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1 January 1977

EXPERT IN PHOSPHATE ROCK BENEFICIATION PLANTS

TURKEY

(DP/TUR/74/030/11-01/05)

Assignment Findings and Recommendations.

Terminal Report prepared for

ETIBANK SOUTH EAST ANATOLIA PHOSPHATE GROUP

and

MINISTRY OF ENERGY AND NATURAL RESOURCES

by

Michael H. Buckenham

Expert of the United Nations Industrial Development
Organization acting as Executing Agency
for the United Nations Development Programme*

* This Report has not been cleared with the United Nations Industrial Development Organization which does not therefore necessarily share the views presented.

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UNITED NATIONS DEVELOPMENT PROGRAMME IN TURKEY



with
07540

21 February 1977

EXPERT IN PHOSPHATE ROCK BENEFICIATION PLANTS

TURKEY

(IP/TUR/74/030/11-01/05)

Supplement to Project Terminal Report

including Trip Report to Geomin, Romania

Michael H. Buckenham

SUMMARY

Since the preparation of the Project Terminal Report (DP/TUR/74/030/11-01/0) dated 1 January 1977 the expert has been active as follows:

- visiting the Mazidagi phosphate deposit and reviewing on site development as at the end of the assignment.
- discussing the establishment of a "Fertilizer Research and Training Centre" (Project DP/TUR/75/059) with Dr. K.S. Chari, UNIDO expert and others.
- collecting and collating reference material and contributed publications for the SEAPG technical information facility and reviewing Turkish "fertilizer" statistical data.
- debriefing in Ankara and discussing future UNDP/UNIDO collaboration with Etibank SEAPG as recommended in the Terminal Report.
- visiting the offices of GEOMIN (Consultants) in Bucharest and the research and beneficiation facilities in Cluj, Romania, to discuss work and reports to date and to assess evaluation capability.

FINAL VISIT TO MAZIDAGI PHOSPHATE DEPOSIT

A two day visit was made on 24 - 25 January to inspect the site under mid-winter conditions and to observe the GEOMIN sampling programme and the "pilot" beneficiation plant.

While some information was available prior to the visit on the GEOMIN sampling programme for laboratory testing, the report detailing this was not available to the expert at the time. Channel sampling in galleries was inspected and was considered to be thorough but emphasized problems in the obtaining of descriptive materials for beneficiation work. Sampling was in the hands of a competent but "new" geologist further emphasizing a long standing problem of continuity and thus consistency throughout the Mazidagi work.

With a general curtailment of all but overburden removal in the Semikan 1 area it was not possible to observe mining and beneficiation difficulties under winter conditions although at the time of the visit weather conditions were neither particularly wet nor cold. Consequently

beneficiation and more particularly mining may not present the problems previously emphasized.

The "pilot" beneficiation plant was not operational and at the time of the visit sustained operation had not been possible. Observation suggested that this plant would not be capable of continuous and satisfactory production for some time and even then the processing concept would need to be modified in the interests of controlling phosphate losses and maintaining consistent grade.

FERTILIZER RESEARCH AND TRAINING CENTRE

With the arrival of Dr. K.S. Chari it was evident that proposals for this essential development made by the expert (Report DP/TUR/74/O30/MHB/A of 6 August 1976) were in good hands. The Terminal Report on "Fertilizer Training and Development Centre (FTDC) and Fertilizer Association of Turkey (FAT)" and the associated project document, "Fertilizer Training and Development Centre" meet the immediate Turkish needs for raw material assessment and fertilizer production studies so frequently emphasized by the expert. It is essential that this work gains early priority and is not lost sight of in the broader concept proposed by Dr. Chari.

SEAPG INFORMATION FACILITY/REFERENCE MATERIAL/STATISTICAL DATA

During the expert's assignment a considerable amount of reference material and many publications relating to phosphate evaluation, development and utilization and fertilizer technology and research were collected and contributed to SEAPG. This forms a valuable collection to supplement the books being purchased under the project equipment component and the material should be catalogued by Etibank and made available as necessary to Azot Sanayii for research purposes. For much of this material the New Zealand Fertilizer Manufacturers' Research Association (Director: Dr. John Rogers) is acknowledged. (See note of 1 February 1977)

Although the Turkish plans for fertilizer development for the 4th 5 year Development Programme, 1978 - 1982 are not yet available, the figures presented in Tables 1 and 2 show the growing importance of phosphatic fertilizers to the country and the dramatic increase in demand for phosphate rock on which to sustain this development. Table 1 also shows a developing trend towards high analyses fertilizers which is expected to continue.

