Calcite	Dolomite	Gypsum	Micro-crystal-line Silica
4	+++	+				
8	+		+	+++	+	
16		+++				
28	++	++				
30						+++
38	+					
43						
56	++	++				
63	+++					
74						+
81		+++				
89	++		++			
101	+++		+	+		
109	+++					+
113	+++					+
122	+++					
128		+				
129	+++					
134		++++				
140	++		++	+	+	
146				+		
148		+				
153	+	+++				
154	+					+
160	++	+	++			
169	+++					
175	+++					
183	+++	+			+	
186	++	+		+++		
189	+	+		+++		

TABLE 2-15

No.	Compressive strength kg/cm^2	Vickers Hardness load 20kg	Specific gravity	No.	Compressive strength kg/cm^2	Vickers Hardness load 20kg	Specific gravity
4	170	29	4.40	122	700	103	4.32
8	960	288	3.94	128	1070	58	3.74
16	120	86	4.14	129	410	208	3.73
28	1110	304	4.39	134	440	32	3.45
30	540	104	4.20	140	890	102	3.63
38	838	257	4.40	146	410	133	4.46
43	350	106	3.82	148	280	54	3.57
56	190	86	4.54	153	320	70	3.58
63	1150	318	4.33	154	510	106	4.18
74	840	134	4.13	160	220	106	3.68
81	250	128	4.54	169	1040	426	4.30
89	650	134	4.24	175	220	25	4.48
101	450	64	4.40	183	140	57	3.89
109	610	182	3.66	186	500	91	3.71
113	610	426	4.05	189	490	41	3.55

No.	Compressive strength kg/cm^2	No.	Compressive strength kg/cm^2	No.	Compressive strength kg/cm^2
12	170	94	1504	152	880
20	760	111	290	159	470
24	410	117	440	172	620
36	610	120	450	182	410
52	240	124	790	184	750
71	610	137	280	150	490
84	250	143	190		

ranges from 42.47 to 80.08 with an average of 50.61. However, sample 349 is in fact a siltstone with 80.08% SiO_2 and 11.70% Al_2O_3. Its inclusion in the average is not advisable. The average, after the elimination of this sample, is 32.57% Al_2O_3 and 48.65% SiO_2.

The average Fe_2O_3 content is 0.73% while that of TiO_2 is 1.61%. The combined water has an average of 12.40%.

b. X-Ray Powder Diffraction Analysis

The results of the sixteen analyses carried out on clay and kaolin samples indicate that in all of these kaolinite is the main mineral constituent. Few quantities of illite have been detected in three samples (346, 348 and 349). Very little montmorillonite has been detected in only one sample 349, which is in fact a silty clay. Quartz occurs in most samples only in few quantities, but acquires particular importance in samples 346 and 348. In sample 349 (silty clay), quartz seems to be the main mineral constituent. Halite has been recorded in minor amounts in two samples (303 and 348).

The following table summarizes the mineral composition of the analyzed samples of clay and kaolin as deduced from X-ray powder diffraction.

MINERAL CONSTITUENTS

Sample	Clay Minerals			Gangue Minerals	
No.	Kaol.	Ill.	Mont.	Qz.	Hal.
303	+++				+
30	+++				
312	+++			+	
313	+++			+	
316	+++			+	
319	+++			+	
321	+++			+	
325	+++			++	
330	+++				
332	+++				
333	+++			+	
341	+++			+	
343	+++				
346	+++	+	+	++	
348	+++	+		++	+
349	++	+		+++	

c. Study in Thin Sections

Sixteen samples have been studied in thin sections for the analysis of detrital constituents coarser than clays. Quartz forms the major constituent of these coarser detritals. In addition some samples contain very fine grains of heavy minerals. Staining by iron oxides was noticed in some cases. The following table shows the coarser constituents other than the clay minerals.

Sample No.	Quartz	Heavy Minerals
303		
307		
312	+	
313	+	
316	+	
319	+	
321	+	
325	++	
330	++	
332	+	
333	+	
341	++	
343		+
346	+++	+
348	+++	+
349	++++	+

3. Gypsum and Anhydrite

Thirty samples of gypsum ($CaSO_4 . 2H_2O$) and anhydrite ($CaSO_4$) of Ras Malaab have been subjected to the following analyses.

a. Partial Chemical Analysis

One sample (201 anhydrite) shows a very high content of chlorine (most probably as halites). It is expected that both CaO and SO_3 contents in anhydrite are higher than in gypsum. This may be because high values of L.O.I. are obtained, which correspond to loss of water and partial dissociation of sulphates and/or carbonates if present.

b. Complete Chemical Analysis

It is clear from the results that the analyzed samples represent rather pure gypsum or anhydrite. In the former, the value of H_2O^- is 14-15% with CaO of 31-33% and SO_3 of 46-49%. In the latter the H_2O^- content is maximum 1%, with CaO 38-40% and SO_3 53-56%. However, in two samples

(208 and 230 of anhydrite), sodium chlorite has been recorded in appreciable amounts. Silica and carbonates are also minor diluters in sample 208.

c. X-Ray Powder Diffraction Analysis

The results of this analysis indicate the presence of small amounts of gypsum in most of the anhydrite samples, and small amounts of anhydrite in most of the gypsum samples. Sample 208 (anhydrite) also contains some calcite, which corroborates the chemical composition.

The following table summarizes the mineral composition of analyzed samples as deduced from the results of X-ray powder diffraction.

Sample No.	Quan. No.	Ore Type	Mineral Constituents		
			Gyps.	Anhyd.	Calcite
202	1a	Alab.	+++	+	
204	1a	Anhy.	+	+++	
208	1b	Anhy.	+	+++	+
209	1b	Alab.	+++	+	
211	2b	Misc.	+++	+	
215	2a	Alab.	+++	+	
218	3	Misc.	+++		
221	3	Misc.	+++		
223	-	Misc.	+++		
227	4b	Alab.	+++	+	
228	-	Alab.	+++	+	
230	-	Anhy.		+++	

d. Study in Thin Sections

Twelve samples have been studied in thin sections. Nine have been found to consist mainly of gypsum, while the other three have been found to be composed essentially of anhydrite.

Four of the gypsum samples (211, 218, 221 and 223) are formed of selenite, which correspond to the type of ore termed by miners micaceous gypsum. Three other samples (202, 209, 228) show two forms of cuptallization, one very coarse and tabular and the other anhydral finely crystalline. Sample 215 is composed only of fine anhedral crystals while sample 227 is of fibrous texture. Anhydrite is a minor constituent in some of the samples, where it clearly replaced gypsum.

In the anhydrite samples the texture is either prismatic or fine granular.

e. Physical Properties

The Vicker's hardness testing results indicate that both gypsum and anhydrite have very low hardness values ranging from 5 to 32. Neither of them shows a particular trend.

The specific gravity measurements show, however, that anhydrite is clearly denser than gypsum. The former has a value of 2.5, while the latter has a value 2.3.

4. Glass Sand

a. Complete Chemical Analysis

Five samples have been subjected to complete chemical analysis. The results indicate that SiO_2 ranges between 96 and 98% and Fe_2O_3 ranges from 0.06 to 0.20. Al_2O_3, which is always less than 1% titanium, was not detected.

b. Grain Size Analysis

Fifteen samples of white glass sand were mechanically analyzed. The results show that in samples 401 to 411 the fractions of 0.5-0.25 mm and 0.25-0.125 mm constitute more than 93% and up to 99%, i.e. very good sorting. Sample 412 is very ill sorted, while samples 413 to 415 are fine sands with the maximum content in fraction 0.25-0.125 mm, and appreciable content in the following two fractions.

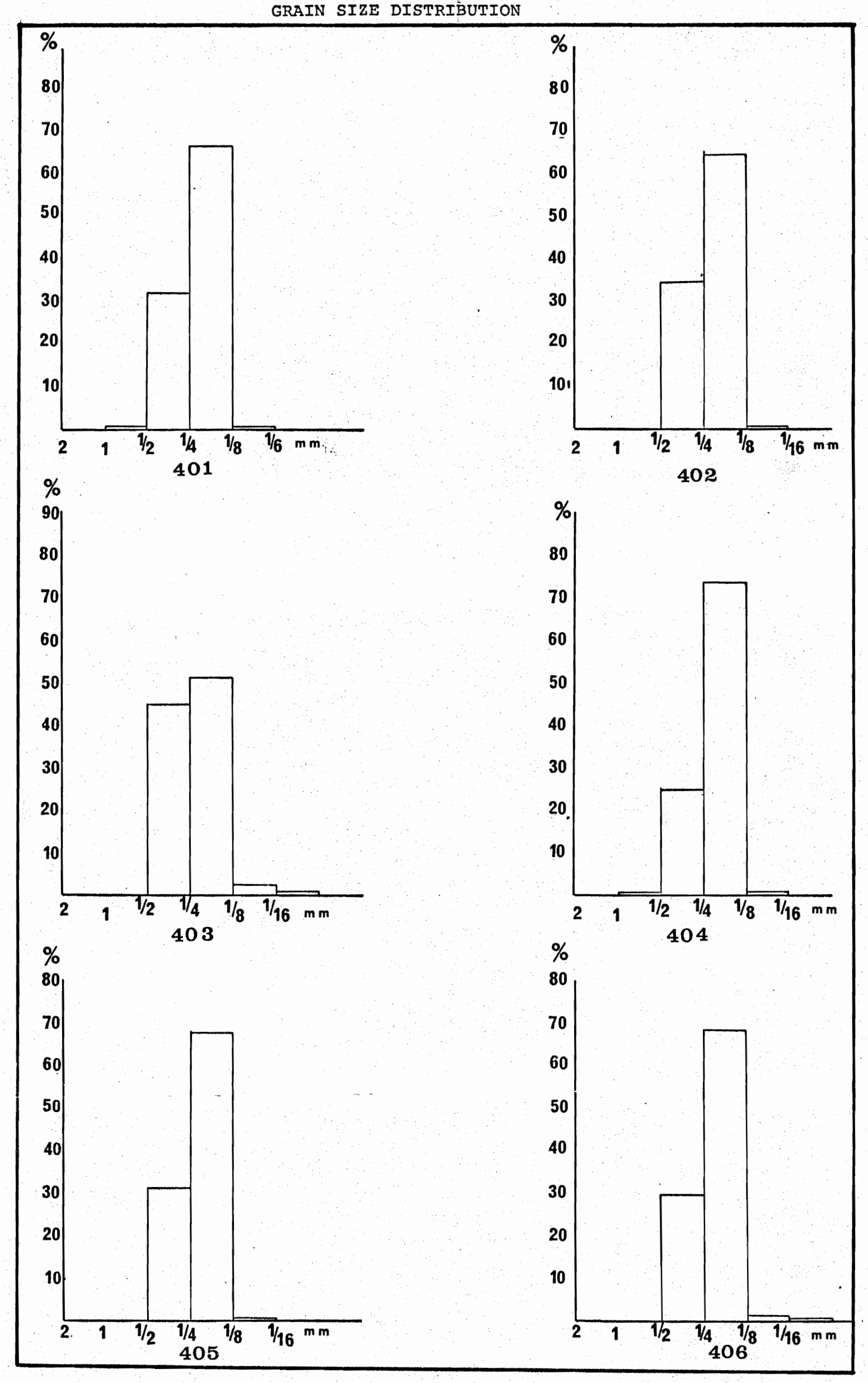
The graphs below represent the histograms of the grain size distribution in the analyzed samples.

c. Heavy Mineral Constituents

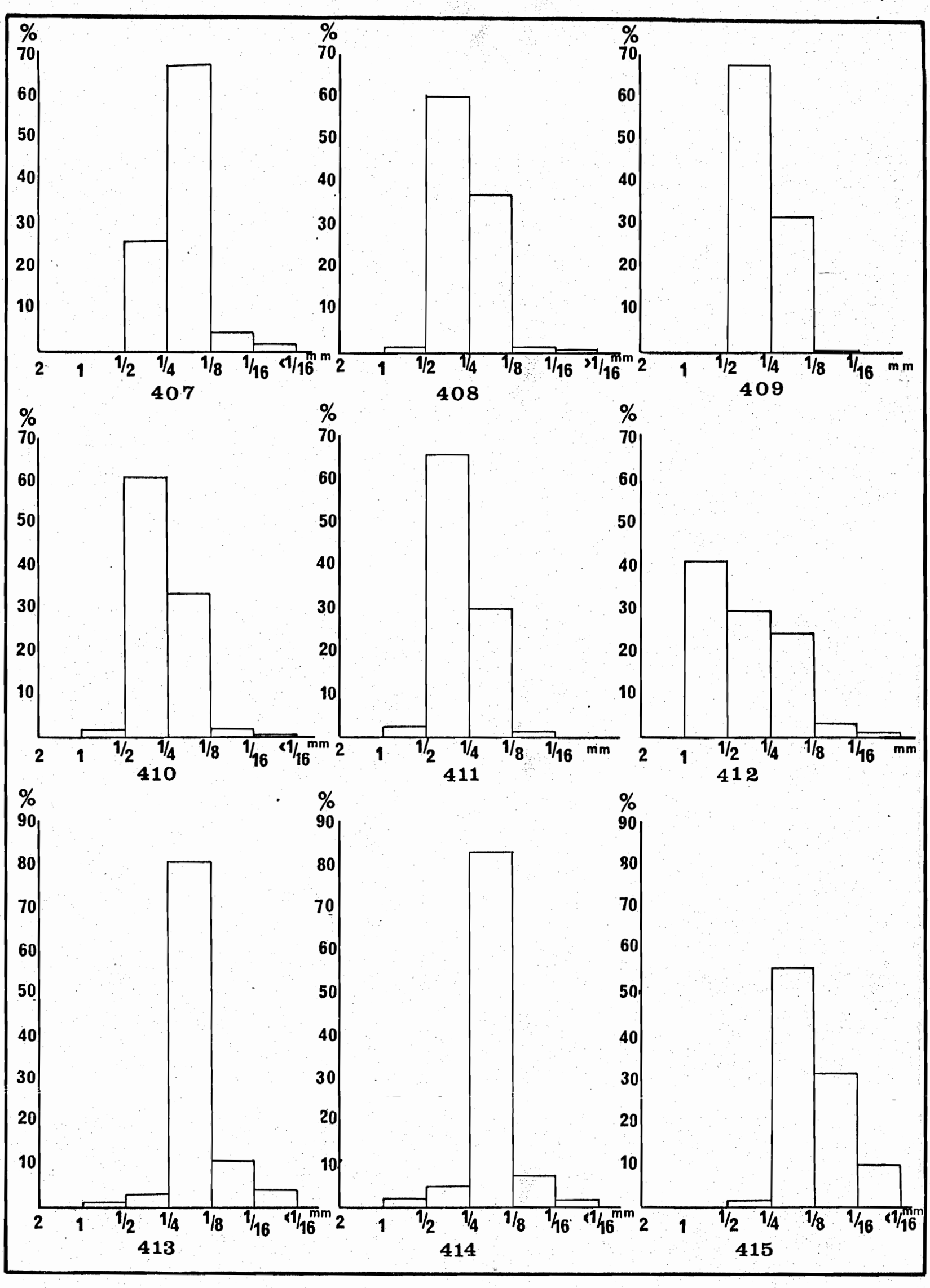
The heavy mineral constituents were separated from two size fractions (0.25-0.125 mm and 0.125-0.063 mm) of fine glass sand samples. The separated grains were studied microscopically. The results indicate that the size fraction 0.125-0.063 mm contains much higher values of heavy mineral content (average 0.4%) than the coarser fraction (average 0.12%), although the latter represents a higher percentage of the original sample.

The mineral species identified includes opaques, tourmaline, hornblende, actinolite, zircon, monazite and rutile.

GRAIN SIZE DISTRIBUTION



GRAIN SIZE DISTRIBUTION



5. Limestone and Dolomite

a. Partial Chemical Analysis

The results differentiate limetone and dolomite by the MgO content. In the dolomite samples, MgO is clearly lower than CaO. In some samples, the relatively high values of L.O.I. may correspond to a partial dissociation of some other constituents (e.g. sulphates and chlorides).

b. Complete Chemical Analysis

Two samples of dolomite and two samples of limestones have been subjected to this analysis. In the limestone samples, the Na_2O content is relatively high indicating the presence of appreciable amounts of halite (detected by X-ray analysis). The total of sample 503 is only 96.88 because the same gypsum was detected in the X-ray analysis, while SO_3 content was not chemically dosed. Silica is also relatively high in sample 503.

c. X-Ray Powder Diffraction Analysis

In the limestone samples, some quartz with little gypsum or halite have been detected. In the dolomite samples, quartz is less abundant, but calcite is always an associate of dolomite.

The following table summarizes the mineral composition of the analyzed samples as deduced from the results of X-ray powder diffraction.

Sample No.	Carbonate Minerals		Gangue Minerals		
	Calcite	Dolomite	Quartz	Gypsum	Halite
503	+++		+	+	
507	+++		+		+
510	+	+++	+		
513	+	+++	+		

d. Study in Thin Sections

Two limestone samples were studied in thin sections. They were found to be represented by biomicrite with small foraminefera fossil allochems. On the other hand, the two dolomite samples were found to be composed of medium to coarse dolomite rhombs. Calcite and quartz are present only in minor amounts.

e. Physical Properties

The Vicker's hardness values are clearly lower for the limestone samples (6 and 25) than for the dolomite samples (172 and 360). The specific gravity is clearly lower for the limestone (2.34 and 2.43) than for the dolomite (2.66 and 2.68).