Reference should be made to "Chemical Fertilizer Industry in Turkey" the Yapi ve Kredi Bankasi Report (Turkish August 1976, English November 1976) for this and related statistical data.

Table 1: PRODUCTION OF PHOSPHATIC FERTILIZERS - TURKEY, 1968 - 1975
(tons at 18% P₂O₅)

<u>Product</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>
SSP-16-18%P ₂ O ₅	135,682	97,300	121,116	131,017	179,377	189,020	352,834	153,980
TSP-45%P ₂ O ₅	141,120	148,176	221,883	413,502	551,948	372,917	459,406	1,295,751
DAP-46%P ₂ O ₅	-	-	-	-	6,912	11,597	129,465	383,600
TOTAL:	276,802	245,476	342,999	544,519	738,237	573,534	941,705	1,833,335
Equiv.tons P ₂ O ₅	49,824	44,186	61,740	98,013	132,883	103,235	169,507	330,000
Equiv.tons rock at 32% P ₂ O ₅	155,701	138,080	192,937	306,292	415,358	322,613	529,709	1,031,250

Table 2: PROJECTED PHOSPHATE ROCK REQUIREMENTS - TURKEY - 1975-1982
(tons)

<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>
1,166,465	2,196,850	2,592,871	2,846,250	3,074,722	3,513,370	3,882,973	4,131,000

DEBRIEFING ANKARA, ETIBANK SEAPG AND UNDP/UNIDO

Formal discussions were held with the SEAPG in the presence of Mr. R.D. Lalkaka, Senior Industrial Development Field Adviser, on 9 February 1977. The recommendations contained in the Terminal Report received general acceptance by the counterparts and procedures whereby these could be implemented particularly where UNDP/UNIDO assistance was involved were clarified. The contribution of the expert over the period of assignment was acknowledged.

Debriefing procedures with UNDP in Ankara were completed on 10 February and departure for Vienna via Romania was on 11 February 1977.

ROMANIAN VISIT

In view of the importance of the GEOMIN investigation to the future of the Mazidagi project (refer Terminal Report p.19) visits were made to Bucharest (14 - 16 February 1977) and to Cluj (16 - 18 February 1977) where GEOMIN offices and the Non-Metallic Minerals Institute for Research and Design (NMMIRD) are located. It was possible to examine briefly and to discuss the initial GEOMIN report, "Mazidagi Phosphate Project - Geological and Mining Report" presented after 2 - 3 months initial evaluation and dated December 1976.

The report states the minable reserves at Mazidagi to be as follows:

	<u>Proved</u>	<u>Probable</u>	<u>Possible</u>	<u>Total</u>
Million tons	2.2	8.8	19.6	30.6
Av. thickness, m.	2.02	1.52	1.5	1.54
Mean grade, %P ₂ O ₅	22.59	20.58	20.29	20.54

The above quoted reserves are based on a minimum grade of 15% P₂O₅ and a minimum mining thickness of 0.7 meters and the classification on the frequency of available sampling data. Economic constraints apart from those inherent in the reserve definitions were not applied in arriving at the above figures.

The stated reserves can be considered realistic in the light of available data but as in all previous estimates relate to opinion and definition and have little meaning until beneficiation studies have been completed and economic evaluations made. It is of interest to relate the above figures to those reported by the expert in his initial report, DP/TUR/74/030/MHB/1 of 7 April 1976.

The GEOMIN report emphasises the need for beneficiation studies, a more detailed description, both chemical and mineralogical of the phosphate and defines the conditions under which both surface and underground (longwall) mining might be applicable.

The report is considered to be a thorough and realistic presentation and evaluation of the work done to date on the Mazidagi deposit, and discussions with GEOMIN established their capability and experience to effectively continue the evaluation under the terms of the contract. Nevertheless it is very important that SEAPG make a critical assessment of two GEOMIN proposals viz to considerably extend the drilling, driving, pitting and trenching work at Mazidagi in order to better define "ore reserves" and to initiate an experimental underground longwall mining operation.