TABULATION OF SAMPLES TESTED
NATIONAL RESEARCH CENTER, CAIRO
May - July 1980

Sample No.	Area	Mining Lease	Primary Mineral	Complete Chemical Analysis	Partial Chemical Analysis	X-Ray	DTA & TGA	Polished Section	Thin Section	Hardness & sp. gr.	Compressive Strength	Grain Size Analysis
1	Area 45	292	Manganese		x							
2	Area 45	292	Manganese		x							
3	Area 45	292	Manganese		x							
4	Area 45	292	Manganese	x		x	x	x	x	x	x	
5	Area 45	292	Manganese		x							
6	Area 45	292	Manganese		x							
7	El Ramsy	367	Manganese		x							
8	El Ramsy	367	Manganese	x		x	x	x	x	x	x	
9	El Ramsy	367	Manganese		x							
10	El Ramsy	367	Manganese		x							
11	El Ramsy	367	Manganese		x							
12	El Ramsy	367	Manganese	x				x			x	
13	El Ramsy	367	Manganese		x							
14	El Ramsy	367	Manganese		x							
15	El Ramsy	367	Manganese		x							
16	El Ramsy	367	Manganese	x		x	x	x	x	x	x	
17	El Ramsy	367	Manganese		x							
18	El Ramsy	367	Manganese		x							
19	El Ramsy	367	Manganese		x							
20	El Ramsy	367	Manganese	x				x			x	
21	El Ramsy	367	Manganese		x							
22	El Ramsy	367	Manganese		x							
23	El Ramsy	367	Manganese		x							
24	El Ramsy	367	Manganese	x				x			x	
25	El Ramsy	367	Manganese		x							
26	El Ramsy	367	Manganese		x							
27	El Ramsy	367	Manganese		x							
28	Area 8	288	Manganese	x		x	x	x	x	x	x	
29	Area 8	288	Manganese		x							
30	Hill 5	286	Manganese	x		x	x	x	x	x	x	
31	Abu Hamat Shemal	297	Manganese		x							
32	Abu Hamat Yemin	300	Manganese		x							
33	Abu Hamat Yemin	300	Manganese		x							
34	Abu Zarab	298-299	Manganese		x							
35	Abu Hamat Shemal	296-297	Manganese		x							
36	Abu Hamat Shemal	296-297	Manganese	x				x			x	
37	Abu Hamat Shemal	296-297	Manganese		x							
38	Abu Hamat Shemal	296-297	Manganese		x							
39	Abu Hamat Yemin	291-300	Manganese		x							
40	Abu Hamat Yemin	291-300	Manganese		x							

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	Sample No.	Area	Mining Lease	Primary Mineral		Complete Chemical Analysis	Partial Chemical Analysis	X-Ray	DTA & TGA	Polished Section	Thin Section	Hardness & sp. gr.	Compressive Strength	Grain Size Analysis
1	41	Abu Hamat Yemin	291-300	Manganese			x							
2	42	Abu Hamat Yemin	291-300	Manganese			x							
3	43	Abu Hamat Yemin	291-300	Manganese		x		x	x	x	x	x	x	
4	44	Abu Hamat Yemin	291-300	Manganese			x							
5	45	Abu Hamat Yemin	291/300	Manganese			x							
6	46	Abu Hamat Yemin	291/300	Manganese			x							
7	47	Abu Hamat Yemin	291/300	Manganese			x							
8	48	Abu Hamat Yemin	291/300	Manganese			x							
9	49	Abu Hamat Yemin	291/300	Manganese			x							
10	50	Abu Hamat Yemin	291/300	Manganese			x							
11	51	Area 8	288	Manganese			x							
12	52	Area 8	288	Manganese		x				x			x	
13	53	Area 8	288	Manganese			x							
14	54	Area 8	288	Manganese			x							
15	55	Area 8	288	Manganese			x							
16	56	Area 8	288	Manganese		x		x	x	x	x	x	x	
17	57	Area 8	288	Manganese			x							
18	58	Area 8	288	Manganese			x							
19	59	Area 8	288	Manganese			x							
20	60	Area 8	288	Manganese			x							
21	61	Area 8	288	Manganese			x							
22	62	Abu Zarab	298/299	Manganese			x							
23	63	Abu Zarab	298/299	Manganese		x		x	x	x	x	x	x	
24	64	Abu Zarab	298/299	Manganese			x							
25	65	Abu Zarab	298/299	Manganese			x							
26	66	Abu Zarab	298/299	Manganese			x							
27	67	Abu Zarab	298/299	Manganese			x							
28	68	El Korba	294	Manganese			x							
29	69	Abu Zarab	298/299	Manganese			x							
30	70	Abu Zarab	298/299	Manganese			x							
31	71	Abu Zarab	298/299	Manganese		x				x			x	
32	72	Abu Zarab	298/299	Manganese			x							
33	73	Abu Thor	401/402	Manganese			x							
34	74	Abu Thor	401/402	Manganese		x		x	x	x	x	x	x	
35	75	Abu Thor	401/402	Manganese			x							
36	76	Abu Thor	401/402	Manganese			x							
37	77	Abu Thor	401/402	Manganese			x							
38	78	Abu Thor	401/402	Manganese			x							
39	79	Abu Thor	401/402	Manganese			x							
40	80	Abu Thor	401/402	Manganese			x							

	Sample No.	Area	Mining Lease	Primary Mineral	Complete Chemical Analysis	Partial Chemical Analysis	X-Ray	DTA & TGA	Polished Section	Thin Section	Hardness & sp. gr.	Compressive Strength	Grain Size Analysis
1	81	Abu Thor	401-402	Manganese	x		x	x	x	x	x	x	
2	82	Abu Thor	401-402	Manganese		x							
3	83	Abu Thor	401-402	Manganese		x							
4	84	Abu Thor	401-402	Manganese	x				x			x	
5	85	Abu Thor	401-402	Manganese		x							
6	86	Alluga	354	Manganese		x							
7	87	Alluga	354	Manganese		x							
8	88	Alluga	354	Manganese		x							
9	89	Alluga	354	Manganese	x		x	x	x	x	x	x	
10	90	Alluga	354	Manganese		x							
11	91	Alluga	354	Manganese		x							
12	92	Alluga	354	Manganese		x							
13	93	Alluga	354	Manganese		x							
14	94	Alluga	354	Manganese	x				x			x	
15	95	Alluga	354	Manganese		x							
16	96	Alluga	354	Manganese		x							
17	97	-	-	Manganese		x							
18	98	-	-	Manganese		x							
19	99	-	-	Manganese		x							
20	100	-	-	Manganese		x							
21	101	Alluga	354	Manganese	x		x	x	x	x	x	x	
22	102	Marahil		Manganese		x							
23	103	Hashash		Manganese		x							
24	104	Om Sylat	311	Manganese		x							
25	105	Om Sylat	311	Manganese		x							
26	106	Om Sylat	311	Manganese		x							
27	107	Om Sylat	311	Manganese		x							
28	108	Om Sylat	311	Manganese		x							
29	109	Om Sylat	311	Manganese	x		x	x	x	x	x	x	
30	110	Om Sylat	311	Manganese		x							
31	111	Om Sylat	311	Manganese	x				x			x	
32	112	Om Ratam	265	Manganese		x							
33	113	Om Ratm	265	Manganese	x		x	x	x	x	x	x	
34	114	Om Ratam	265	Manganese		x							
35	115	Om Ratam	265	Manganese		x							
36	116	Om Ratam	265	Manganese		x							
37	117	Om Ratam	265	Manganese	x				x			x	
38	118	Lahian-Zobeir	256	Manganese		x							
39	119	Lahian-Zobeir	256	Manganese		x							
40	120	Lahian-Zobeir	256	Manganese	x				x			x	

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	Sample No.	Area	Mining Lease	Primary Mineral	3	4 Complete Chemical Analysis	5 Partial Chemical Analysis	6 X-Ray	7 DTA & TGA	8 Polished Section	9 Thin Section	10 Hardness & sp. gr.	11 Compressive Strength	12 Grain Size Analysis	
1	121	Lahian-Zobeir	256	Manganese			x								1
2	122	Lahian-Zobeir	256	Manganese		x		x	x	x	x	x	x		2
3	123	Lahian-Zobeir	256	Manganese			x								3
4	124	Lahian-Zobeir	256	Manganese		x				x			x		4
5	125	Lahian-Zobeir	256	Manganese			x								5
6	126	Lahian-Zobeir	256	Manganese			x								6
7	127	Lahian-Zobeir	256	Manganese			x								7
8	128	Lahian	253	Manganese		x		x	x	x	x	x	x		8
9	129	Wadi Nassib	312	Manganese		x		x	x	x	x	x	x		9
10	130	Om Rinna	368	Manganese			x								10
11	131	Om Rinna	368	Manganese			x								11
12	132	Om Rinna	368	Manganese			x								12
13	133	Om Rinna	368	Manganese			x								13
14	134	Om Rinna	368	Manganese		x		x	x	x	x	x	x		14
15	135	Om Rinna	368	Manganese			x								15
16	136	Om Rinna	368	Manganese			x								16
17	137	Om Rinna	368	Manganese		x				x			x		17
18	138	Wadi Nassib	312	Manganese			x								18
19	139	Wadi Nassib	312	Manganese			x								19
20	140	Wadi Nassib	312	Manganese		x		x	x	x	x	x	x		20
21	141	Wadi Nassib	312	Manganese			x								21
22	142	Wadi Nassib	312	Manganese			x								22
23	143	Wadi Nassib	312	Manganese		x				x			x		23
24	144	Lahian	253	Manganese			x								24
25	145	El Malha	–	Manganese			x								25
26	146	El Malha	–	Manganese		x		x	x	x	x	x	x		26
27	147	El Malha	–	Manganese			x								27
28	148	Sid El Banat	–	Manganese		x		x	x	x	x	x	x		28
29	149	Sid El Banat	–	Manganese			x								29
30	150	Mokhra	–	Manganese		x				x			x		30
31	151	Kharig	–	Manganese			x								31
32	152	Kharig	–	Manganese		x				x			x		32
33	153	Marahil		Manganese		x		x	x	x	x	x	x		33
34	154	Lahian-Zobeir	256	Manganese		x		x	x	x	x	x	x		34
35	155	Tamaria	–	Manganese			x								35
36	156	Tamaria	–	Manganese			x								36
37	157	Tamaria	–	Manganese			x								37
38	158	Alligat	–	Manganese			x								38
39	159	Alligat	–	Manganese		x				x			x		39
40	160	Alligat	–	Manganese		x		x	x	x	x	x	x		40

	Sample No.	Area	1 Mining Lease	2 Primary Mineral	3	4 Complete Chemical Analysis	5 Partial Chemical Analysis	6 X-Ray	7 DTA & TGA	8 Polished Section	9 Thin Section	10 Hardness & sp. gr.	11 Compressive Strength	12 Grain Size Analysis
1	161	Alligat	–	Manganese			x							
2	162	Alligat	–	Manganese			x							
3	163	Ras El Samra	–	Manganese			x							
4	164	Ras El Samra	–	Manganese			x							
5	165	El Somiera	–	Manganese			x							
6	166	El Homarra	–	Manganese			x							
7	167	Om Tmayim	–	Manganese			x							
8	168	El Homarra	–	Manganese			x							
9	169	El Homarra	–	Manganese		x		x	x	x	x	x	x	
10	170	El Homarra	–	Manganese			x							
11	171	El Homarra	–	Manganese			x							
12	172	Ramlat Habous	–	Manganese		x				x			x	
13	173	Ramlat Habous	–	Manganese			x							
14	174	Ramlat Habous	–	Manganese			x							
15	175	Om Ratam	265	Manganese		x		x	x	x	x	x	x	
16	176	Om Ratam	265	Manganese			x							
17	177	Alligat	–	Manganese			x							
18	178	Alligat	–	Manganese			x							
19	179	Farsh Ebeid	–	Manganese			x							
20	180	El Homarra	–	Manganese			x							
21	181	Makhroga	–	Manganese			x							
22	182	Makhroga	–	Manganese		x				x			x	
23	183	Filk	–	Manganese		x		x	x	x	x	x	x	
24	184	Sid El Banat	–	Manganese		x				x			x	
25	185	Ras El Samra	–	Manganese			x							
26	186	Ras El Samra	–	Manganese		x		x	x	x	x	x	x	
27	187	Farsh Ebeid	–	Manganese			x							
28	188	Farsh Ebeid	–	Manganese			x							
29	189	Farsh Ebeid	–	Manganese		x		x	x	x	x	x	x	
30	190	Farsh Ebeid	–	Manganese			x							
31														
32														
33														
34														
35														
36														
37														
38														
39														
40														

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Sample No.	Area	1 Mining Lease	2 Primary Mineral	3	4 Complete Chemical Analysis	5 Partial Chemical Analysis	6 X-Ray	7 DTA & TGA	8 Polished Section	9 Thin Section	10 Hardness & sp. gr.	11 Compressive Strength	12 Grain Size Analysis
	FINES AND BUNKERS												
1F	Stockpile Abu Zeneima		Manganese			x							
2F	Stockpile Abu Zeneima		Manganese			x							
3F	Stockpile Abu Zeneima		Manganese			x							
4F	Stockpile Abu Zeneima		Manganese			x							
5F	Stockpile Abu Zeneima		Manganese			x							
6F	Stockpile Abu Zeneima		Manganese			x							
7F	Stockpile Abu Zeneima		Manganese			x							
8F	Stockpile Abu Zeneima		Manganese			x							
9F	Stockpile Abu Zeneima		Manganese			x							
10F	Stockpile Abu Zeneima		Manganese			x							
1B	Stockpile & Bunker, Abu Zeneima		Manganese			x							
2B	Stockpile & Bunker, Abu Zeneima		Manganese			x							
3B	Stockpile & Bunker, Abu Zeneima		Manganese			x							
4B	Stockpile & Bunker, Abu Zeneima		Manganese			x							
5B	Stockpile & Bunker, Abu Zeneima		Manganese			x							
1	Fines Stockpile Abu Hamat Shemal		Manganese			x							
2	Fines Stockpile Abu Hamat Shemal		Manganese			x							

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	Sample No.	Area	1 Mining Lease	2 Primary Mineral	3	4 Complete Chemical Analysis	5 Partial Chemical Analysis	6 X-Ray	7 DTA & TGA	8 Polished Section	9 Thin Section	10 Hardness & sp. gr.	11 Compressive Strength	12 Grain Size Analysis
1	201	Ras Malaab		Gypsum & Anhydrite			x							
2	202	Ras Malaab		Gypsum & Anhydrite		x		x			x	x		
3	203	Ras Malaab		Gypsum & Anhydrite			x							
4	204	Ras Malaab		Gypsum & Anhydrite		x		x			x	x		
5	205	Ras Malaab		Gypsum & Anhydrite			x							
6	206	Ras Malaab		Gypsum & Anhydrite			x							
7	207	Ras Malaab		Gypsum & Anhydrite			x							
8	208	Ras Malaab		Gypsum & Anhydrite		x		x			x	x		
9	209	Ras Malaab		Gypsum & Anhydrite		x		x			x	x		
10	210	Ras Malaab		Gypsum & Anhydrite			x							
11	211	Ras Malaab		Gypsum & Anhydrite		x		x			x	x		
12	212	Ras Malaab		Gypsum & Anhydrite			x							
13	213	Ras Malaab		Gypsum & Anhydrite			x							
14	214	Ras Malaab		Gypsum & Anhydrite			x							
15	215	Ras Malaab		Gypsum & Anhydrite		x		x			x	x		
16	216	Ras Malaab		Gypsum & Anhydrite			x							
17	217	Ras Malaab		Gypsum & Anhydrite			x							
18	218	Ras Malaab		Gypsum & Anhydrite		x		x			x	x		
19	219	Ras Malaab		Gypsum & Anhydrite			x							
20	220	Ras Malaab		Gypsum & Anhydrite			x							
21	221	Ras Malaab		Gypsum & Anhydrite		x		x			x	x		
22	222	Ras Malaab		Gypsum & Anhydrite			x							
23	223	Ras Malaab		Gypsum & Anhydrite		x		x			x	x		
24	224	Ras Malaab		Gypsum & Anhydrite			x							
25	225	Ras Malaab		Gypsum & Anhydrite			x							
26	226	Ras Malaab		Gypsum & Anhydrite			x							
27	227	Ras Malaab		Gypsum & Anhydrite		x		x			x	x		
28	228	Ras Malaab		Gypsum & Anhydrite		x		x			x	x		
29	229	Ras Malaab		Gypsum & Anhydrite			x							
30	230	Ras Malaab		Gypsum & Anhydrite		x		x			x	x		
31														
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	Sample No.	Area	Mining Lease	Primary Mineral		4 Complete Chemical Analysis	5 Partial Chemical Analysis	6 X-Ray	7 DTA & TGA	8 Polished Section	9 Thin Section	10 Hardness & sp. gr.	11 Compressive Strength	12 Grain Size Analysis
1	303	Budra	190	Kaolin + Clay		x		x			x			
2	307	Abu Natsh	423	Kaolin + Clay		x		x			x			
3	312	Dehissa	382	Kaolin + Clay		x		x			x			
4	313	Dehissa	382	Kaolin + Clay		x		x			x			
5	316	Dehissa	382	Kaolin + Clay		x		x			x			
6	319	Farsh El Guzlan	414	Kaolin + Clay		x		x			x			
7	321	Farsh El Guzlan	414	Kaolin + Clay		x		x			x			
8	325	Farsh El Guzlan	414	Kaolin + Clay		x		x			x			
9	330	Musabba Salama	407	Kaolin + Clay		x		x			x			
10	332	Musabba Salama	407	Kaolin + Clay		x		x			x			
11	333	Musabba Salama	407	Kaolin + Clay		x		x			x			
12	341	Musabba Salama East	406	Kaolin + Clay		x		x			x			
13	343	Musabba Salama	406	Kaolin + Clay		x		x			x			
14	346	El Khaboba	411	Kaolin + Clay		x		x			x			
15	348	El Khaboba	411	Kaolin + Clay		x		x			x			
16	349	El Khaboba	411	Kaolin + Clay		x		x			x			
17														
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	Sample No.	Area	1	2 Primary Mineral	3	4 Complete Chemical Analysis	5 Partial Chemical Analysis	6 X-Ray	7 DTA & TGA	8 Polished Section	9 Thin Section	10 Hardness & sp. gr.	11 Compressive Strength	12 Grain Size Analysis
1	401	Om Tmayim		Glass Sand										x
2	402	Om Tmayim		Glass Sand										x
3	403	Om Tmayim		Glass Sand		x					x			x
4	404	Om Tmayim		Glass Sand										x
5	405	Om Tmayim		Glass Sand										x
6	406	Shalal		Glass Sand										x
7	407	Shalal		Glass Sand		x					x			x
8	408	Shalal		Glass Sand										x
9	409	Shalal		Glass Sand										x
10	410	Abu Kafas		Glass Sand		x					x			x
11	411	Abu Kafas		Glass Sand										x
12	412	Khaboba		Glass Sand										x
13	413	Khaboba		Glass Sand		x					x			x
14	414	Khaboba		Glass Sand										x
15	415	Khaboba		Glass Sand		x					x			x
16														
17														
18														
19														
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21														
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Sample No.		Primary Mineral	Complete Chemical Analysis	Partial Chemical Analysis	X-Ray	DTA & TGA	Polished Section	Thin Section	Hardness & Sp. Gr.	Compressive Strength	Grain Size Analysis
501	500 meters after Basalt fill at right hand of the asphalt road towards Suez.	Limestone & Dolomite		x							
502	From lower part of the hill east to clay hill in Khaboba area.	Limestone & Dolomite		x							
503	From left hand side of asphalt road after 1.8 km from sample 501.	Limestone & Dolomite	x		x				x		
504	From middle part of the hill east to clay hill in Khaboba area.	Limestone & Dolomite		x							
505	From Wadi El Homr at 3 km from asphalt road (El Taiba).	Limestone & Dolomite		x							
506	Upper part of the hill east to clay hill in Khaboba area.	Limestone & Dolomite		x							
507	At 4.75 km from plant to quarry north AZ near railway.	Limestone & Dolomite	x		x				x		
508	From west side of the hill east to clay hill in Khaboba area.	Limestone & Dolomite		x							
509	From north side of the hill east to clay hill in Khaboba area.	Limestone & Dolomite		x							
510	From right hand hill of entrance of branch of w. Khaboba Om Thora down.	Limestone & Dolomite	x		x				x		
511	From right hand hill of entrance of branch of w. Khaboba to Om Thora upper.	Limestone & Dolomite		x							
512	From left hand hill of entrance of branch of w. Khaboba to Om Thora upper.	Limestone & Dolomite		x							
513	From the hill east of the glass sand quarry of El Khaboba lower.	Limestone & Dolomite	x		x				x		
514	From the hill east of the glass sand quarry of El Khaboba upper.	Limestone & Dolomite		x							
515	Same as Sample 507	Limestone & Dolomite		x							