In the opinion of the expert the first proposal is not an evaluation priority although in the longer term should development proceed a production requirement. The second requires careful economic analysis/evaluation before implementation as it is considered that underground extraction of the phosphate rock at Mazidagi would only be achieved at prohibitive cost. Should this not in fact be the case, the value of such work for experimental and training purposes is accepted.

The report gives due emphasis to mineralogical and chemical work, beneficiation studies and fertilizer production testing. While a detailed beneficiation plan is not presented, it is accepted that this must await preliminary sample assessment and must remain flexible in approach. Sampling for the initial amenability testing with modifications as discussed with GEOMIN is considered acceptable in the light of the specific difficulties presented at Mazidagi.

It was concluded from the visit to Bucharest that SEAPG must critically evaluate the proposals of GEOMIN in economic terms and in doing so apply recognised procedures and criteria. Project priority areas must be emphasised and unnecessary/uneconomic proposals rejected. Reference should be made to report DP/TUR/74/030/MHB/7 of 22 June 1976 for this purpose.

The beneficiation studies to be undertaken by GEOMIN will be contracted out to the Non-Metallics Mineral Institute for Research and Design in Cluj some 500 km from Bucharest. It was concluded following discussions with staff and an inspection of facilities that this Institute should be able to effectively carry out this most important phase of the overall evaluation. Facilities available for and experience in mineralogical, chemical, physical, beneficiation and pilot scale techniques were impressive and desirably orientated towards non metallic (e.g. phosphate rock) evaluation.

Good co-operation and understanding between GEOMIN and NMMIRD will however be essential for effective work and it is recommended that selected staff from Cluj visit Mazidagi in order to obtain an on-site appreciation of the Mazidagi deposit and local conditions and to observe and benefit from the existing "pilot" plant recently constructed there. In particular materials handling and large scale crushing experience would be invaluable.

Important product evaluation work, i.e. fertilizer production and technology investigations is to be conducted in the Chemical Research Institute (ICECIM) Bucharest and again the need for a co-operative approach is emphasized.

In conclusion the visit to Romania was reassuring and the approach of GEOMIN and NMMIRD impressive. It once again emphasised the need for sound economic appraisal of the project by SEAPG as new data and new proposals become available and are made, and demonstrated the contribution the Expert could make during the next 12 months or perhaps longer during which time this most critical evaluation work is being undertaken.

" It ain't the guns or armament
Nor tunes the band can play,
But the close co-operation
That makes us win the day.
It ain't the individual
Nor the army as a whole;
But the everlasting teamwork
of every bloomin' soul."

Rudyard Kipling

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SUMMARY - TURKISH

Türkiye'nin gittikçe büyüyen fosforlu gübre sanayiini destekleyip geliştirecek olan yerli fosfat kayasına ihtiyacının arttığı aşikardır. Şu andaki proje değerlendirmesiyle, ekonomik olarak işletilebilen, zenginleştirilebilen, etkili bir şekilde, kabul edilebilir gübrelere dönüşebilen ve bir üretim faaliyetini destekleyecek olan yeterli miktarda bir fosfat varlığı kanıtlanırsa, Mazıdağı fosfat sahası bu ihtiyacı uzun yıllar karşılayabilecektir.

Cevher karakterinin kompleks, tenör ve hacminin marjinal, yerinin ucra ve gerekli alt yapı hizmetlerinin yetersiz olduğu Mazıdağı sahası için mükemmel bir değerlendirme şarttır. Bu değerlendirme, devam edilen saha etüdlerinden ziyade bundan böyle cevher zenginleştirme ve gübre üretim teknolojisi üzerinde yoğunlaşmalı; madencilik ve cevher zenginleştirme işlemlerinin baş sorumlusu Etibank'ın dışındaki kuruluşların uyumlu ve koordineli çabasını da kapsamalıdır.

İyimserlik maden aramaları sonunda bir yarar sağlamaktaysa da, istatistikler çok az maden keşfinin başarılı bir maden üretim tatbikatı ile sonuçlandığını ortaya koymaktadır. Bu yüzden projenin rentabilitesi ile ilgili kararlarının projenin ömrü içinde mümkün olan en kısa zamanda, sağlıklı olarak verilmesi için projenin kritik bölümlerinin bir an önce tanımlanması ve buralarda daha saf veriler elde edilmesi, bir maden projesinin değerlendirilmesinde şarttır. Mazıdağı projesinin değerlendirilme sırası tesbit edilmiş teknolojik ve ekonomik gerçeklerden ziyade hissi olarak etkilendiği için yukarıda belirtilen prensibin takip edilmediği görülmektedir.