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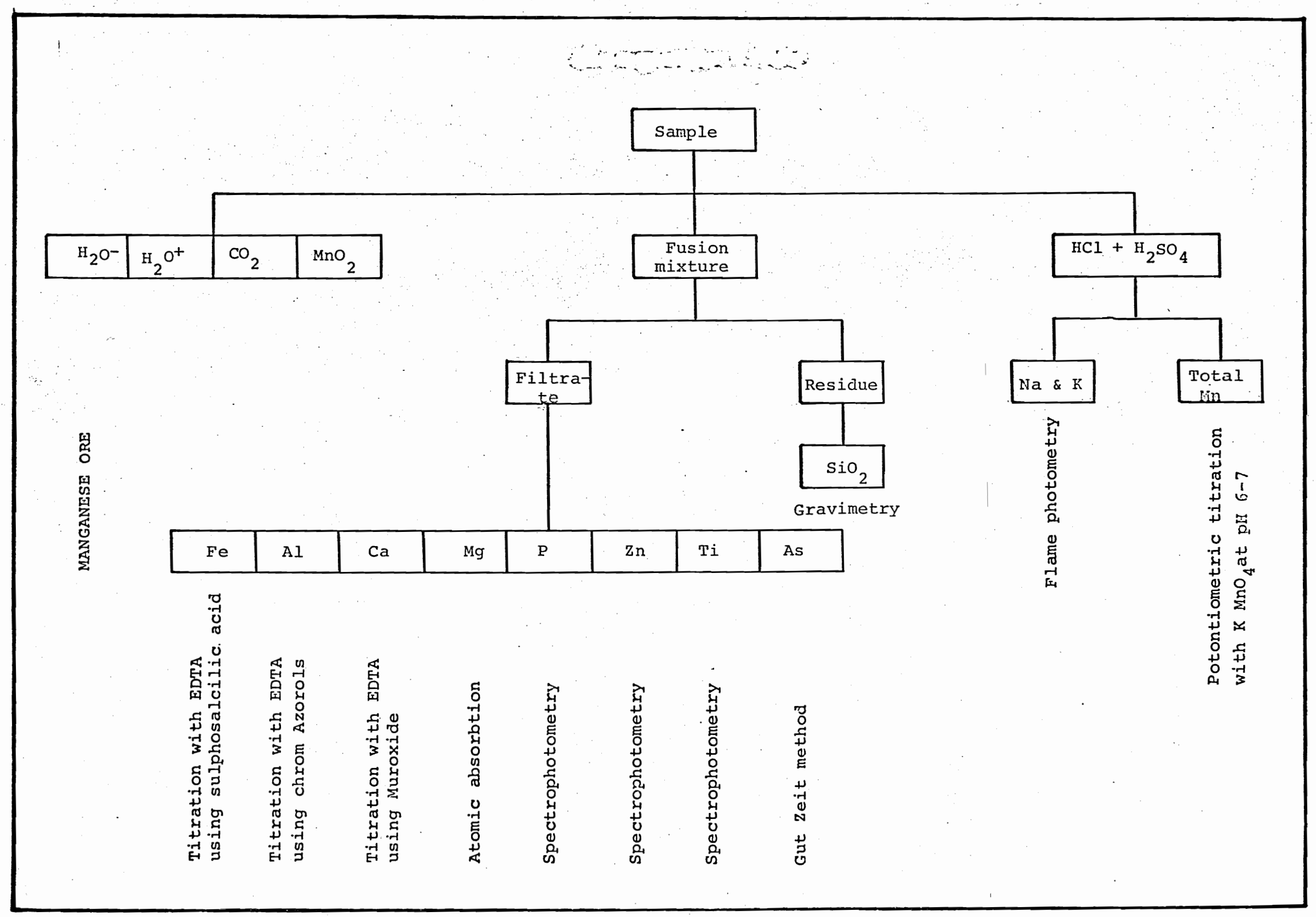
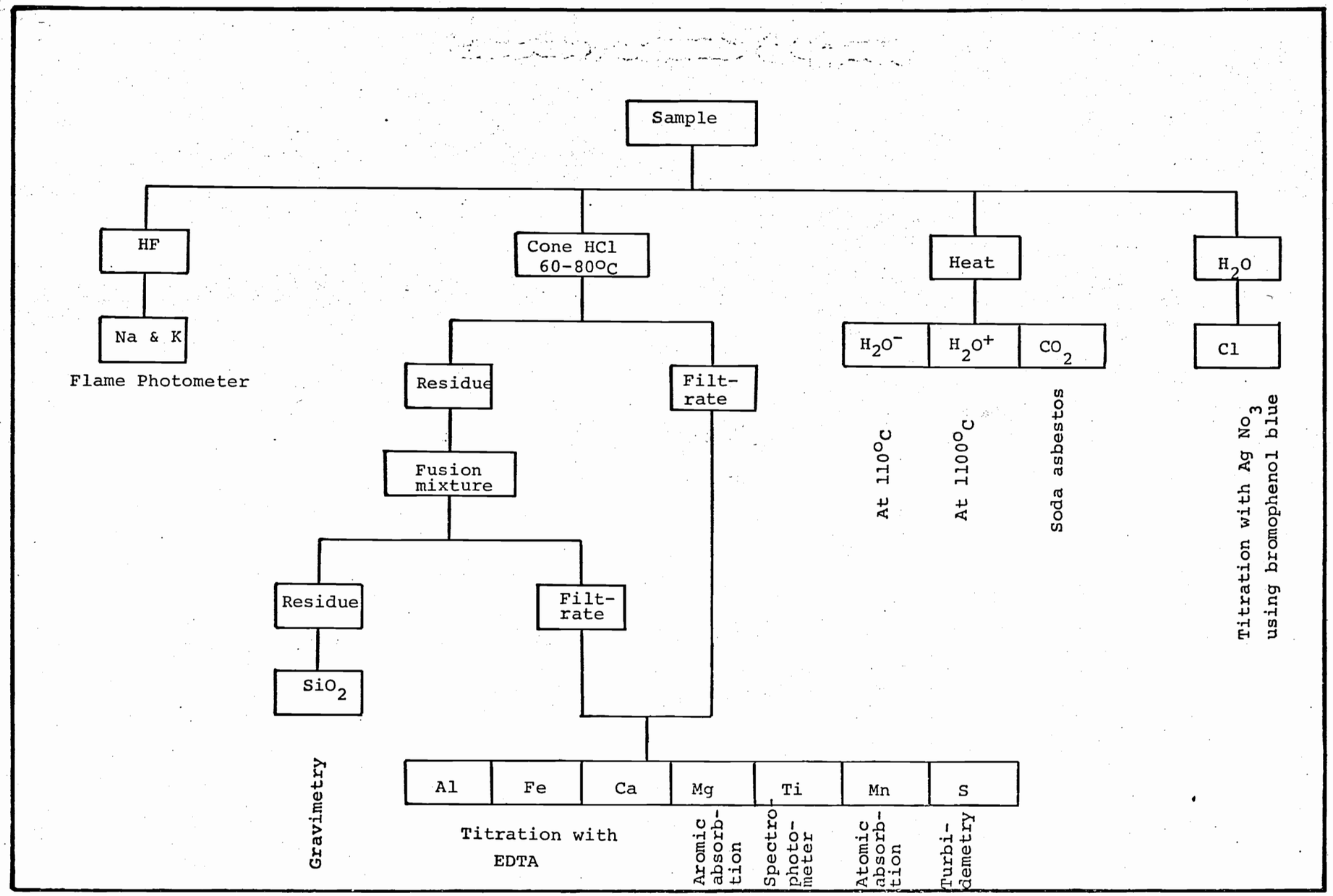
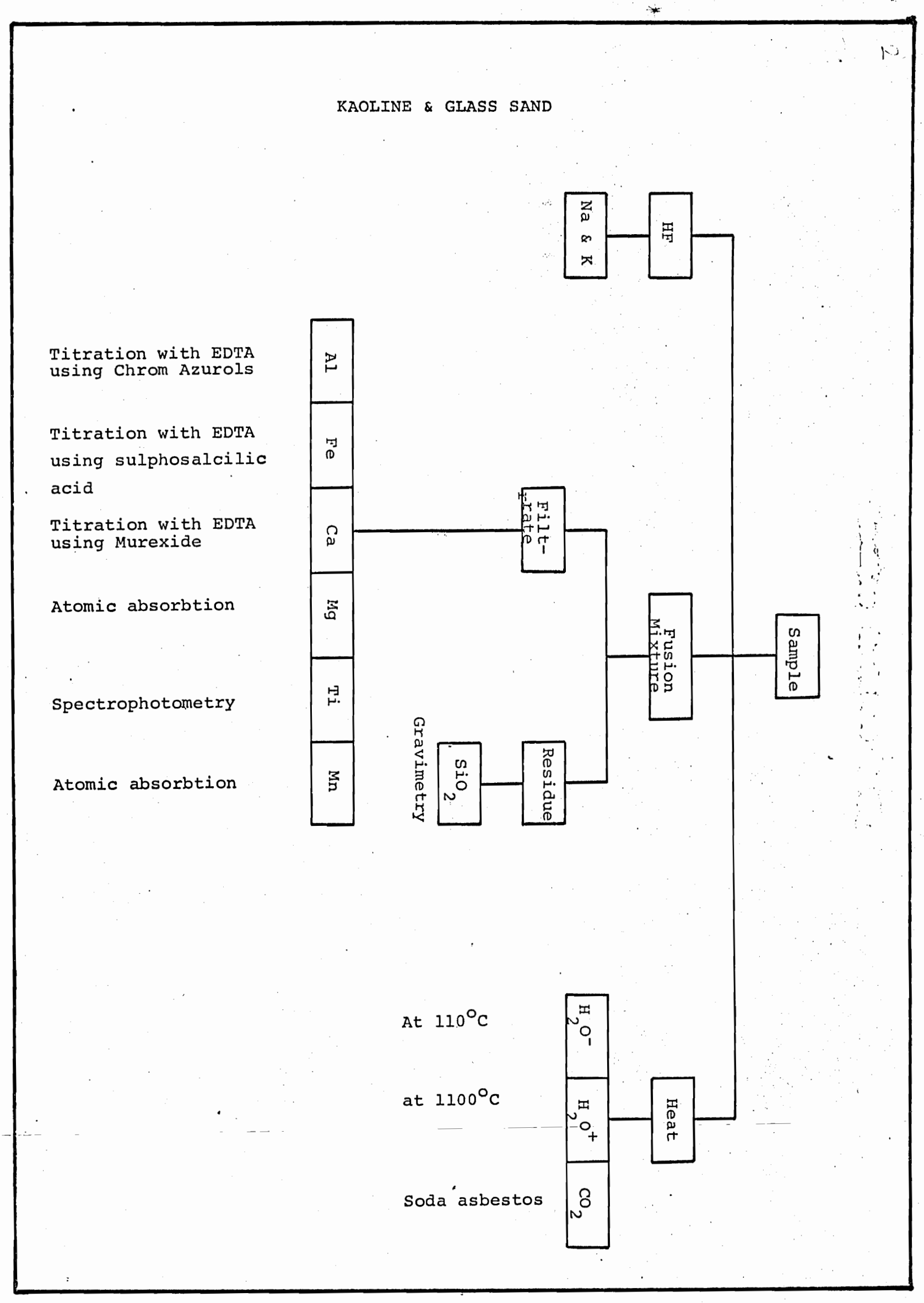

MANGANESE ORE
Sample
H_2O^-
H_2O^+
CO_2
MnO_2
Fusion mixture
$HCl + H_2SO_4$
Filtrate
Residue
SiO_2
Gravimetry
Na & K
Total Mn
Fe
Al
Ca
Mg
P
Zn
Ti
As
Titration with EDTA using sulphosalcilic acid
Titration with EDTA using chrom Azorols
Titration with EDTA using Muroxide
Atomic absorbtion
Spectrophotometry
Spectrophotometry
Spectrophotometry
Gut Zeit method
Flame photometry
Potentiometric titration with K MnO_4 at pH 6-7

LIMESTONE, DOLOMITE & GYPSUM




KAOLINE & GLASS SAND
Sample
Fusion Mixture
HF
Na & K
Filt-rate
Residue
Gravimetry
SiO_2
Al
Fe
Ca
Mg
Ti
Mn
Titration with EDTA using Chrom Azurols
Titration with EDTA using sulphosalcilic acid
Titration with EDTA using Murexide
Atomic absorbtion
Spectrophotometry
Atomic absorbtion
Heat
H_2O^-
H_2O^+
CO_2
At 110°C
at 1100°C
Soda asbestos

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Prepared for

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CHEMICAL ANALYSES AND MINERALOGY OF SINAI MANGANESE ORE SAMPLES

August 21, 1980

HRI Project No. 4995
Copy No. 3

CHEMICAL ANALYSES AND MINERALOGY OF SINAI MANGANESE ORE SAMPLES

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TABLE OF CONTENTS

	Page No.
Introduction and Summary	1
Samples Received and Work Requested	3
Chemical Analyses	5
Mineralogical Investigation	7
Megascopic Description and Sample Preparation	7
X-ray Diffraction Analyses	8
Ore Microscopic Studies	9
Sample 153	9
Sample 154	10
Sample 178	11
Petrographic Thin Section Studies	11
Sample 153	12
Sample 154	12
Sample 178	12
Differential Thermal Analysis and Thermogravimetric Analysis	22
DTA	22
Sample 153	23
Sample 154	24
Sample 178	24
TGA	24
Determination of Specific Gravity	25

INTRODUCTION AND SUMMARY

On June 9, 1980, Kaiser Engineers, Inc. requested from Hazen Research, Inc. a quotation for chemical analyses and mineralogical studies of six manganese ore samples from the Sinai area, Egypt. This work was originally authorized by purchase order number 80012-3; however, it was subsequently modified to include fewer assays and mineralogical studies on only three of the six samples provided.

For the mineralogy, six small samples designated 128, 129, 153, 154, 166, and 178, and consisting of a few specimens varying in size from 1/2 inch to three inches, were received on June 23, 1980. For assays, six minus 100-mesh sample pulps weighing from 4.81 to 19.21 grams were received on July 8, 1980. Although the sample designations are the same for five out of the six samples, it is not known whether they correspond exactly to the samples studied mineralogically.

In accordance with the request, the object of this investigation was (1) to analyze the six assay pulps for manganese, iron, and other important elements; and (2) identify and quantify the manganese ore minerals and associated gangue minerals, and determine their intergrowth relationships plus any other features pertinent to potential beneficiation of this ore.

As part of the mineralogical studies, differential thermal and thermogravimetric analyses (DTA and TGA), and specific gravity determinations of the three samples were also requested.

The assays show a highly variable manganese and iron content ranging from 18.8 to 51.1% Mn and from 6.54 to 39.3% Fe, corresponding to a variation in Mn:Fe ratios from 0.48:1 to 7.81:1.

By a combination of X-ray diffraction, microscopic, and DTA-TGA analyses, manganese mineralization in the three samples was found to consist chiefly of pyrolusite and psilomelane with variable quantities of goethite and hematite, both of which can locally exceed the manganese mineralization. Other constituents identified, occurring in lesser quantities, are carbonates, detrital quartz, and variable amounts of clay minerals. There was complete agreement of all three mineralogical techniques as to the general composition of these samples.

With respect to beneficiation of this ore, the dominant feature is that the majority of the manganese and iron mineralization is associated on a microscopically small scale. Within the realm of economic feasibility, possibilities are extremely remote to substantially reduce the iron content of these samples by physical beneficiation methods. On the other hand, it might be possible to increase the grade of both the iron and the manganese by removal of the discrete detrital quartz, and perhaps carbonates. This could probably be achieved by gravity separation, high intensity magnetic separation of the manganese and iron oxides, or reversed froth flotation of the gangue.

SAMPLES RECEIVED AND WORK REQUESTED

For this investigation, six ore samples of 1/2-inch to 3-inch specimens and six pulverized assay pulps were received at Hazen Research, Inc. on June 23 and July 8, 1980, respectively. These samples were designated:

For Mineralogy	For Assays
128	129 M
129	153 M
153	154 M
154	158 M
166	166 M
178	178 M

Since there is no information on how the assay pulps were obtained and since there is considerable variation from one specimen to another in some of the ore samples, the assay results do not necessarily correlate to the mineralogical results.

The work requested by Kaiser Engineers included:

1. Chemical analyses of minus 100-mesh assay pulps for total manganese, total iron, silica, aluminum, magnesium, calcium, arsenic, phosphorus, total sulfur, and barium.
2. Mineralogical studies of coarse ore samples which would include:
   a. X-ray diffraction analyses to determine the major and minor ore and gangue minerals.
   b. Ore microscopic studies to determine their intergrowth relationships and any other features pertinent to potential beneficiation of this ore together with photomicrographs showing typical and significant features of the ore.

c. Petrographic thin section studies to determine the association of the gangue minerals with the ore minerals. This work included modal analyses (point count method) for quantifying the gangue minerals.

d. Differential thermal analyses and thermogravimetric analyses to characterize the thermal behavior (e.g. release of water, phase conversions, recrystallization, etc.) of the samples.

e. Determination of the specific gravity of the ore samples.

CHEMICAL ANALYSES

Six samples of minus 100-mesh ore were received on July 8, 1980, to be used for chemical analyses. Sample designations and weights were as follows:

Sample No.	Sample Weight, g
129M	19.21
153M	9.87
154M	15.73
158M	4.81
166M	5.41
178M	6.22

The analyses originally requested were: Al_2O_3, SiO_2, MnO, MnO_2, total Mn, MgO, CaO, Na_2O, K_2O, BaO, ZnO, TiO_2, As_2O_3, P_2O_5, total S, CO_2, H_2O-moisture, H_2O-combined, weight loss on ignition and X-ray fluorescence scans for elements above Ti in atomic number. However, since the amount of sample provided was insufficient for all these analyses, by consent of Mr. R. Greenwalt of Kaiser Engineers, analyses for MnO and MnO_2 separately, Na_2O, K_2O, ZnO, TiO_2, CO_2, H_2O, L.O.I., and the scan were omitted.

The chemical analyses showed that the total manganese contents in the six assay samples ranges from 18.8% to 51.1% and the total iron contents from 6.54% to 39.3% which corresponds to Mn:Fe ratios of 0.48:1 and 7.81:1. At this point it is not known if the chemical data can be correlated with the findings of the mineralogical work since there was no information on the correspondence of the assay pulps with the

mineralogical samples. A lack of correlation is indicated by the discrepancy found between chemically determined barium contents and the mineralogical studies of polished sections which showed significant amounts of psilomelane which can contain up to 17% BaO[1/]. The following Table 1 gives the detailed results of the assay work.

Table 1

Chemical Analyses of Six Manganese Ore Samples

Sample No.	Mn Total, %	Fe Total, %	Mn:Fe Ratio	SiO_2 %	Al_2O_3 %	MgO %	CaO %	As_2O_3 %	P_2O_5 %	S Total, %	BaO %
129	31.2	24.5	1.27:1	3.74	0.52	0.615	0.880	0.0008	0.026	<0.01	<0.01
153	22.3	22.9	0.97:1	15.8	4.49	0.156	0.509	0.0029	0.519	0.03	0.50
154	51.1	6.54	7.81:1	1.42	0.35	1.08	1.10	0.0003	<0.001	0.05	0.20
158	22.4	15.5	1.45:1	1.25	0.31	1.94	10.9	0.0002	<0.001	1.36	<0.01
166	18.8	39.3	0.48:1	3.43	0.94	0.637	1.07	0.0003	<0.001	0.04	<0.01
178	22.6	22.9	0.99:1	1.57	0.32	0.409	6.90	0.0003	<0.004	0.03	<0.01
Analytical Method	Volumetric	Volumetric		Gravimetric	AA[1/]	AA	AA	Colorimetric	Colorimetric	Leco apparatus	AA

1/ Atomic absorption spectrophotometry.

1/ Palache, C., Berman, H., & Frondel, C. 1968, The System of Mineralogy. Volume 1, p. 669.

MINERALOGICAL INVESTIGATION

MEGASCOPIC DESCRIPTION AND SAMPLE PREPARATION

For the mineralogical investigation, six samples each consisting of two to ten specimens varying in size from 1/2 inch to three inches, were received on June 23, 1980. The original request from Kaiser Engineers, Inc. was to use all six samples for the mineralogical work, but final instructions were to use only three samples, 153, 154, and 178, and to select from these samples the most compact and high grade specimens.

The following is a megascopic sample description carried out prior to selection of specimens for the mineralogical work.

Sample No.	Megascopic Description
128	Massive black manganese ore with carbonate coatings and dark brown earthy fragments
129	Massive black, partly colloform manganese ore with few white coatings and earthy black material
153	Black-brown earthy to massive manganese ore with traces of white coatings
154	Black massive partly recrystallized manganese ore
166	Brown earthy manganese ore with relatively high amount of carbonates which are present as vug fillings or are intimately intergrown with the ore
178	Black earthy manganese ore strongly veined by white gangue and in part brecciated and cemented by red-brown iron-oxides/hydroxides

When these samples were examined megascopically, it was apparent that the fragments comprising a single sample varied somewhat in mineral content and texture. Therefore, since the chemical analyses were not made on the same rock fragments used for the mineralogical examination, an exact comparison between the mineralogical and chemical analyses cannot be made.

The rock fragment selected from each of the three samples was sawed in half so that a facing portion of each half could be used for one thin and one polished section. The remaining portions of each of the three fragments were ground to minus 100-mesh to be used for bulk X-ray diffraction, differential thermal and thermogravimetric analyses, and for specific gravity determinations.

X-RAY DIFFRACTION ANALYSES

These analyses showed that pyrolusite and psilomelane are the dominant manganese ore minerals. Other manganese minerals occurring in minor to trace amounts are hollandite, hausmannite, and chalcophanite. The nonore and gangue minerals are in approximate order of decreasing abundance: goethite, quartz, dolomite, hematite, and clay minerals. The following Table 2 summarizes the results of the X-ray diffraction analyses.

Table 2

Results of X-ray Diffraction Analyses

Sample No.	Minerals Present	
	Major	Minor to Trace
153	Pyrolusite Goethite	Hematite Quartz Psilomelane Montmorillonite
154	Pyrolusite Psilomelane	Goethite Hematite Hollandite Hausmannite Montmorillonite Dolomite
178	Hematite Pyrolusite	Dolomite Psilomelane Hausmannite Hollandite Quartz

ORE MICROSCOPIC STUDIES

For the determination of the manganese minerals, their intergrowth relationships, gangue association, and particle size analysis, polished sections were prepared from the three samples and studied under the ore microscope. Following are the pertinent results of this work.

Sample 153

The dominant manganese mineral in this sample is pyrolusite which occurs mostly as feather-like crystals with the typical cleavage and herringbone texture, or as irregular patches. Frequently this pyrolusite is very fine grained and intimately intergrown with very well crystallized goethite aggregates. Psilomelane is the second frequent manganese mineral exhibiting the typical colloform textures. Occasionally psilomelane is replacing pyrolusite. Some pyrolusite is also being replaced by goethite. Particle size analysis of the pyrolusite crystals

showed them to be quite variable and ranging from ≤ 5 microns to ≤ 1 mm in length and ≥ 1 micron to 500 microns in width. The majority of the pyrolusite crystals (±80%) fall in the size range of 400 to 600 microns in length and 80-200 microns in width. The psilomelane aggregates range in size from 5 to 700 microns with an average size range of 40 to 250 microns.

Goethite, which mostly occurs in crystal aggregates, shows an average size range of 60 to 200 microns. Quartz is the dominant gangue mineral and occurs commonly in the form of disseminated rounded to irregular grains which have grain sizes from ≤10 microns to 600 microns and an estimated average grain size of 400 microns. Some of the quartz grains are fractured, with the fractures being filled with pyrolusite and/or psilomelane.

The modal analysis (1000 points counted) showed 45% pyrolusite, 18% psilomelane, 22% goethite, traces of hematite, 15% gangue.

Sample 154

This ore sample which, megascopically, appears to be composed of massive manganese minerals,consists generally of a very intimate and fine grained intergrowth of psilomelane and pyrolusite. Great portions of the pyrolusite have been replaced by psilomelane. Another characteristic feature of this sample is the extremely fine admixed siliceous gangue (quartz, clay minerals?), and goethite. The particle size of the fine intergrowth between psilomelane and pyrolusite as well as the gangue-goethite association is generally ≤30 microns. Few very small veinlets of chalcophanite (20 to 40 microns in width) are intersecting the sample.

The modal analysis (1000 points counted) showed 30% pyrolusite, 16% psilomelane, 52% goethite, trace of hematite, 1% gangue, and 1% chalcophanite.

Sample 178

This sample consists of a very porous and intimate intergrowth of the manganese minerals (pyrolusite and psilomelane) and hematite but also some goethite and gangue components (carbonates, siliceous matrix material and larger quartz grains). The hematite content of this sample is comparatively high with hematite occurring in large aggregates (up to 2 mm in diameter). These aggregates are very porous with the pore space being filled by siliceous gangue or manganese minerals. Pyrolusite occurs mostly as needle-like aggregates with a crystal size of 5 to 20 microns in length and 2 microns in width. Carbonate grains and grain aggregates (≤10 to 40 microns in diameter) are dispersed throughout the whole sample. Also, carbonate veinlets up to 500 microns in width are intersecting the sample from various directions. Some of the larger carbonate aggregates are intimately interlocked with hematite and pyrolusite. Traces of pyrite are present. Occasionally, the carbonates form a matrix in which very fine grained manganese minerals (≤5 microns) are embedded exhibiting "intersertal" texture.

The modal analysis (900 points counted) showed 26% pyrolusite, 12% psilomelane, 2% goethite, 18% hematite, and 42% gangue.

Figures 1 to 8 at the end of this section show typical and significant features of the three samples.

PETROGRAPHIC THIN SECTION STUDIES

For the investigation of the gangue minerals and their textural relationships as well as size distribution, petrographic thin sections were prepared from the opposite side of the slab which was used for the polished section preparation. The thin sections were then studied with

the polarizing microscope. The pertinent findings of this work are as follows:

Sample 153

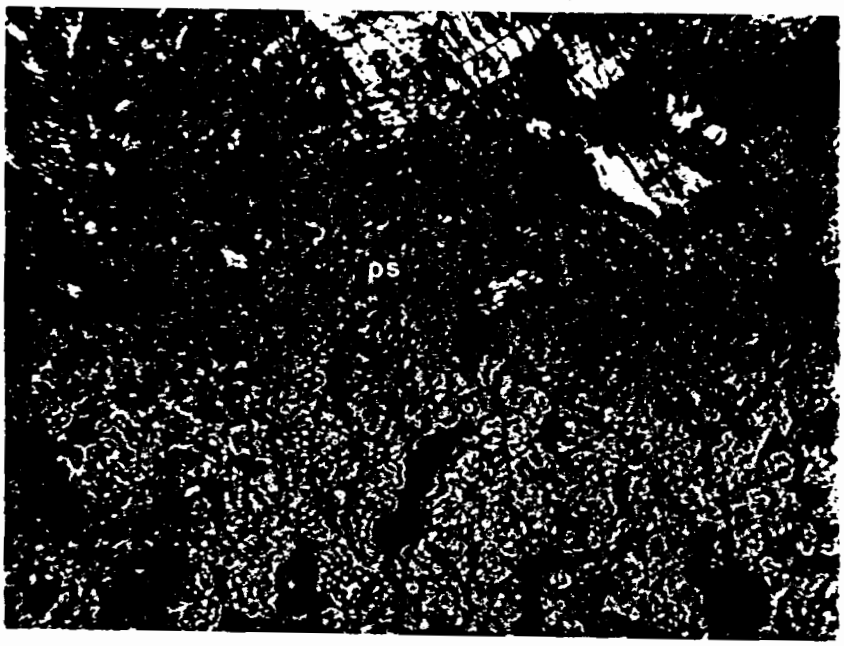
The only gangue mineral found in this sample was quartz. Modal analysis of the thin section showed 17 vol % quartz and 83 vol % opaque minerals. The quartz occurs as equant and/or sub-equant, less frequently elongated grains. Most grains are well rounded indicating the quartz to be detrital in origin. Quite frequently quartz grains are fractured and the fractures filled with manganese minerals, mostly with pyrolusite (as determined by ore microscopic study). The grain size of the quartz varies from ≤10 microns to 0.9 millimeter with the majority (±80%) of the grains ranging from 300 to 400 microns. Figure 9 shows the typical mode of occurrence of the detrital quartz.

Sample 154

The characteristic gangue minerals in this sample are extremely fine grained siliceous constituents and carbonates which are generally intimately intergrown with pyrolusite, psilomelane and goethite, and very minor amounts of hematite. Because of the low amount of gangue and its extremely fine grained occurrence, point count analysis could not be carried out.

Sample 178

The characteristic gangue minerals of this sample are carbonates (predominantly dolomite and trace of calcite) and quartz. Modal analysis showed 4 vol % carbonates, 3 vol % quartz, and 93 vol % of opaque minerals. The carbonates occur as finely dispersed grains which are mostly ≤20 microns in diameter but also as small veinlets and/or stringers of <20 microns in width or as massive aggregates of several centimeters in diameter. Quartz occurs as well rounded detrital grains.



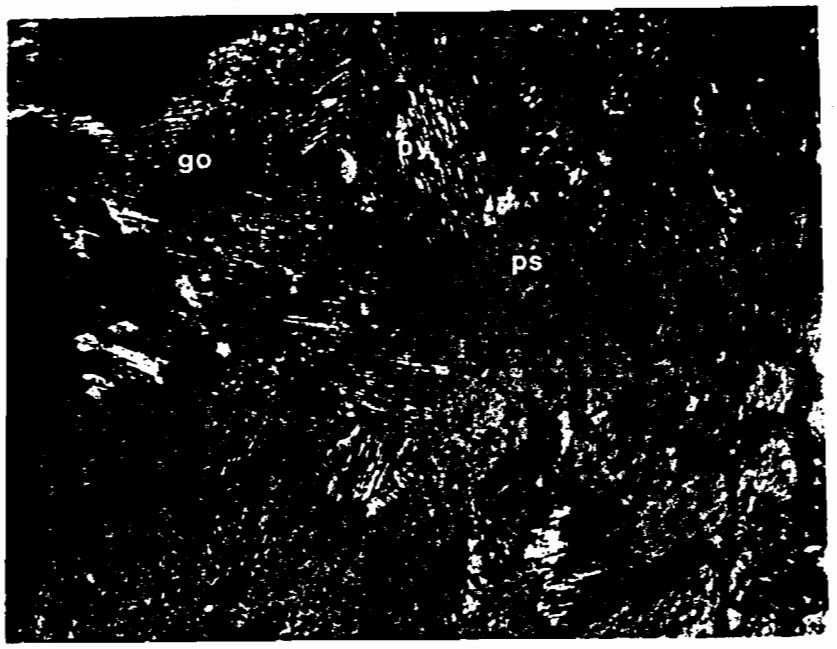
Sample 153

Photomicrograph showing colloform psilomelane (ps) replacing pyrolusite (py). Black inclusions in psilomelane are gangue minerals.

Plain incident light 160X

Scale = 100 microns

Figure 1



Sample 153

Intimate intergrowth of pyrolusite (py), goethite (go), psilomelane (ps), and gangue (black).

Plain incident light 160X

Scale = 100 microns

Figure 2

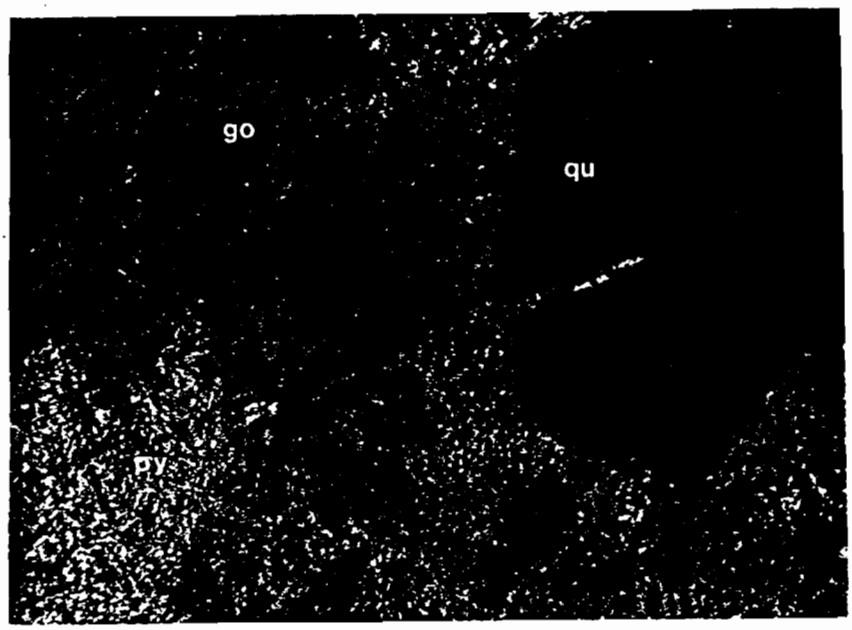
Sample 153

Portion of a detrital quartz grain (qu) is fractured and filled with mobilized pyrolusite (py). Rimming the quartz grain and sprouting into the pyrolusite is well crystallized goethite (go).

Plain incident light 160X

Scale = 100 microns

Figure 3



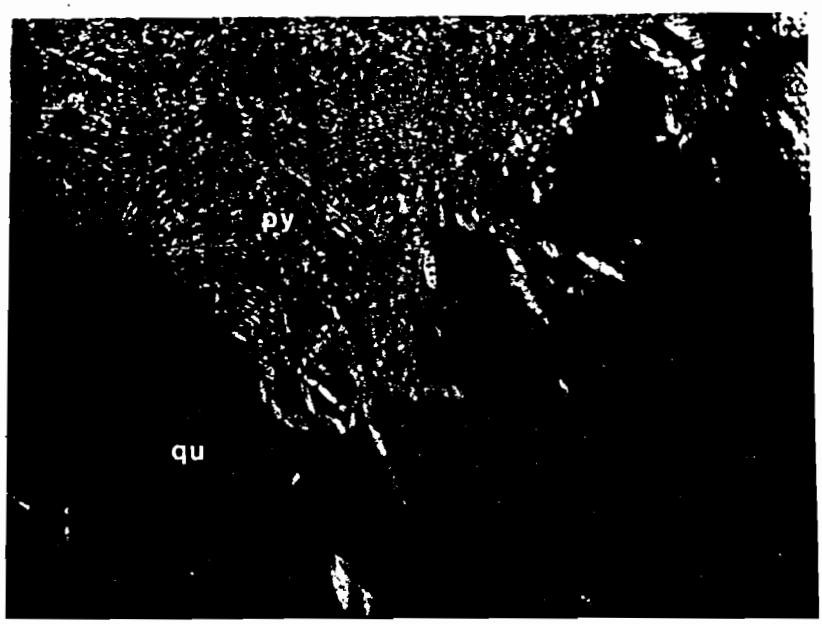
Sample 153

Extremely fine grained (intersertal-like) intergrowth of goethite (go) with pyrolusite (py). An irregular quartz grain (qu) is fractured and filled with pyrolusite.

Plain incident light 160X

Scale = 100 microns

Figure 4



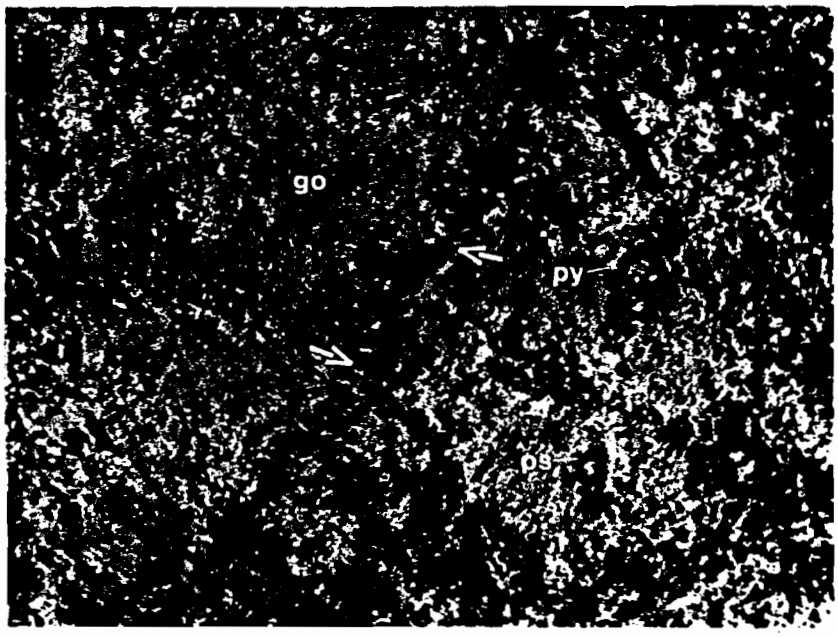
Sample 153

Relatively coarse grained pyrolusite (py) is growing into cavity filled with mounting media. Portions of rounded detrital quartz grains (qu) are also present.

Plain incident light 160X

Scale = 100 microns

Figure 5



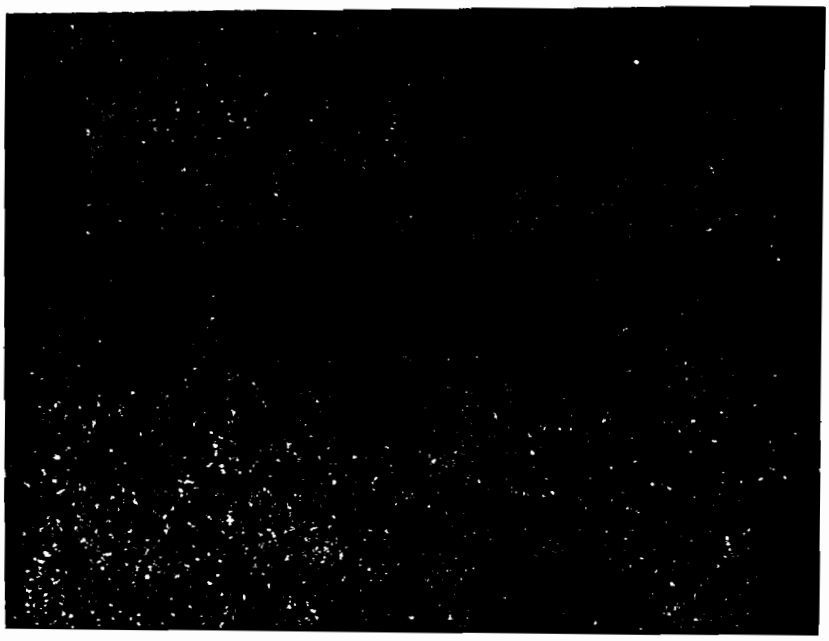
Sample 154

Extremely fine grained intergrowth of pyrolusite (py), psilomelane (ps), goethite (go), and gangue (black). The sample is transected by a chalcophanite veinlet (see arrows).