Yukarıdaki nedenlerden dolayı şu andaki GEOMİN çalışmalarının içeriği tam ve kapsamlı, bulguları kesin olmalı, böylece Mazıdağı'nın nihai geliştirme veya reddedilme kararı daha çok geçikmeden alınabilmelidir.

Projeye ilgili bu nihai Rapor Mazıdağı Projesini yeniden gözden geçirmekte, Uzmanın proje rentabilitesini değerlendirmesini göstermekte, gelecekteki çalışmaların hangi özel alanlarda yoğunlaşması gerektiğini belirtmekte ve UNDP/UNİDO ile Etibank'ın arzu edilen işbirliği hakkında tavsiyelerini içermektedir.

Amaçlı yardımcı olan bu Raporun takdiminde Uzman, tatbik edilmiş bulunan bir maden değerlendirme stratejisini daha sonra düzeltmeye çalışmanın ve eleştirmenin basit olduğunu kabul ettiğinden çok zor şartlar altında bu güne kadar tamamlanan Mazıdağı projesiyle ilgili bu mükemmel teknik çalışmayı takdirle anar.

SUMMARY - ENGLISH

Turkey's increasing need for an indigenous source of phosphate rock on which to base and develop their expanding phosphatic fertilizer industry is obvious. The Mazidagi prospect may fulfil this need over many years if the current evaluation establishes that sufficient phosphate which can be economically extracted, upgraded and effectively converted to acceptable fertilizers is available to support a production operation.

Very thorough evaluation is essential in the case of the Mazidagi prospect as it is complex in character, marginal in grade and extent, remote in location and not well supported by external but necessary services. This evaluation must now focus on beneficiation and fertilizer production technology rather than continued field assessment and must involve the concerted and co-ordinated effort of groups other than Etibank which has a prime responsibility only for mining and beneficiation operations.

While optimism is an asset in exploration, statistics reveal that very few mineral discoveries result in successful mineral producing ventures. It is therefore essential in mineral project evaluation that the critical project areas are identified early and more refined data is generated in these so that soundly based decisions on project viability can be made as early in the project life as possible. This principle does not appear to have been followed in the case of Mazidagi assessment in which intangibles rather than the established technological and economic facts have influenced the course of evaluation.

For the above reasons the current GECMIN study must be comprehensive and complete in its content and conclusive in its findings so that an informed decision on the ultimate development/rejection of Mazidagi can be taken without further delay.

This project Terminal Report reviews the Mazidagi project, presents the Experts assessment of its viability, highlights the specific areas in which future work should be concentrated and includes recommendations on which UNDP/UNIDO and Etibank action is desirable.

In presenting this Report, which is constructive in its intent, the Expert recognises that it is easy in retrospect to improve a mineral evaluation strategy and to be critical of work done, and therefore acknowledges the very thorough technical work that has been completed on the Mazidagi project under most difficult conditions.

ABBREVIATIONS, UNITS AND TERMINOLOGY

Abbreviations:

BPL	Bone Phosphate of Lime or $\text{Ca}_3(\text{PO}_4)_2$
DCF	Discounted Cash Flow
CENTO	Central Treaty Organization
GEOMIN	A Company for Mining and Geological Co-Operation
MTA	Mineral Research Institute Maden Tetkik ve Arama Enstitusu
NZFMRA	New Zealand Fertilizer Manufacturers Research Association
SEAPG	South East Anatolia Phosphate Group Guneydogu Anadolu Fosfatlari Grup
SPO	State Planning Organization
SSP	Single Super Phosphate - 14-20% P_2O_5
TSP	Triple Super Phosphate - 40-50% P_2O_5
TSE	Turkish Standards Institute Turk Standartlari Enstitusu
\$US	\$ US United States Dollar and TL. Turkish Lira:
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization
(UN)OTC	United Nations Office of Technical Co-Operation
USAID	United States Aid for International Development

Units

Ton	Metric ton or 1000 kilograms
\$US	Equivalent to 16.0 - 16.5 TL through assignment
% P_2O_5	Equivalent to $0.46 \times \% \text{Ca}_3(\text{PO}_4)_2$ or % BPL

Terminology

Ore	Refers to mineralization that may be exploited economically otherwise "ore" used
Mazidagi	Refers to the Mardin-Mazidagi phosphate field
Reserves	Refer to indicated extent of mineralization but used without specific definition
Assignment	Refers to UN mission undertaken by the Expert
Project	Refers to the Etibank SEAPG Mazidag Operation

I. INTRODUCTION

1. General

This Terminal Report is based on approximately 10½ months of duty during which time 6 visits were made to the Project site near Mazidagi and visits were made to 4 fertilizer production operations. Numerous meetings, discussions and interviews were attended and 19 reports were prepared, reference to and summaries of which are appended.

2. Project Background

To date Turkey has relied almost totally on imported sources of phosphate rock for the production of phosphatic fertilizers demanded in increasing tonnages as agricultural production is emphasized in each successive development programme.

The long term search for domestic sources of phosphate rock resulted in the delineation of the extensive Mazidagi resource shortly before world phosphate prices rose dramatically. This situation accompanied by a desire for an assured raw material supply, regional development objectives and foreign exchange pressures prompted accelerated action at the Mazidagi site.

To assist in this evaluation the UNIDO assignment was established under the Ministry of Energy and Natural Resources and assigned to Etibank within their South East Anatolia Phosphate Group (SEAPG). This section was established by Etibank early in 1975 to carry out the necessary work to evaluate and if desirable develop the Mazidagi phosphate resource. The SEAPG consists of 12 professional and technical staff covering various mineral disciplines but however with a strong mining emphasis and a noticeable lack of specialisation in beneficiation and fertilizer development.

Etibank is a Turkish Government Organization established in 1935 responsible for the mining and recovery of many non ferrous metals.

As such the conventional economic criteria for new projects and existing undertakings do not necessarily apply and this has an important bearing on the work and findings of the Expert. An organizational chart for Etibank showing the administration of the SEAPG is given in Appendix 3.

3. Project Assignment Objectives

- to make available from the Mazidagi resource an acceptable feedstock for use in the domestic fertilizer industry. (Short term)
- to enable the domestic fertilizer industry to become independent of phosphate rock imports. (Long term)
- to achieve production of competitive export grade phosphate rock. (Long term)

4. Assignment Duties

The terms of reference for the assignment as given in the Project Document can be summarized as follows:

- to study background information relating to the Mazidagi phosphate deposit.
- to assess the quality and extent of this occurrence and to examine procedures used for this purpose.
- to study the beneficiation of the phosphate rock and related matters such as scale of operation, flotation chemistry, and water requirements and availability.
- to establish the suitability of the phosphate rock for fertilizer production.
- to assess the economic viability of developing the deposit.

Considerable progress had been made in the assessment and development of the Mazidagi deposit by MTA and SEAPG since the above duties were established and before the Expert took up the assignment. However

in spite of this and the specified duties suggesting a pre judgement of both the value and the technological development of the deposit it was not considered necessary to amend these terms of reference. Instead they were interpreted in the widest sense by the Expert.

The Project Document was signed on behalf of UNIDO on 1 November 1974 and the Expert arrived in Ankara following three days of briefing in Vienna, on 25 March 1976. Involvement in Turkey ceased mid February 1977.

5. Assignment Achievements against Duties

The assessment and subsequent development of a mineral resource takes many years of data generation and evaluation. The Experts assignment represented approximately one year within this longer period of time during which an increasing amount of refined data continues to become available. In the case of the Mazidagi project this will continue to be the case for something like 15 months when a decision must be taken on the future of the Mazidagi resource.

Against such a changing background progress was made in all assignment duties the ultimate objectives of which have not been achieved in many cases for the reasons given above, the need for data presently unavailable and the inter relationship and inter dependency of so many of the duties.

Nevertheless it is considered that the Experts involvement has resulted in:

- the Mazidagi phosphate resource being put in its proper perspective and accepted as a marginal and most difficult development operation.

- the general realization that co-operation and not independent action from the raw material producers, fertilizer producers, fertilizer industry planners and fertilizer consumers is essential.