Plain incident light 160X

Scale = 100 microns

Figure 6



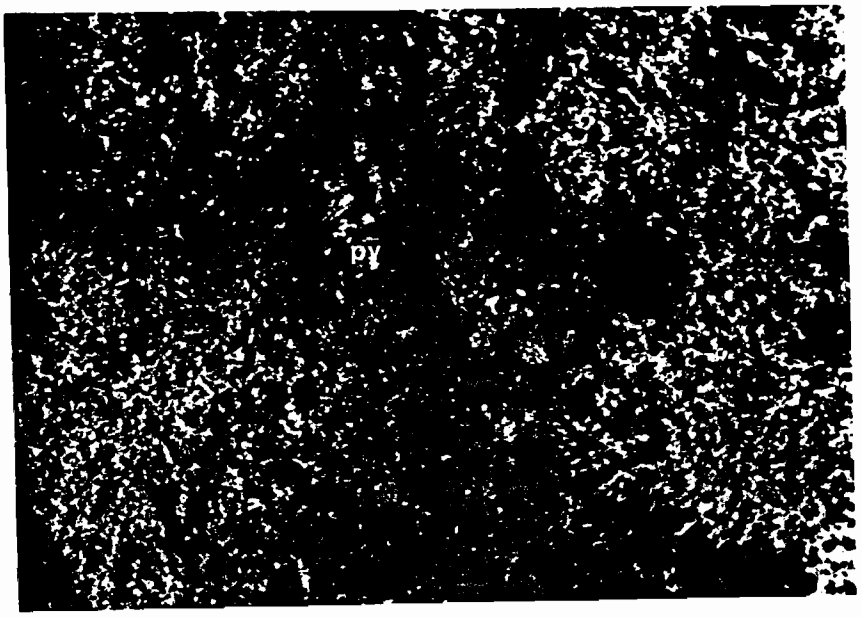
Sample 178

Photomicrograph showing extremely fine grained intergrowth of pyrolusite and/or psilomelane and hematite (light gray) in carbonate matrix (dark gray).

Plain incident light 160X

Scale = 100 microns

Figure 7



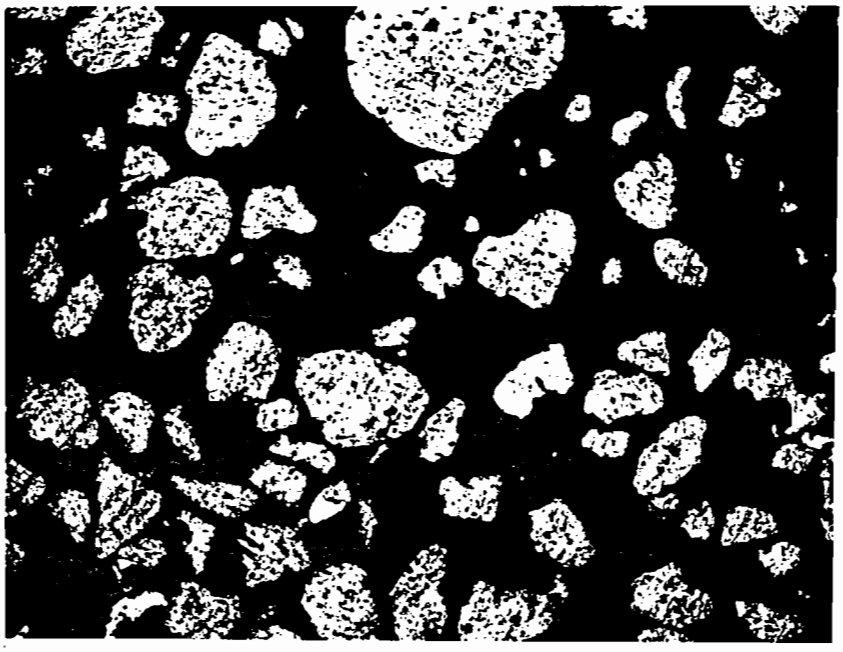
Sample 178

Very intimate association of pyrolusite (py), hematite (he), and gangue (gray to black).

Plain incident light 160X

Scale = 100 microns

Figure 8



Sample 153

Photomicrograph showing a portion of the thin section with a high concentration of fractured quartz grains. Note the variation in grain size. Most grains are rounded to subrounded indicating detrital origin of the quartz.

Plain polarized light 32X

Scale = 0.5 millimeter

Figure 9

DIFFERENTIAL THERMAL ANALYSIS AND THERMOGRAVIMETRIC ANALYSIS

By means of differential thermal analysis (DTA) and thermogravimetric analysis (TGA), the samples 153, 154, and 178 were investigated in order to determine the thermal reactions that will occur with this particular assemblage of minerals.

DTA

The following were the equipment and operation conditions used for this investigation:

Apparatus	DuPont 990 Thermal Analyzer
Heating rate	2 and 5°C/inch 10°/minute
Atmosphere	Air
Inert reference material	Calcined Al_2O_3
Crucible	Platinum
Flow rate	100 cc/minute

For the interpretation of the DTA-thermograms of manganese minerals, it should be considered that the temperature ranges of their thermic reactions may deviate from published data due to variable chemical composition, operating conditions, etc.

The most significant reactions found in the thermograms are the pyrolusite conversions. Pyrolusite shows a distinct endothermic peak at 620/625°C in samples 153 and 154 and a comparatively smaller endothermic peak at 690°C in sample 178. Minor endothermic reactions occur in samples 153 and 154 at 950 and 980°C but are missing in sample 178. Instead, an exothermic reaction is indicated in the latter

sample which is probably caused by recrystallization of psilomelane. The chief endothermic reactions of the pyrolusite dorrespond to the reaction $4MnO_2 \rightarrow 2Mn_2O_3 + O_2$, corresponding to the conversion of pyrolusite (β-MnO_2) to bixbyite (α-Mn_2O_3, with Fe_2O_3 in the structure) which takes place around 500 to 700°C. The minor endothermic reactions occurring at 950 and 980°C, respectively, are probably due to formation of hausmannite (Mn_3O_4).

Ukai et al (1956), Roy (1968), and Agiorgitis (1969)[1/] have shown that α, β, γ, and δ-MnO_2 minerals are all transformed to bixbyite when heated to temperatures between 500 and 700°C in air and this bixbyite further transforms to hausmannite at 900 to 1000°C.

Muan & Somiya (1962)[2/] have shown, however, that iron-free bixbyite can already convert to hausmannite at 877°C whereas the presence of iron oxides shifts the conversion temperature up to 900°C or more, depending on the iron concentration.

The association of silica with the manganese oxide minerals could lead to the formation of braunite ($Mn_2O_8 \cdot SiO_4$) and/or rhodonite ($MnSiO_3$) with rising temperature.

The other peaks observed in the three samples are interpreted as follows:

Sample 153

Major endothermic peak at 330 to 340°C is due to dewatering of goethite. Weak endothermic reaction at 570°C is due to the inversion of $\alpha \rightleftharpoons \beta$-quartz which occurs at ±573°C.

1/ Ukai, Y., Nishimura, B., & Mayeda, T.: Mineralogical study on the manganese dioxide minerals, Mem. Coll. Sc. Univ. Kyoto, Series B, vol. 23, pp. 203-222, 1956.
Roy, S.: Mineralogy of the different genetic types of manganese deposits, Economic Geology, vol. 63, pp. 760-786, 1968.
Agiorgitis, G.: Über differential-thermoanalytische und infrarotspektroskopische Untersuchungen von Mangan-Mineralien, Tschermaks Miner. u. Petrogr. Mitt., 13, pp. 273-283, 1969.

2/ Muan, A. & Somiya, S.: The system iron oxide-manganese oxide in air, Amer. Journ. Sci., vol. 260, pp. 230-240, 1962.

Sample 154

Broad endothermic reaction between 100 and 300°C is probably due to dewatering of both manganese and clay minerals.

Sample 178

Broad endothermic reaction between 80 and 200°C is due to dewatering. Exothermic reaction at 350°C is due to recrystallization of hematite. Distinct endothermic peak at 570°C is due to quartz inversion. Minor but distinct endothermic peak at 630°C due to psilomelane and at 690°C due to pyrolusite. The broad exothermic reaction between 700 and 780°C is believed to result from psilomelane recrystallization.

The thermograms of samples 153, 154, and 178 are shown at the end of this section.

TGA

The thermogravimetric analyses were run under the following conditions:

Apparatus	DuPont 951 Thermogravimetric Analyzer
Weight of samples	26.54 mg (sample 153) 8.47 mg (sample 154) 7.41 mg (sample 178)
Heating rate	10°/minute
Atmosphere	Air

The most significant weight loss in the three samples occurs in the temperature range 500 to 650°C and corresponds to the transformation of pyrolusite to bixbyite. The weight loss due to absorbed water or moisture is negligible in sample 153 whereas samples 154 and 178 show approximately 2% weight loss at 110°C. The following Table 3 summarizes the results of the thermogravimetric analysis.

Table 3

Thermogravimetric Analysis

Sample No.	Significant Weight Loss (%) in Temperature Range (°C)				Total Weight Loss
	≤110	280-340	500-650	910-940	
153	-	4	4	1	11
154	≤110	110-550	550-650		19
	2	8	5		
178	≤110	110-450	450-70		16
	2	3	8		

The thermogravimetric patterns are given at the end of this section.

DETERMINATION OF SPECIFIC GRAVITY

Samples 153, 154, and 178 were pulverized to minus 100-mesh, and about 30 to 50 grams of each sample were used to determine the specific gravity in a Le Chatelier flask. After the first run, the samples were filtered, dried and then retested. The following Table 4 gives the average values of the two runs for each sample.

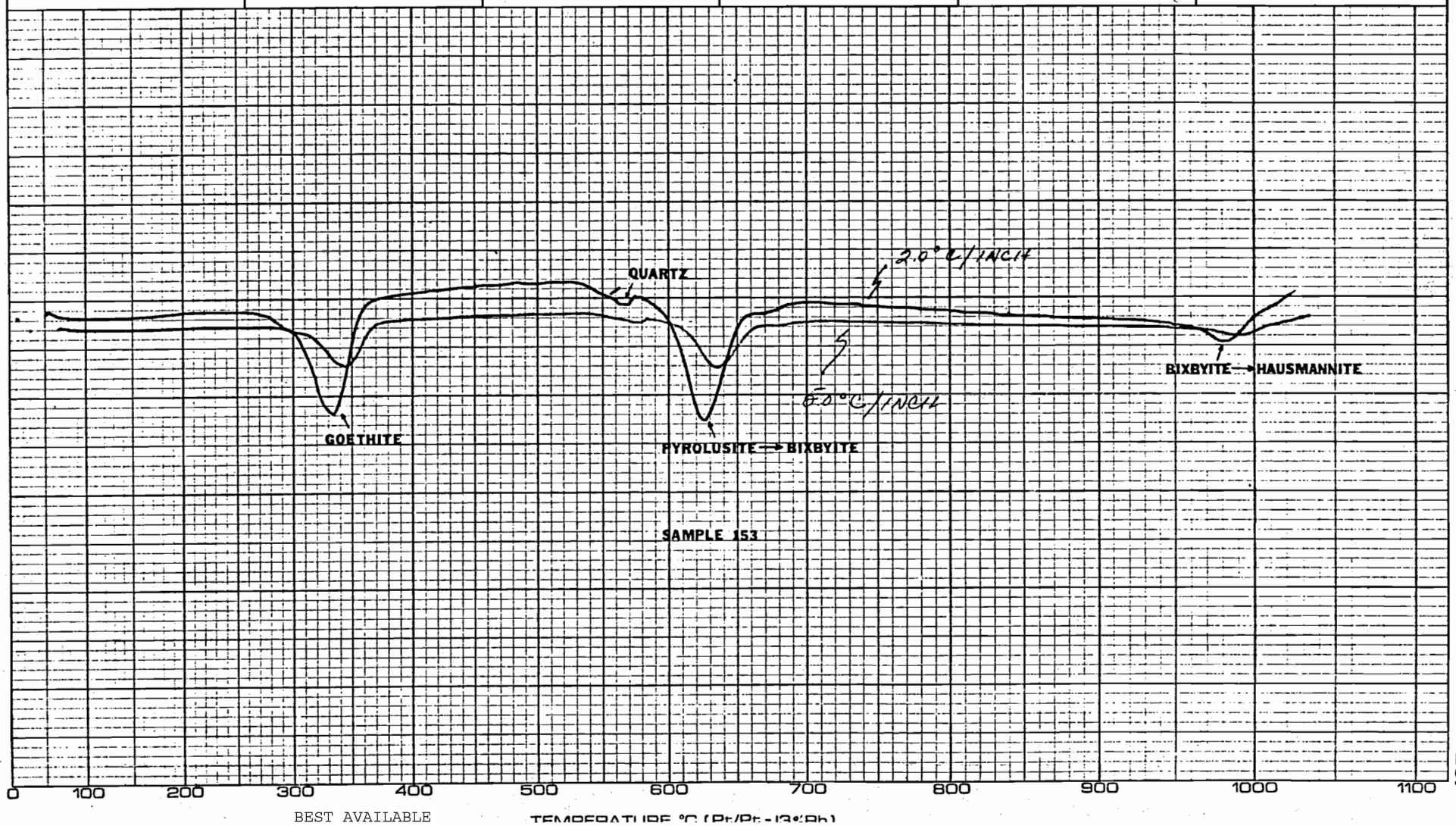
Table 4

Results of Specific Gravity Determinations

Sample No.	Specific Gravity
153	4.37 ±0.05
154	3.83 ±0.05
178	3.52 ±0.05

PART NO. 990092

RUN NO. 3 DATE 7-8-80	T-AXIS	DTA-DSC	TGA	TMA	no fusion
OPERATOR S Pay	SCALE, mv/in 0.8	SCALE, °C/in	SCALE, mg/in	SCALE, mils/in	
SAMPLE: 4995	PROG. RATE, °C/min 10	(mcal/sec)/in	SUPPRESSION, mg	MODE	
#1 Repeat	HEAT ✓ COOL ___ ISO ___	WEIGHT, mg	WEIGHT, mg	SAMPLE SIZE	
ATM AIR @ STP	SHIFT, in 0	REFERENCE	TIME CONST., sec	LOAD, g	
FLOW RATE 100cc/min			dY, (mg/min)/in	dY, (10X), (mils/min)/in	



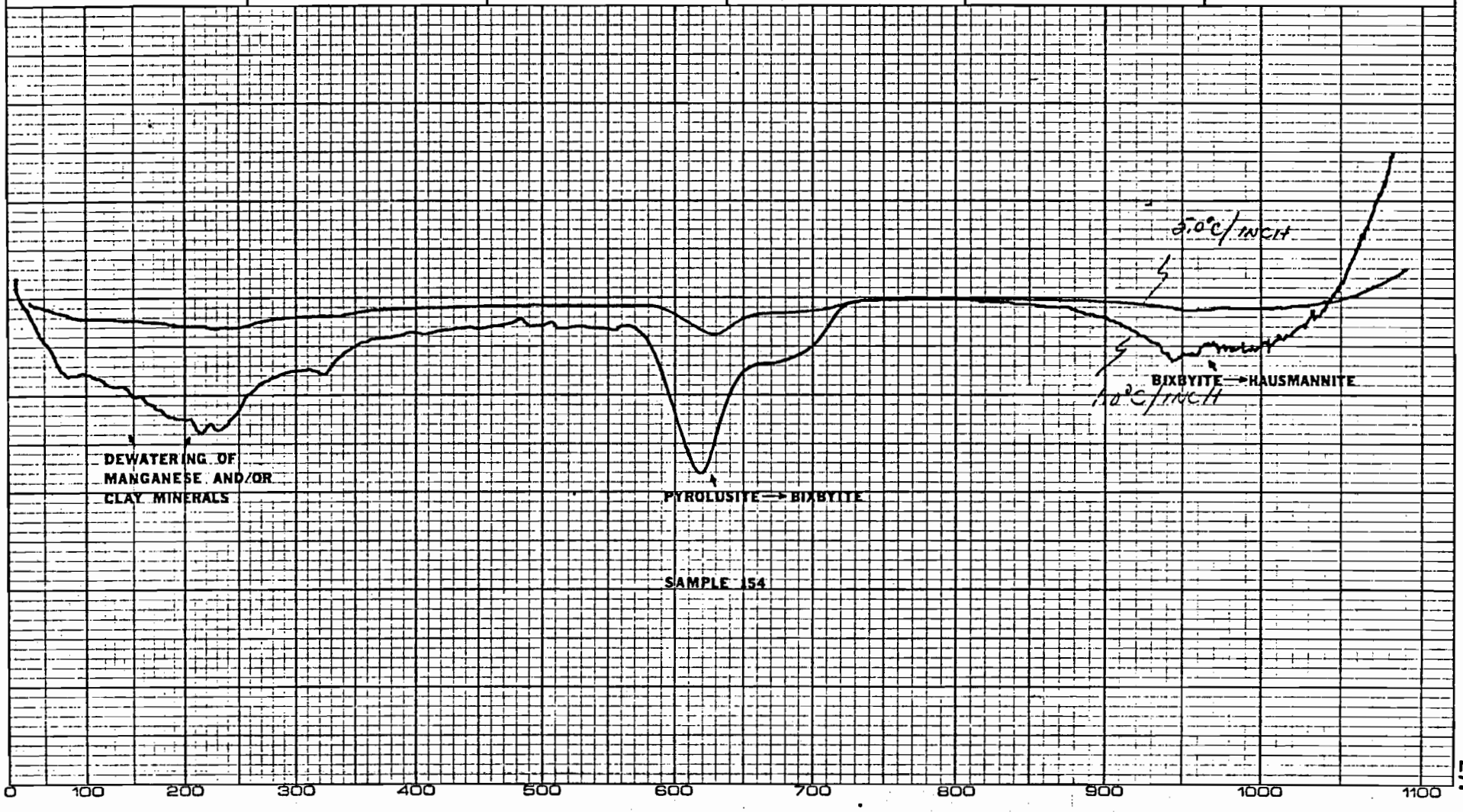
DUPONT Instruments

MEASURED VARIABLE

BEST AVAILABLE

PART NO. 990092

RUN NO. 1 DATE 7-8-90	T-AXIS	DTA-DSC	TGA	TMA	no fusion
OPERATOR S Pay	SCALE, mv/in 0.8	SCALE, °C/in	SCALE, mg/in	SCALE, mils/in	
SAMPLE: 4995 #2	PROG. RATE, °C/min	(mcal/sec)/in	SUPPRESSION, mg	MODE	
	HEAT COOL ISO	WEIGHT, mg	WEIGHT, mg	SAMPLE SIZE	
ATM Air @ STP	SHIFT, in 0	REFERENCE	TIME CONST., sec	LOAD, g	
FLOW RATE 100cc/min			dY, (mg/min)/in	dY, (10X), (mils/min)/in	