- the acceptance that viable development is critically dependent upon the establishment of a successful and versatile beneficiation approach and the capability of the fertilizer industry to effectively make acceptable products (in particular high analysis fertilizers).
- an appreciation of the need to reappraise the strategy of mineral project evaluation in particular the obtaining and assessing of basic data on which decision making is possible.
- educational benefits in both general and specific areas of mineral evaluation, beneficiation and fertilizer technology in particular.
- numerous important if incomplete contributions within the specific assignment duties.
- identification of where the Expert and UNIDO can contribute in the most worthwhile ways to the evaluation (and development) of the Mazidgi resource and other mineral prospects, the improvement of the Turkish fertilizer industry and the education and training of indigenous professionals and technicians.

II. MAZIDAGI PHOSPHATE PROJECT REVIEW

Phosphate exploration in the Mardin-Mazidagi region of South East Turkey has been actively conducted by MTA (and others) for many years resulting in the delineation of three potentially commercial phosphate occurrences within an area of approximately 200 square kilometers.

Initially the West Kasrik (the present Mazidagi) occurrence was discovered in 1961. Following assessment, exploration moved to surrounding areas resulting in the discovery of the Akras and Tasit deposits both found at the time to be uneconomic. Exploration effort was renewed in the Mazidagi (West Kasrik) area in 1968 and has continued to the present time.

The deposits are all sedimentary in origin and Cretaceous in age, representing three phosphate bearing horizons namely Akras, Kasrik and Tasit in a downward sequence. A location map and a vertical section showing the stratigraphy in the area are given in Appendix 3.

The Akras phosphate is glauconitic, low grade (8-14% P_2O_5) and high in the oxides of iron and aluminum. Indicated reserves are small "a few million tons" but the material showing a high citric acid solubility and a potash content could have use as a direct application fertilizer. The phosphate does not respond well to conventional beneficiation processes.

The Tasit deposit estimated to contain 200 million tons averaging 10-11% P_2O_5 is associated with marls and limestones and in the beneficiation work reported was shown to yield an acceptable grade of phosphate with respect to P_2O_5 content following calcination and desliming. Phosphate recovery however was low and processing economics doubtful.

The Kasrik phosphate (the basis for the present study) covering approximately 45 square kilometers has been divided into seven areas for convenience viz Semikan 1,2,3 and 4; Arisu 1 and 2 and Desan blocks. The phosphate mineralization occurs in two horizons - Semikan (Upper) and Kasrik (Lower). The Semikan horizon consists essentially of oolitic

phosphate associated with argillaceous phosphate over a thickness of about 1.5 meters and the Kasrik horizon averaging about 1.2 meters in thickness consists of complex phosphate/limestone associations. In between these is an intercalated series or zone comprised of limestone, chert and clay containing variable but little phosphate and up to 20 meters in thickness.

Limestone, chert and clay of inconsistent thickness overlie the Kasrik formation and limestone predominates beneath it. The above mentioned structural and mineralogical characteristics have a most important bearing on any mining, beneficiation and development strategy.

"Ore" reserves in this area referred to as the Mazidagi deposit remain unknown for want of practical and economic definition but estimates range from an over optimistic 200 million tons to a more realistic 10-20 million tons based on available data.

The phosphate mineralization at Mazidagi can be classified into five distinct types passing from one to another in short vertical and horizontal intervals and grading into associated clays, limestones and cherts. The five types are:

- phosphatic limestones
- calcareous phosphates
- colitic phosphates
- clayey phosphates
- siliceous phosphates

It is to be noted that each of these types requires a different process or combination of processes for upgrading.

A considerable amount of unrelated small scale beneficiation work lacking practical orientation has been carried out on the various "ore" types in which only reasonable metallurgical results were obtained. Beneficiation work relating to a practical mining approach to the deposit and to establish the suitability of the resultant phosphate for the fertilizer industry is lacking as too are sound and realistic economic

evaluations and studies to ascertain how the Mazidagi resource if exploitable may fit the longer term Turkish Government/fertilizer industry/agricultural plans and demands.

Extensive core drilling (over 3000 meters), driving (over 5500 meters), trenching and pitting work together with sampling and analysis have been completed in the area in order to establish the extent, quality and character of the phosphate and to delineate the more economic and practical mining locations. Numerous cost projections of little present day relevance have been made.

Site development at Mazidagi is well advanced with the establishment of office, living, messing, store, workshop, laboratory etc. facilities and the construction of roading and a "pilot" beneficiation plant. Stripping and preparation for mining of two of the better locations (Semikan level phosphate in the Semikan 1 and Arisu 1 blocks) has been completed. The Etibank commitment at the site to date approximates 300 million TL.