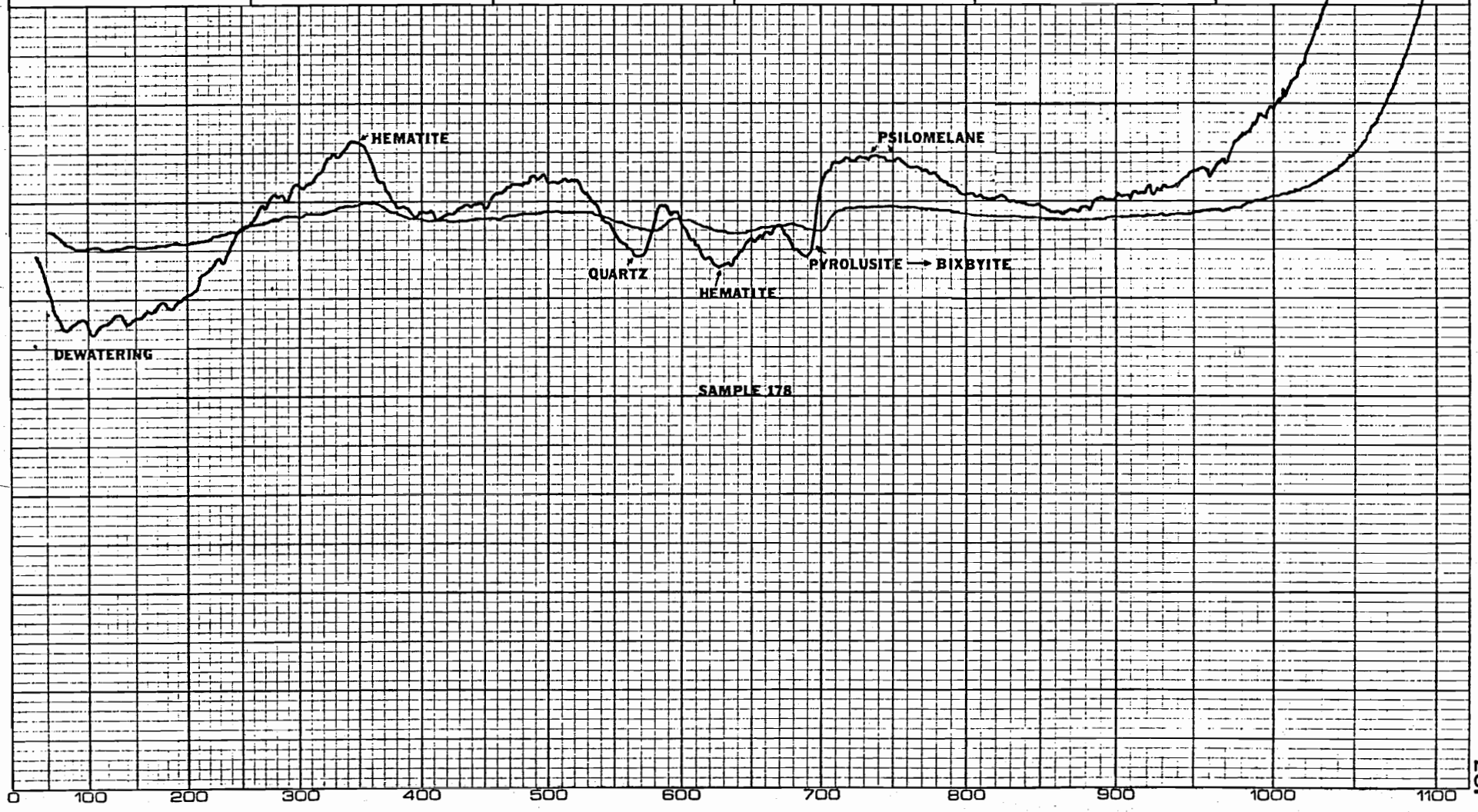


MEASURED VARIABLE

DUPONT Instruments

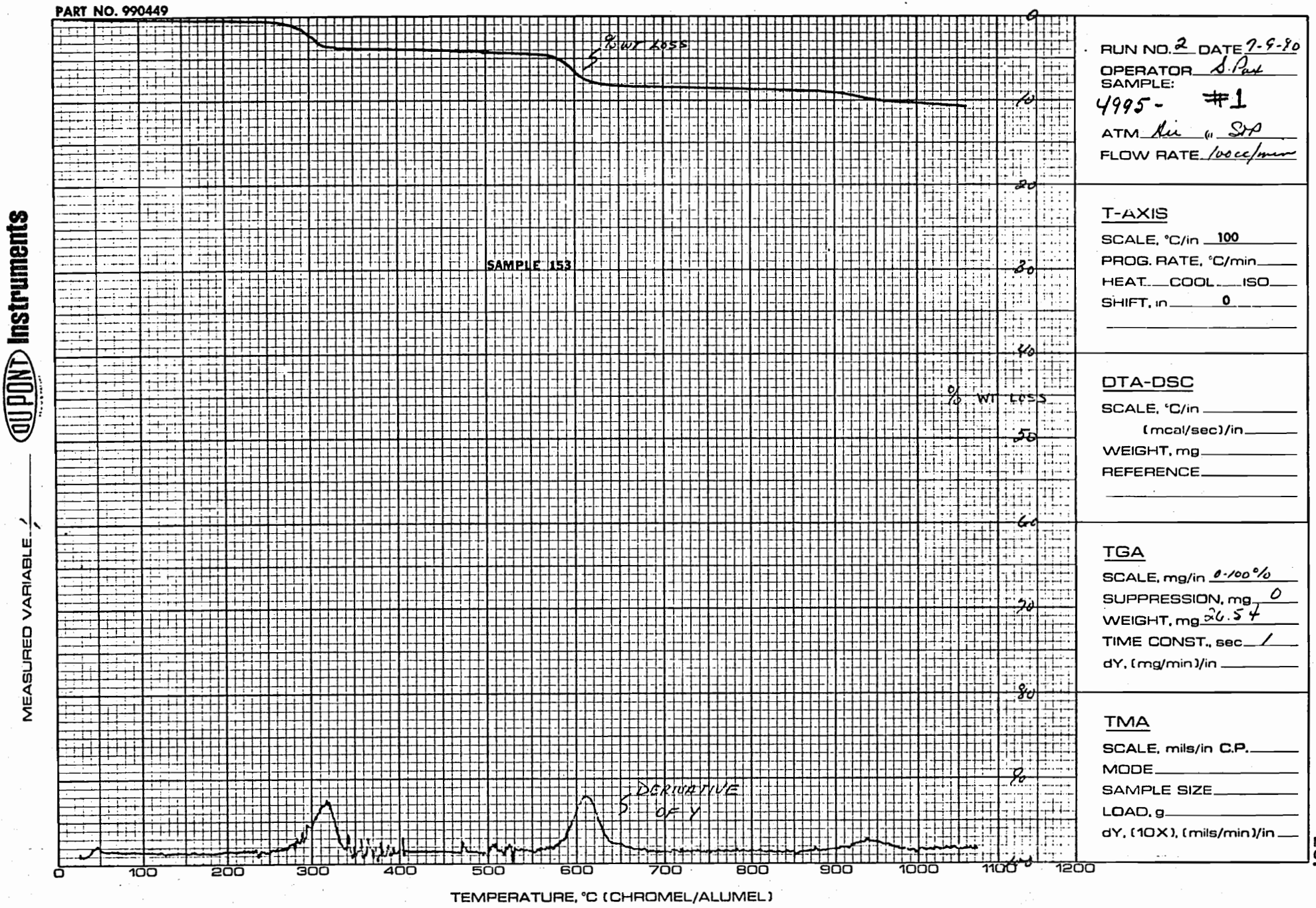
PART NO. 990092

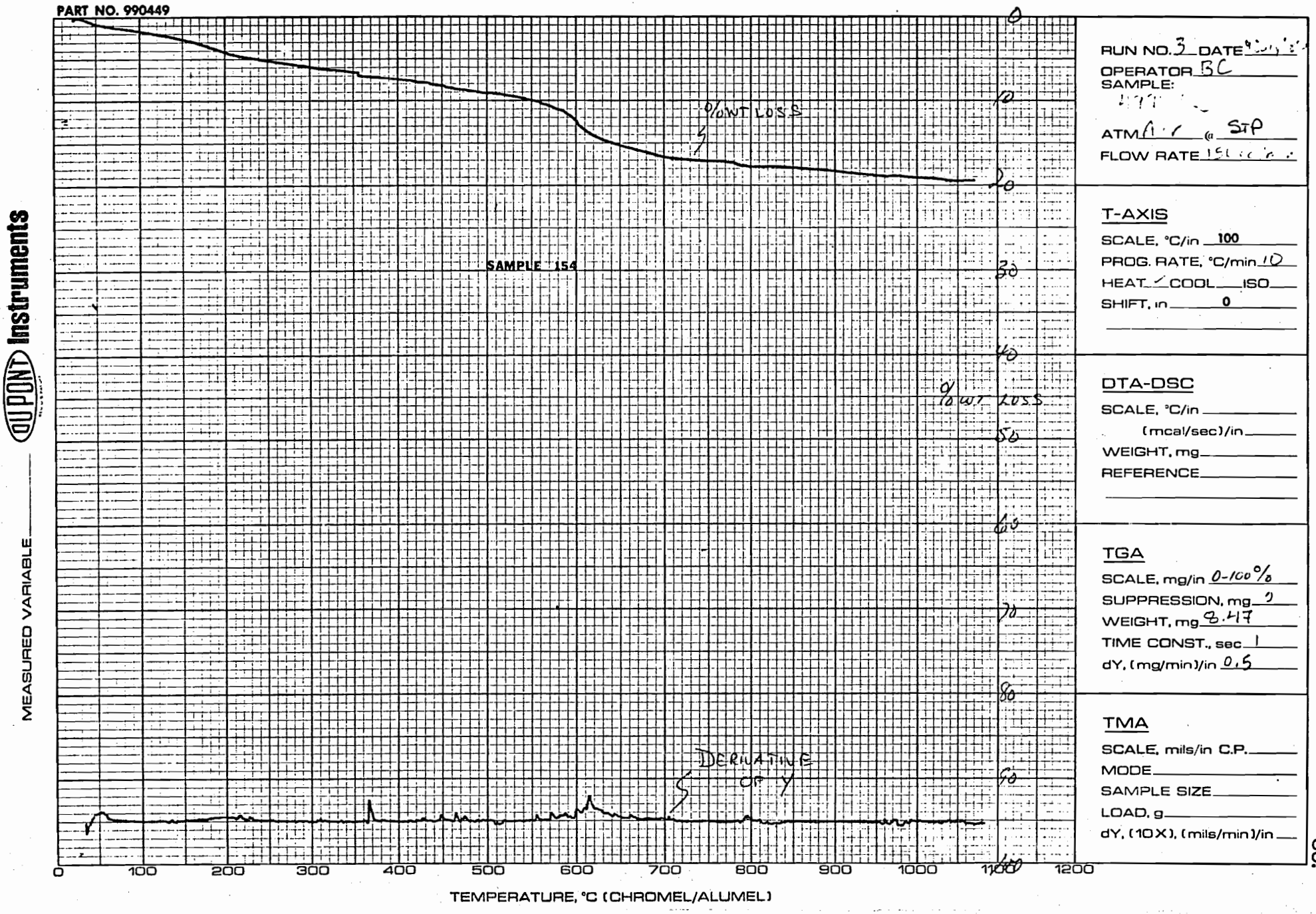
	T-AXIS	DTA-DSC	TGA	TMA	
RUN NO. 2 DATE 7-8-80	SCALE, mv/in 0.8	SCALE, °C/in	SCALE, mg/in	SCALE, mils/in	no fusion
OPERATOR [illegible]	PROG. RATE, °C/min 10	(mcal/sec)/in	SUPPRESSION, mg	MODE	
SAMPLE: 4995 #3	HEAT ✓ COOL ___ ISO ___	WEIGHT, mg	WEIGHT, mg	SAMPLE SIZE	
ATM Air @ STP	SHIFT, in 0	REFERENCE	TIME CONST., sec	LOAD, g	
FLOW RATE 100cc/min			dY, (mg/min)/in	dY, (10X), (mils/min)/in	



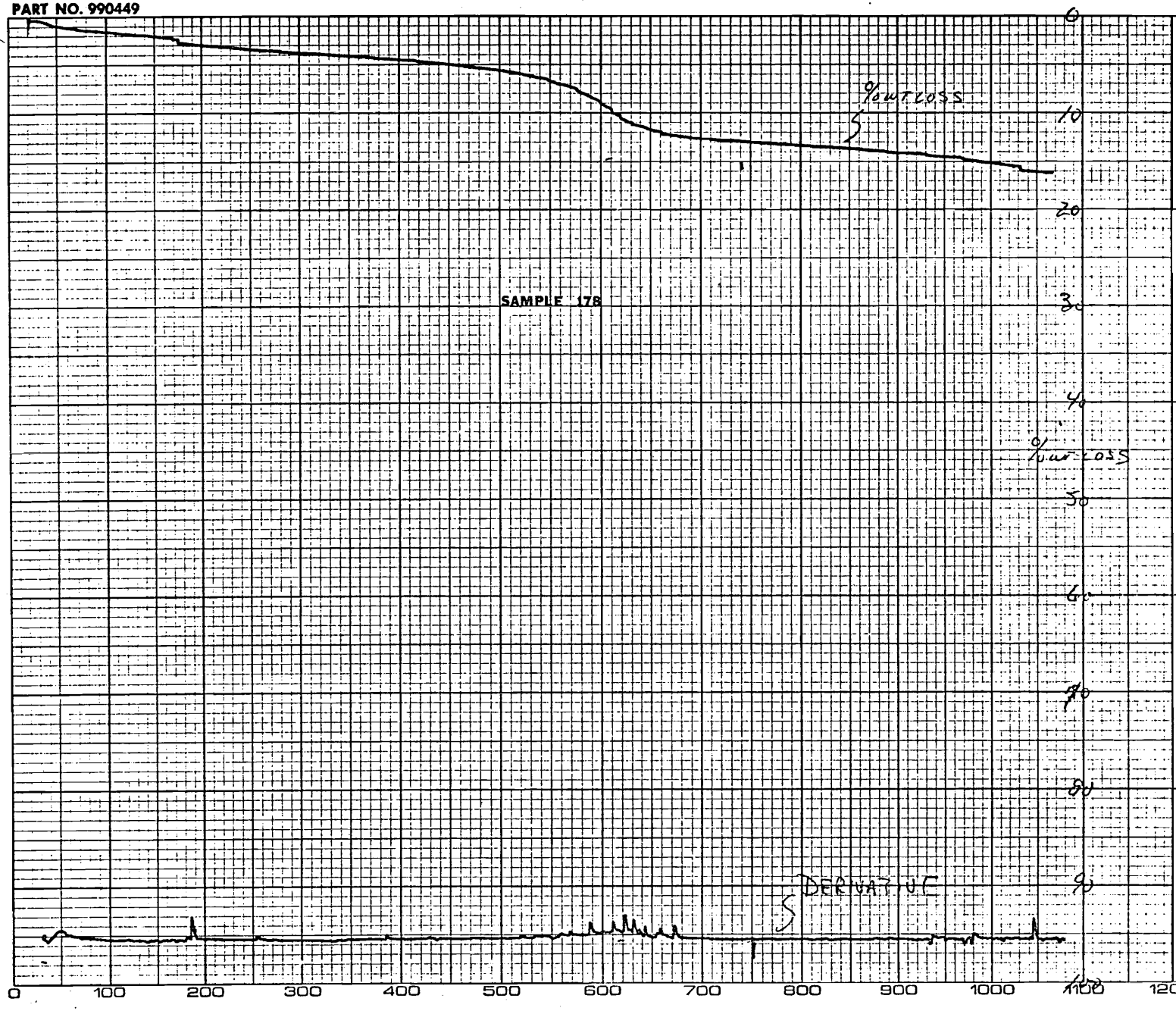
MEASURED VARIABLE

DUPONT Instruments


PART NO. 990449
DuPont Instruments
MEASURED VARIABLE
% WT LOSS
SAMPLE 153
% WT LOSS
DERIVATIVE OF Y
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
TEMPERATURE, °C (CHROMEL/ALUMEL)
RUN NO. 2 DATE 7-9-80
OPERATOR S. Pat
SAMPLE:
4995- #1
ATM Air " SP
FLOW RATE 100cc/min
T-AXIS
SCALE, °C/in 100
PROG. RATE, °C/min
HEAT COOL ISO
SHIFT, in 0
DTA-DSC
SCALE, °C/in
(mcal/sec)/in
WEIGHT, mg
REFERENCE
TGA
SCALE, mg/in 0-100%
SUPPRESSION, mg 0
WEIGHT, mg 26.54
TIME CONST., sec 1
dY, (mg/min)/in
TMA
SCALE, mils/in C.P.
MODE
SAMPLE SIZE
LOAD, g
dY, (10X), (mils/min)/in


PART NO. 990449
DUPONT Instruments
MEASURED VARIABLE
% WT LOSS
SAMPLE 154
% WT LOSS
DERIVATIVE OF Y
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
TEMPERATURE, °C (CHROMEL/ALUMEL)
RUN NO. 3 DATE
OPERATOR BC
SAMPLE:
ATM AIR @ STP
FLOW RATE
T-AXIS
SCALE, °C/in 100
PROG. RATE, °C/min 10
HEAT ✓ COOL ISO
SHIFT, in 0
DTA-DSC
SCALE, °C/in
(mcal/sec)/in
WEIGHT, mg
REFERENCE
TGA
SCALE, mg/in 0-100%
SUPPRESSION, mg 0
WEIGHT, mg 8.47
TIME CONST., sec 1
dY, (mg/min)/in 0.5
TMA
SCALE, mils/in C.P.
MODE
SAMPLE SIZE
LOAD, g
dY, (10X), (mils/min)/in

PART NO. 990449



RUN NO. 1 DATE 10 July 85
OPERATOR BL
SAMPLE: 1995 #3
ATM Air @
FLOW RATE 150 cc/min

T-AXIS
SCALE, °C/in 100
PROG. RATE, °C/min 10
HEAT ✓ COOL ___ ISO ___
SHIFT, in 0

DTA-DSC
SCALE, °C/in ___
(mcal/sec)/in ___
WEIGHT, mg ___
REFERENCE ___

TGA
SCALE, mg/in 0-100%
SUPPRESSION, mg 0
WEIGHT, mg 7.41
TIME CONST., sec 1
dY, (mg/min)/in 0.5

TMA
SCALE, mils/in C.P. ___
MODE ___
SAMPLE SIZE ___
LOAD, g ___
dY, (10X), (mils/min)/in ___

DUPONT Instruments

MEASURED VARIABLE ___

VIII. COMMENT ON ADEQUACY OF ORE RESERVES

A. Quantity

On the mine maps that they submitted, SMC bounded the ore basins by using curved lines between the ends of proven ore in the tunnels. SMC used a half-circle method instead of the more conservative straight lines method. The curved lines increase the areas of the basins and consequently the ore reserve quantities; but this increase is without adequate data support.

After reviewing SMC technical reports, the field team noticed that a certain thickness for basins was indicated, although no exploration had been done. No explanation by SMC was available to account for the thickness. The field team measured many thicknesses for every basin and plotted them on the maps. The average thickness for the basin was determined by calculating the arithmetic average of the thicknesses for each basin or for each mine.

SMC's letter No. 52-80 about ore reserves, dated March 1980, did not indicate the key-date of ore reserves. In the technical reports prepared by geologist M. Abu El Enein, the same numbers of ore reserves with the same type of writing were found, indicating that the key-date of the ore reserves is 30.6.1965. The ore reserves in SMC's letter do not represent any probable ore. The end of mining activities at Om Bogma occurred on June 5, 1967, or two working years after the key date.

Examination of Table No. 4 of SMC's ore reserves for Abu Hamat Shemal, lease Nos. 297 and 298 in SMC's report No. 2 indicate that in order to obtain the ore reserves of June 6, 1964, the amount of production for the year 1963/1964 was subtracted from the previous total proven ore reserves for these leases.

SMC report No. 2 stated: "Until 30.6.1964, after adding the quantities of ore which were proved by the prospecting operations and also the ore quantities which were developed during the production operations, the final estimates of ore reserves after subtracting production for 1959 and 1964, are as follows:

- Proven ore - 2,061,000 tonnes
- Probable ore - 990,000 tonnes
- Possible ore - 1,300,000 tonnes

These figures of probable and possible ore are the same as the figures given in the SMC letter on ore reserves, as well as in the Egyptian Mining Authority's report. In the report of the Egyptian Mining Authority, which was studied during the Authority Board meeting No. 33 dated 22.12.1964 (memorandum No. 4/33/64), the following was stated:

"The prospecting operations of manganese ore before the year 1956 were concentrated in Abu Hamat Yemin and Shemal due to their proximity to the Om Bogma production areas. No prospecting efforts were made in the West Central Sinai. The total ore reserves including proven, probable and possible reserves were estimated to be 4.5 million tonnes."

The ore reserves calculated at the end of the year 1963/1964 are as follows:

Proven ore before 1956		1.9 million tonnes
Proven ore after 1956	Add	1.3 million tonnes
	Total	3.2 million tonnes
Total ore production 1959 to 1964	Subtract	1.1 million tonnes
Remaining ore reserves 30.6.1964		2.1 million tonnes

On page 10 of report No. 1 which describes the activities of the Sinai Managanese Company before 1967, it states that overall losses as fines due to the scheme of mining and transport operations vary from 30% to 50%.

Therefore, using the method previously applied by SMC, which subtracted the net annual production of the company from the proven ore, it is shown that the true mineable reserve was not increased by an extra 30% to 50% of the ore produced as fines. This amount should also be deducted from the previous total proven ore reserves.

The following was found after reviewing the probable and possible ores:

Report No. 2, page 2, presents the basis for probable and possible ores estimate. The translation of page 15 of the same report, which is illustrated by Table 2-16 , shows the numbers of each classification of ore reserves in various areas without mentioning the names of the areas, the thickness of the reserves, or indicating these areas on the mine maps. In the same report, page 2, as well as in the Mining Authority report, the following was indicated:

In 1959 the Company carried out a geological exploration program in the West Central Sinai for manganese ores. It was estimated that the ore reserves at the beginning of 1960, including what was actually known before 1956, were as follows:

- Proven ore - 1,240,000 tonnes
- Probable ore - 1,355,000 tonnes
- Possible ore - 2,130,000 tonnes

The same report stated the ore reserves on 30.6.1964 were:

TABLE 2-16

(Translation)

S.M.C.
The General Department for
Factories & Technical Affairs

Manganese Ore Reserves in the West Central
District of Sinai
on 30.6.1964

—

Figures are from page 15 in report No. 2.
Details of Probable and Possible Ore Reserves in the West
Central District of Sinai.

District	Probable O.R. (x 1000 tonnes)	Possible O.R. (x 1000 tonnes)
285	10	-
364 (913)	5	-
289	5	-
296-297	100	-
292	50	-
291	50	-
295 (658)	100	50
293	10	-
298	100	50
Alluga	100	250
401 (914)	10	-
367 (Ramsy)	100	100
312 (612)	50	50
W. Nassib	-	250
W. El Saho	100	150
Bir Rakis	50	-
District 45	100	300
Om Rinna	50	100
	990	1300

The criteria for estimating probable ore reserves are:

1 - The extended ore outcrop on the edge of hills 8, done trenches and the samples taken.
2 - From underground workings which expose the ore at two side maximum.
3 - From superficial & underground geological features upon which prospecting depends.

The criteria for estimating possible ore reserves are:

1 - If there is an ore outcrop or some geological features which indicate the possibility of the presence of ore.
2 - From the underground tunnels which expose the ore from a maximum of one side.
3 - Superficial and underground features upon which the basis of ore prospecting demands.

- o Proven ore - 2,061,000 tonnes
- o Probable ore - 990,000 tonnes
- o Possible ore - 1,300,000 tonnes

Report No. 3 indicates the following:

According to the previous data, the ore reserves in the West Central Sinai at the end of 1961 were:

o Proven ore reserves in the production areas	670,000 tonnes
o Proven ore reserves in the prospecting areas	1,062,500 tonnes
o Probable and possible ore reserves in the prospecting areas	3,000,000 tonnes
Total	4,732,500 tonnes

Ore reserve studies made by SMC, February 1962, compared the company's results with the German A.I.D. report. This was submitted on March 1961. Some differences were noted by SMC. Also, some errors were made in the revised ore reserve estimate for each separate area and the summary ore estimate. These errors were in not placing the quantities in their proper ore classification, or omitting reserve quantities in some areas, particularly the eastern side, amounting to about one million tonnes.

Demag, the German company, engineers estimated the SMC reserves to be 3 million tonnes. This discrepancy in the estimate from that of SMC was due to the following:

o A difference of 600,000 tonnes in the total of proven and probable ores between the Demag engineers' and SMC estimates. The 600,000-t discrepancy is broken down according to the reserve areas shown below:

- Abu Thor area	70,000 tonnes
- El Hessenia	100,000 tonnes
- Abu Hamat Shemal (tunnels 1B, 1A) and El Korba area	90,000 tonnes
- Om Bogma area	180,000 tonnes
- Abu Zarab and Alluga area	160,000 tonnes
Total	600,000 tonnes

o The difference between the two estimates for the possible ore reserves is about 400,000 tonnes. The 400,000-t discrepancy is broken down according to the reserve areas shown below:

- El Hessenia area	150,000 tonnes
- Wadi Nassib area	250,000 tonnes
Total	400,000 tonnes

SMC studies, annex No. 2, report on missing work by Demag, 12.8.1961, as follows:

- o Proven ore - 351,000 tonnes
- o Probable ore - 1,295,000 tonnes
- o Possible ore - 1,775,000 tonnes

Total 3,421,000 tonnes

The above SMC studies, annex No. 2, figures do not differ greatly from the previous estimate which was submitted by the English consultant, Dr. Ford, to SMC November 19, 1959. This report reported that the proven ore reserves inside the boundaries of the Company's mining leases were 300,000 tonnes with the probability of adding 200,000 tonnes to this number. This would make the total sum about 500,000 tonnes.

The Demag ore reserves estimate dated 1.1.1961, is illustrated in Table 2-17. A summary of the German and English estimates follows:

	Proven	Probable	Possible
Dr. Ford 19.11.1959	300,000	-	-
R.2 page 2-1.1.1960	1,240,000	1,255,000	2,130,000
Demag 1.1.1961	351,000	1,295,000	1,775,000
R.3 p. 15 30.12.1961	670,000	1,062,500	2,000,000
R.2 p. 1 30.6.1964	2,100,000		

The following figures indicate probable and possible ore reserves:

- o The probable ore reserves are nearly constant figures since 1961 in spite of the prospection operations which were declared by SMC to be as follows:

  1961/1962 - 6,981.2 meters driven to increase the proven reserves by 285,500 tonnes

  1962/1963 - 2,782.1 meters driven to increase the proven reserves by 616,000 tonnes

  1963/1964 - 84.7 meters driven to increase the proven reserves by 74,000 tonnes

  1964/1965 - 664.8 meters driven to increase the proven reserves by 45,000 tonnes

- o The possible ore reserves are unchanged since 30.6.1964.

- o The decrease in proven ore reserves on 30.6.1965 from 2,061,000 tonnes to 1,688,000 tonnes for one year is realistic. The actual quantity extracted from the mines during the period

TABLE 2-17

ORE RESERVES OF OM BOGMA CALCULATED
BY DEMAG AKTIENGESELLSCHAFT

Dated 1.1.1961

	Proven	Probable	Possible	Lease No.
Om Riglien	-	2,500	1,000	
Sarabet	-	2,000	-	
Gebel Ghorabi	-	1,500	-	716
Gebel Adedia	-	4,000	10,000	240
Om Ratam	-	20,000	20,000	-
Om Sylat	-	30,000	10,000	
Wadi Shelal & L45	-	48,000	240,000	292
Abu Kafas	-	15,000	35,000	266, 267
Om Tmayim	-	-	10,000	
Hill 638	-	3,000	-	
El Qor	-	-	7,000	
Bir Rakis W & N	-	-	60,000	
Long Hill	-	-	50,000	
Om Rinna	-	-	50,000	308
Alluvionen	-	-	6,000	
Lease 10	10,000	-	-	
L 9 and 170	-	50,000	-	
L 8 - group	323,000*	237,000	108,000	288
Abu Hamat Yemin	18,000	286,000	44,000	291-300
Abu Hamat Shemal	-	296,000	54,000	296-297
Abu Zarab	-	-	655,000	298-299
El Alluga	-	40,000	-	353-354
Abu Thor	-	-	175,000	293-401-402
Gebel Ramsy	-	255,000	245,000	367
Ras El Homarra	-	5,000	-	426
	351,000	1,295,000	1,775,000	

*From which 21,000 are in stocks, Hill 8 1,780,000

Not included 600,000 tonnes in measured reserves are the road safety pillars in Lease 8.

and not the net annual production was subtracted from the balance of the previous proven ore reserves.

- In the SMC annex No. 1, "The Company comments on the German Aid Report", a difference of 600,000 tonnes in the total proven and probable ore reserves were indicated without specifying the individual quantities of proven and probable ores.

- Probable and possible ore reserves were indicated in the SMC letter of 30.6.1964.

- In the KECI/ACB review, those areas of the mines which were collapsed were not reviewed and were not included in the 1980 calculations as possible ore.

- Ore reserves included the quantities of ores in 7 cancelled leases, as follows:

  - El Ramsy - Lease 367
  - Om Rinna - Lease 368
  - Wadi Rakaiz - Lease 309
  - Om Bogma - Lease 285
  - Wadi Nassib - Lease 310
  - Om Bogma - Lease 289
  - Wadi El Zaraa - Lease 364

  All the above areas of ore reserves were included in the SMC ore reserve estimates, in spite of the fact that some of the cancelled leases had been exhausted; for example, Om Bogma lease 285 and lease 289, Wadi Nassib lease 310 and Wadi El Zaraa lease 364. Other leases were unmined; for example, El Ramsy 367.

- In spite of what was stated in the SMC annex No. 1 about the ore reserves of El Hessenia area, no ore reserves were considered for El Hessenia leases.

- In spite of the list of 27 specified SMC leases, the KECI/ACB ore reserve studies included all the leases in the various SMC reports. This brings the total leases and areas in the 1980 study to 34 leases, including some which were cancelled by SMC.

B. Quality

The following is a review of the mean contents of manganese and iron for each lease area. In some cases there is a great difference between the percentages of manganese given by SMC and those presented by KECI and ACB. Block thickness affects the manganese percentage.

- SMC block thicknesses are always estimated to approximate 0.5 meters or a round figure except 4 figures in Abu Hamat Shemal (lease 296-297).

TABLE 2-18
DECLARED ORE RESERVES
(X 1,000 TONNES)

Lease	Area	Proven Ore Before 1956	Proven 19 Nov 1959 Dr. Ford	1-1-1960	30-12-61	Ore Reserves Add 59	60	61/62	62/63	63/64	64/65	Total	Demag Ore Reserves 1-1-1961 Prov	Prob	Poss	Ore Reserves 30-6-1964 Prov	Prob	Poss	Ore Reserves 30-6-1965 Prov	Prob	Poss
288	Area 8	-	-		Report 3, page 15	-	-	-	-	-	-	-	323	237	108	415	-	-	308	-	-
364/310	W. Nassib and Zaraq					-	-	6.5	-	-	-	-	-	-	-	18	-	-	-	5	250
289	Area (up)									65		65	-	-	-	76	-	-	-	5	-
287	Om Bogma						39	22	4	-	-	65	-	-	-	-	-	-	-	-	-
290	Om Bogma	Report of														10					
285	Area G	Geol. Zatoout, and others			Report of Mining Authority Page 5.			59	27	9	17	112		50	-	19	-	-	-	10	-
Zone 10	Area 10	Page 4.											10	-	-	24	-	-	-	-	-
286	Hill 5												-	3	-	10	-	-	3	-	-
292	Area 45									24		24	-	48	240	57			52	50	-
296-297	Al Hamat Shermal												-	296	54	174			30	100	-
300-291	Al Hamat Yemin					32.5	15	8	8			63.5	18	286	44	253	-	-	231	50	-
295	Beida (658)												-	-	-	21			21	100	50
293	Ab Thor					29	70	5				104	-	-	175	104			104	10	-
294	El Karbo												-	-	All Abu Thor Mines	27			64	-	-
298	Abu Zarab						2	61	167		28	258	-	-	655	230			230	200	50
353+354	Allunga					3.5	97	56.5	74			831	-	40	-	231	-	-	231	100	250
367	El Ramsy					-	-	50.5	314			364.5		255	245	364			364	100	100
401-402	Abu Thor					-	13	17				30	30	-	-	30			30	10	-
El Zafria	El Soghia												-	-	-	-	-	-	-	-	-
El Zafria	El Kubra												-	-	-	-	-	-	-	-	-
312	W. Nassib												-	-	-					50	50
309	W. Rekiez												-	15	45					100	300
266/267	Abu Kafas and Om Tmaym													-	50					50	100
239/265	Om Rinnia W. Saahom and Hessenia												-	50	30					100	150
	Others												-	15	134						
		1900	300 or 500	Proven 1240	Probable 1355	Possible 2130	Proven 1733	Probable	Possible 2000	65	236	285.5	618	74	45	1317	351	1295	1780	2061	990	1300	1688	990	1300

TABLE 2-18

MAGANESE ORE RESERVES (x 1,000 TONNES)

KEY DATE 1.6 1980

SERIAL No.	M.L. No.	AREA	SMC						KECI/ACB						REMARKS
			Prv.	Pro.	Pos.	Total	Mn	Fe	Prv.	Pro.	Pos.	Total	Mn	Fe	
1	367	El Ramsy	364	100	100	564	16.8	36.3	343	76	–	419	23.21	26.74	No Lease
2	353-354	El Alluga (861)	231	100	250	581	21.1	33.9	79	4	19	102	29.43	25.23	(4)
3	288	Area 8	308	–	–	308	19.5	38.4	160	–	–	160	25.66	31.69	
4	293	Abu Thor	104	10	–	114	36.2	20.7	42	4	–	46	38.81	16.85	
5	401-402	Abu Thor	30	10	–	40	22.3	31.5	20	18	–	38	33.51	16.50	
6	296-297	Abu Hamat Left	30	100	–	130	21.9	38.0	47	10	15	72	25.35	30.33	(1)
7	292	Area 45	52	50	–	105	28.3	37.3	'16	2	–	18	31.90	18.07	
8	291-300	Abu Hamat Right	251	50	–	301	19.6	27.7	+07	46	40	193	22.65	36.32	(2)
9	298-299	Abu Zarab	230	100	50	380	17.2	38.6	116	15	52	183	30.51	27.06	(3)
10	294	El Korba	64	–	–	64	30.5	25.4	2	½	–	2½	36.79	19.98	
11	266-267	Abu Kafas	–	100	300	400	–	–	9	1	24	34	24.34	23.66	
12	253	Lahian (long Hill)	–	–	–	–	–	–	8	–	–	8	27.66	16.83	
13	311	Om Sylat	–	–	–	–	–	–	55	11	34	100	31.06	23.45	
14	256	Lahian-Zobeir	–	–	–	–	–	–	24	–	–	24	29.74	29.04	
15	286	Dump.							99	–	–	99	34.89	15.99	
		Om Bogma (Hill 5)	3	–	–	3	16.0	37.0	3	–	–	3	10.88	48.04	
16	295	El Beida	21	100	50	171	22.1	33.9	–	–	–	–			(5)
17	368	Om Rinna	–	50	100	150	–	–	–	–	–	–			No Lease
18	309	Wadi Rakeiz	–	50	–	50	–	–	–	–	–	–			No Lease
19	285	Om Bogma	–	10	–	10	–	–	–	–	–	–			No Lease
20	239-265	Wadi Saaho	–	100	150	250	–	–	–	–	–				
21	310	Wadi Nassib	–	–	250	250	–	–	–	–	–	–			No Lease
22	312	Wadi Nassib	–	50	50	100	–	–	4	–	4	8	31.89	17.39	
23	289	Om Bogma	–	45	–	5	20.9	35.1	–	–	–	–			No Lease
24	364	Wadi El Zaraa (G. Fouad)	–	5	–	5	19.7	34.3	–	–	–	–			No Lease
25	240	G. Addedia	–	–	–	–	–	–	–	–	–	–			
26	283	G. Addedia	–	–	–	–	–	–	–	–	–	–			
27	426	Om Bogma (Ras Homara)	–	–	–	–	–	–	–	–	–	–			

- The SMC block thicknesses are larger than KECI/ACB estimates. For example, in area 8 (lease 288), the largest thickness given by SMC is 7.0 meters, while according to KECI/ACB it is only 5.50 meters. The thickness estimate has a direct effect on the mean content of manganese. Thus, by taking a sample from a larger thickness than the actual, it will contain a part from the roof or from the floor. Therefore, the analysis will indicate a lower manganese percentage.

More information on ore reserve estimates (1980) is detailed below:

a. Abu Hamat Shemal, lease 296-297

- The western part of block 10 has been calculated as possible ore reserves due to the collapse in adit No. 6.

b. Abu Hamat Yemin, lease 291

- Block No. 7-B: The western part of this block was not reviewed due to the collapse in the adit and was calculated as possible ore reserves.
- Block No. 10: Collapse at the end of the adit making the inner part of the adit inaccessible. It is estimated as possible ore reserves.
- Block No. 13: The entrance of the adit is collapsed. The inner part could not be reviewed and the block was estimated as possible ore reserve.
- Block No. 14: The adits which lead to this block are collapsed and could not be reviewed. Material was estimated as possible ore reserves.
- Block No. 15: The adit is collapsed at the end and could not be reviewed. Material was considered as possible ore reserves.

c. Abu Zarab, lease 298-299

- Block No. 4: There is a complete collapse before the manganese block, which prevented any reviewing of material. Ore is classified as possible reserves.

d. El Alluga, lease 354

- Block No. 3: About 75% of this block was not reviewed due to the collapse adit and material was considered as possible ore reserves in the estimate.

e. El Beida, lease 295

- All the entrance adits of the mine are collapsed and no review was possible. The mining engineer responsible in the district stated that all the ore was exploited and no ore should be considered in the estimate.

IX. DEFINITION OF ADDITIONAL EXPLORATION REQUIREMENTS

In accordance with paragraphs I.B.1.g and I.B.2 of the Scope of Project Services (Appendix A-1 to the Contract), the KECI/ACB study team carried out preliminary exploration of the Om Bogma district and contiguous areas of likely ore potential. The results of this work and our recommendations were described in our Report On Additional Exploration Requirements for Manganese Ore in Om Bogma & Contiguous Areas (attached) which was submitted to SMC on 11 May 1980, and indicated that perhaps 2 million tonnes of additional moderate grade ore could be defined by further exploration work.

Subsequent discussions resulted in a proposal by KECI/ACB on 12 May 1980 to carry out the recommended 5-month exploration program and, after negotiation and cost revisions, resulted in a modified proposal which was tentatively approved by SMC on 13 June. The scope was virtually identical with that recommended in the 11 May report. The KECI/ACB forces were immediately mobilized, and by 21 June were at work in the Sinai. By 17 August, amendment No. 2 covering the proposed program had been formally signed by both SMC and KECI.

The 5-month program (Phases A and B) now underway will conclude on 21 November 1980. The result is a report on the program plus recommendations for the scope of further work. Additional work, designated as Phase C, will be scheduled to provide for the Stage 2 Feasibility Study if it is implemented.

The exploration program has been delayed due to difficulties in obtaining the necessary explosives permits, but results, when available will be evaluated and covered by a letter report to SMC.

X. FERRUGINOUS MANGANESE ORES, OUTSIDE OM BOGMA DISTRICT

The area of Sharm El Sheikh is at present inaccessible from the Egyptian side. It was not possible, therefore, for our field team to make any site visits. It seems, however, of particular importance to cite the most valuable data pertaining to Sharm El Sheikh manganese deposits as obtained from previous literature.

At Sharm El Sheikh, manganese and iron oxides are known to occur in association with sandstones and conglomerates (4 meters thick). The chemical analysis of two samples gave the following results, as reported by Hume (1906):

	Sample 1	Sample 2
SiO_2 + I.R.	54.78	70.10
$Al_2O_3+Fe_2O_3$	2.32	12.92
MnO_2	30.33	12.67
CaO	Tr.	Tr.
MgO	-	Tr.
L.O.I.	9.48	5.06
Total	100.75	96.91

The area is cut by several faults running NW to SE, commonly filled with manganese minerals. It is believed that these deposits were formed by the action of percolating surface waters.

In June 1961, SMC made a study trip to the area. At a site named Sharm Moba, an old pit 4 meters deep was observed. The thickness of the ore is about 3 meters and its extension is about 1500 meters toward the northeast.

As a result of the SMC surface exploration in the area of Sharm El Sheikh, several veins were discovered, most important of which is the vein of Wadi Khoreita, which extends for 200 meters with a thickness of 2-3 meters. Trenches across the vein strike were also executed to validate the vein extension and thickness variation. Another vein was discovered at Wadi Telet Fadda, with a thickness of about 2 meters.

The resulst of chemical analyses of samples taken from these sites are:

Area	Sample No.	Mn %	Fe %	Remarks
Sharm Moba	1	14.9	1.2	At contact of vein with granite.
	2	24.8	24.8	At middle of vein.
	3	13.4	1.6	At contact of vein with sandstone.
Wadi Khorate	4	51.3	3.4	At middle of vein.

The vertical downward extension of these veins has to be estimated for an accurate ore reserves calculation.

REPORT ON ADDITIONAL EXPLORATION REQUIREMENTS FOR MANGANESE ORE IN OM BOGMA DISTRICT & CONTIGUOUS AREAS

11 May 1980

Table of Contents

I. BACKGROUND

II. PROGRAM APPROACH & OBJECTIVES
- A. Geological Approach
- B. Mining & Ore Transport Aspects
- C. Metallurgical Considerations

III. PRELIMINARY EXPLORATION & FINDINGS
- A. New, Contiguous Areas
- B. Om Bogma District

IV. RECOMMENDATIONS
- A. Scope
- B. Schedule

Exhibit I. Tabulation of Excavation/sampling Requirements

Map - Abu Zeneima-Om Bogma Area

REPORT ON

ADDITIONAL EXPLORATION REQUIREMENTS FOR MANGANESE ORE IN OM BOGMA DISTRICT & CONTIGUOUS AREAS

11 May 1980

Because of the extensive background and experience of our associate, the Arab Consulting Bureau, our proposal and the consequent scope of the Contract anticipated that additional exploration work would eventually be required to define additional and higher-grade ore reserves to support an economical ferromanganese smelter operation at Abu Zeneima. Therefore, in parallel with the review and evaluation of declared SMC ore reserves, and in accordance with Paragraphs I.B.1.g. and I.B.2 of the Scope of Project Services, the KECI/ACB field team began immediately to undertake preliminary exploration for manganese ore both within the "Om Bogma district", and contiguous areas.

I. BACKGROUND

The current "declared" ore reserves of SMC are based on geological exploration that was concentrated in areas within economical reach of the aerial ropeway ore transport system which served the heart of the Om Bogma district since 1913. The geological methods were based on manganese deposition theories which emphasized hydrothermal replacement along major fault structures, and thus exploration was confined to faulted areas near the ropeway. Consequently, the potential SMC ore reserves were considered restricted to the "Om Bogma" district, and the Abu Zeneima smelter project was initiated to make use of the low-grade ferruginous ores that could not be sold as direct-shipping ore.

In the last 13 years, the situation has changed completely. The historical ore transport system, the ropeway, was disabled during the occupation. Most of the mines it once served are worked-out, depleted; and their supporting infrastructure at Om Bogma is destroyed or disintegrated beyond repair. A new, realistic approach to exploitation of the Sinai manganese ores was mandatory.

II. PROGRAM APPROACH & OBJECTIVES

The current preliminary exploration program under the Stage I prefeasibility study was based on entirely new approaches and objectives, using new geological criteria, geared to the needs of the current smelting technology, and based on current mining costs, and product market situations. Because it was felt imperative to define the probabilities of developing new ore of higher grades as soon as possible, the KECI/ACB field teams began exploration efforts more than 2 months ago, predicated on methodology and objectives as summarized below, relative to the main technical aspects of the project.

A. Geological Approach

The KECI/ACB field team has adopted, based on accumulation of observations going back more than 20 years, the sedimentary theory of manganese ore formation, as indicated by a multitude of criteria. Their recent field investigations in the area corroborated this conviction, and added new information permitting an improved definition of the geologic setting of the areas that would most likely contain important deposits of manganese ores. With such a primordial theoretical geologic background in mind, basic indices were carefully looked for during our field investigations. Among the most basic of these geologic indications, we may cite the following:

1. Observation of an appropriate number of outcrops of ore with suitable thickness and grade in a manner to indicate high possibility of continuation in both horizontal directions.

2. Suitable continuity of the ore-bearing stratigraphic horizon (in most cases the base of the dolomitic Om Bogma Formation of Middle Carboniferous) on one or both sides of the observed outcrops.

3. Favourable structural setting, most important of which is the relative scarcity of the major faults which would result in abrupt dislocation

of the ore-bearing horizon. However, the presence of fault planes with reasonably small throw are not considered a hindering factor, once the structural setting is well understood during both the exploratory work, and the later production phase.

4. Proper situation of the area within the regionally defined belt of the mineralized Middle Carboniferous dolomitic horizon (or its lateral variant).

The extra effort of our experts in creation of preliminary geological maps in the field, from aerial photographs, was of great help in detecting these favourable criteria.

The subsequent field investigations have been able to defferentiate between those areas actually showing indications (outcrops) for the presence of substantial important quantities of ore reserves, and those areas that contain minor or negligible quantities. Verification of ore thickness on outcrops, and degree of reliability of the positive geological criteria cited above, then permitted the definition of those most promising areas and the limits of future exploration works required.

In this manner, the emphasis or major manpower effort, of the exploration team was concentrated on those areas selected as most promising from a geological point of view.

B. Mining & Ore Transport Aspects

In addition to the geological theories relative to occurrence, the KECI/ACB team kept in mind the relative economics of various occurrences as pertained to mining and ore transport.

Because manganese ores are friable, and subject to considerable attrition and increase of undesirable fines, rehandling during transport should be minimized. Since the ropeway is not a factor, truck haulage at wadi floor levels is probably most economical. The ore from high plateau or mesa

areas will probably be transported by simple gravity skipway down to wadi floor. Therefore, areas with potentially good haulage characteristics were favored in the exploration program.

Obviously, areas subject to open pit mining were favored over those exploitable only by the much more expensive underground methods, and larger orebodies were sought in preference to smaller ones. The lower labor requirements, in both numbers and skill level, of open cut mining, would result in greatly reduced estimates of mining costs.

C. Metallurgical Considerations

The most important criteria in the preliminary exploration program were grade of Mn, and the Mn/Fe ratio. Use of the low-grade ferruginous ore averaging 19% Mn and 36% Fe, proposed as feed for the existing smelter at Abu Zeneima, is simply uneconomical in current market conditions, using realistic shadow prices for raw materials, labor, electric power, and product revenues.

Smelting fewer tons, of higher grade, would reduce mining and transport costs, and also drastically reduce the power requirements per ton of ferromanganese product. In addition, with higher -grade feed, one of several attractive single-step smelting processes could be used, which could make it possible to meet the domestic ferromanganese requirements of Egypt from one smelter instead of two. This would make Abu Zeneima especially attractive over other sites since capital costs of rehabilitation of the single existing furnace, smaller generating plant, etc. would be much lower and faster than new construction elsewhere.

Therefore, in order to utilize more energy and cost-effective smelting processes, it was necessary to find additional ore reserves of higher grade and better Mn/Fe ratio. A manganese-iron ratio of 7:1 was defined as ideal from a smelting point of view.

III. PRELIMINARY EXPLORATION & FINDINGS

Based on the methodology and criteria described earlier, the preliminary exploration program concentrated on areas where it was thought ores averaging 30-40% manganese and with low iron content could be found. Some areas were known to have been sources for limited production by private-sector miners of the late nineteen fifties of especially high-grade metallurgical ores (plus 50% Mn, with less than 3% Fe) and were thus early targets for additional exploration. In addition, certain leases previously exploited by SMC in the Om Bogma district were known to have produced relatively high manganese-low iron ore, and thus became primary targets for preliminary exploration.

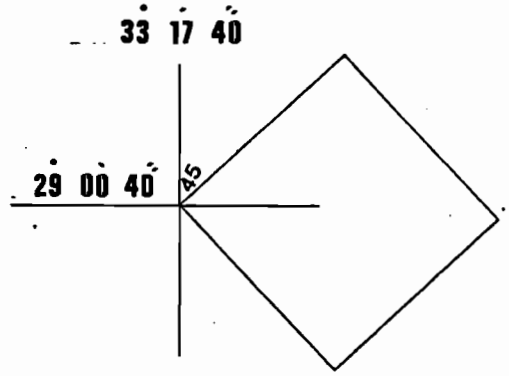
Field work over the last 2 months has identified 14 areas (see map attached) where additional exploration and sampling would be justified. Conservative provisional estimates indicate that two to three million tons of moderate grade, low-iron manganese ore can be defined by an additional exploration program as defined subsequently herein under Recommendations. The preliminary program is still continuing, and it is likely that even more areas will be evaluated as worthy of further exploration.

A. New "Contiguous" Areas

The exciting and most significant result of the preliminary exploration program is that 7 of the 14 areas are new discoveries within 2 major areas of mineralization not yet covered by SMC leases. Some of these discoveries are relatively free of overburden, exhibit clear outcrops of good thickness on several sides, and thus will be relatively easy to prove-up, and mine. These new discoveries are grouped in two main areas west of the Om Bogma district:

1. Area A

An area of 3 x 3 Kms with the following geographic position:



This area includes Ras Alleigat, Ras Samra and Farsh El Ebeidiya. The favorable geological setting, added to the relatively extended mineralization outcrops, and the relative favorable position as concerns production and transportation requirements, makes this area the No. 1 priority for exploration program outside the Om Bogma district.

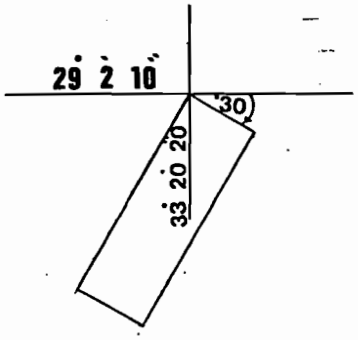
- o Ras Alleigat - Three main locations. In two of them is hardly any overburden, and the ore outcrops on the surface, therefore 15 pits are needed. In the third location, the ore outcrop on the hill side where a tunnel (of 10m length) is needed.

- o Farsh El Abeidiya - The ore outcrops mostly on the surface. Twenty pits and about five trenches are required.

- o Ras El Samra - The ore outcrops almost on the surface. Ten pits and one tunnel are needed.

2. Area B

An area of 3 x 1 Km with the following geographic position:



This area includes Tamariya, Makhrouga, Filk and Ras Moghra.

- o Tamariya - There are three open cast faces, where the ore thickness reaches 2-4 meters with relatively thick overburden. Five tunnels and about ten trenches are thus needed.

- o Filk and Ras El Moghra - Three tunnels and about thirty trenches are needed.

B. Om Bogma District

The Om Bogma District is defined as that regional area including the Om Bogma mines, as well as, all other SMC prospection licences and exploitation leases for manganese ores. The area can be geographically described as from the east by Wadi Lehian and Wade Zabeir, from the north by Dibbet El Qeri, from the west by Wadi Baba and from the south by Wadi Shallal and Wadi Sahoo and their tributaries.

The field team made appropriate field investigations of all the accessible SMC exploitation leases and prospection licences. Comprehensive data built-up supporting the possibilities of expansion of ore reserves in some of these areas, and resulted in the recommendations for additional exploratory work for seven areas as described under Recommendations.

The recommendations are based both on geological indications and considerations of mining and transportation requirements, but they only reflect the areas covered by field investigations todate, since some promising mining areas are currently inaccessible due to cave-ins.

IV. RECOMMENDATIONS

Results todate of the preliminary exploration for manganese ore carried out in accordance with Paragraphs I.B.1.g and I.B.2 of Appendix A-1 of the Contract, indicate that fourteen areas are recommended for additional exploration under a three-phase program as described herein.

According to Law No. 86 for the year 1956, it is recommended that SMC immediately apply for a prospection licence or licences which cover the two new areas, (Areas A & B), as described in Section III.

The additional exploration program should be implemented immediately so that results of the first phase (Phase A) of two months duration can be incorporated in the Stage 1 Work Report.

During Phase A, smelting technology, process requirements and evaluation of other associated study scope items should be predicated on reasonable expectations that the exploration program will succeed in developing additional ore reserves of better quality, assuming a new "nominal" average ore grade. The characteristics of this "nominal" ore will be conservatively defined, based on good professional judgement, as soon as analysis results of the samples already taken are available, probably within 10 days. This assumed "nominal" grade will then be adjusted to reflect results of Phase A of the exploration program; and used to develop the final process evaluations and cost estimates for the Stage 1 Work Report.

Phase B will last approximately three months, and conclude with a report on all findings and recommendations. During Phase B, the exploration and sampling requirements for the third Phase C will be defined, and presented to the Company as further recommendations for work to be completed in time for inclusion in the final report of the Stage 2 Feasibility Study.

Approximate schedules of the three phases would thus be as follows:

Phase A - approx 2 months (June-July 1980)
Phase B - approx 3 months (Aug-Oct 1980)
Phase C - approx 6 months (Nov 80 - Apr 81)

Scope, schedule, and cost aspects of phases A & B of the recommended program are as follows:

A. Scope

The additional exploration program under Phases A and B shall include a comprehensive excavation /sampling program including trenching, pits, and adits; plus a concurrent geological surveying program.

A topographic map, scale 1:5,000 and contour interval of 1m on flat areas, and 5m on steeply sloping areas, will be prepared for the proposed areas of exploration. Furthermore, a detailed geologic map, to the same scale, shall be prepared, whereby all observable geologic features are to be plotted on the topographic maps. Before the end of Phase B, the Consultant shall define scope, schedule and estimated cost for Phase C and submit to the Company as a recommendation.

The collected samples are to be assayed for Mn,Fe and LOI., while only about 10% are to be subjected to complete chemical analysis, X-ray, DTA, and ore microscopied analyses.

The excavation/sampling program under Phases A & B, shall be carried out by experienced miners and workers familiar with this type of work. The scope requirements are tabulated on Exhibit 1, and total as follows for Phases A and B combined:

Trenches	131 each
Adits	250 LM
Pits	320 LM
Samples	245 each
Topographic survey	14.0 km^2
Geological survey	17.0 km^2

B. Schedule

Phase A and B combined will be 5 months duration, with the interface dependent on when the program is implemented and how late data can usefully be received as input for the Stage 1 Work Report. Phase C will follow-on directly after Phase B, according to scope and schedule to be defined before the end of Phase B, and submitted to the Company for review and approval.

Exhibit 1.

TABULATION OF EXCAVATION/ SAMPLING REQUIREMENTS
PHASE A & B

Area Name	Lease No.	Trenches, each	Adits		Pits**		Samples, each	Area (km^2) of Survey		Remarks
			Quant	LM	Quant	LM		Topo.	Geol.	
Ras El-Allegat	Area A*	-o-	1	10	15	75	17	incl.	incl.	Included in total area of 9 km^2
Farsh El-Ebeidaya	Area A*	5	-o-	-o-	20	100	25	9	9	
Ras El-Samra	Area A*	-o-	1	10	10	50	12	incl.	incl.	
El Tamariya	Area B*	10	3	30	-o-	-o-	16	incl.	incl.	Included in total area of 3 km^2
El Makhroga	Area B*	5	-o-	-o-	-o-	-o-	5	incl.	incl.	
El Filk	Area B*	16	2	20	-o-	-o-	20	3	3	
Moghra	Area B*	9	1	10	-o-	-o-	11	incl.	incl.	
Abu Zorab	298/299	16	3	30	-o-	-o-	22	-o-	1.5	
Lehian (Long Hill)	253	20	-o-	-o-	6	30	26	-o-	0.5	
Zobeir-Lehian (V-shaped hill)	256	5	-o-	-o-	10	50	15	-o-	0.5	
Um Rinna	368	10	6	60	3	15	25	1.0	1.0	
Um Ratam	265	15	3	30	-o-	-o-	21	0.5	0.5	
El Hessania	311	10	2	20	-o-	-o-	14	-o-	0.5	
El Hemeira	292	10	3	30	-o-	-o-	16	0.5	0.5	
Totals		131	25	250	64	320	245	14.0	17.0	

* Discovered for the first time during field investigations by KECI/ACB staff.
** Pits are shafts with square cross-section, 1.5x1.5m.