The "pilot" beneficiation plant is designed to upgrade 500,000 tpa of carefully selected colitic "ore" by hand picking, selective crushing and screening followed by drying. (See Appendix 3 for flowsheet)

Recently (late October) GEOMIN from Bucharest, Romania commenced a 15 month, \$ US 320,000 contract to evaluate the Mazidagi deposit involving the completion of the investigational work in order to do this and enable the preparation of a feasibility report (Appendix 3). This report should establish and its recommendations determine the future of Mazidagi where the "pilot" operation will continue at a small scale on the reserves that have been established in order to supply feedstock for the SSP works at Sivrice near Elazig.

Most of the work reviewed above had been completed, was in progress or had been programmed at the time of the Experts arrival. The Expert has therefore been associated with most of this work and its consequences during his assignment but has had little opportunity of influencing the course it has followed.

III. UNIDO ASSIGNMENT FINDINGS (CONCLUSIONS)

1. Preamble

In considering the Experts role in and contribution to the Mazidagi phosphate project it is important to consider both the state of development and the commitment by Etibank at the time the assignment was taken up and that the Expert was engaged short term in a long term evaluation and development programme. These circumstances influence both the impact of the assignment and the opportunity for the Expert to complete the specified duties.

In spite of the above mentioned constraints it is considered that most worthwhile contributions have been made in many project and related areas which should materially assist in the longer term assessment/development of Mazidagi, in future mineral projects of a similar character and in more orderly and effective development of the Turkish phosphate fertilizer industry. This should be particularly true if opportunity is taken to continue the assistance along the lines recommended in this report.

During the assignment important short and long term relationships were established with other UN project personnel working in Turkey when it was found that common interests and country needs were identified. The work therefore relates to and compliments that of:

a) Mr. K. Thompson, Drilling Adviser for the Mineral Research Institute (MTA) - TUR/75/007 - OTC.

It was mutually and independently concluded that drilling methods employed by MTA at Mazidagi were unnecessarily sophisticated and thus expensive for the purpose, that MTA reports did not realistically evaluate the reserves and economics of the prospect and that much closer liaison could and should have been maintained between MTA and the SEAPG. These observations are pertinent to the project (TUR/76/002 - OTC) now being undertaken by Mr. P. Hall at MTA.

b) Dr. L. W. Coffey, Research and Development Expert in Non Ferrous Metallurgy (Etibank) - TUR/75/046 - UNIDO.

It was mutually agreed that Etibank has an established need for a Research and Development facility. While facilities are available within Turkey for problem solving and for longer term investigational purposes the phosphate project demonstrated such a need the satisfying of which in addition to many other benefits should mean the availability of more meaningful and relevant data more quickly within the Company.

c) Mr. M. S. Montassir, In Plant Training Centre for Engineers - TUR/68/529 - UNIDO.

The need for a "Fertilizer Research Centre" was recognised immediately by the Expert and discussions with Mr. Montassir who is working closely with Azot Sanayi - the State Economic Enterprise for fertilizers - has led to a proposal for the establishment of such a centre which should include raw material assessment, production technology and product evaluation in addition to training facilities for the fertilizer industry.

Co-operation of this type within and cross linkage between UN projects is considered important in Turkey where common needs are frequently identified. Similarly co-operation between various agencies working in the interests of phosphate development in this country could be better developed (e.g. CEMTO and USAID) as should the concept of co-operation and mutual interest in projects such as the Mazidagi one which have broad development implications and important national interests. This is particularly so in the field of non metallic mineral development when as is the case in Turkey, the experience and versatility of major mineral exploration and development companies is not available or is not encouraged.

2. General

a) a very strong case can be made for the development of the Mazidagi phosphate deposit in order to provide a reliable indigenous supply of phosphate rock for fertilizer production.

- b) the Mazidagi phosphate deposit is complex both mineralogically and physically and of doubtful and marginal grade and extent.
- c) MTA estimates were optimistic and overestimated the Mazidagi potential through a lack of practical and economic constraints rather than a lack of evaluation data.
- d) adequate ore reserves must be established at Mazidagi to justify development. This will only be achieved through beneficiation and fertilizer production studies and not by continued field assessment.
- e) until such work is completed and the technological and economic implications evaluated ore reserves at Mazidagi are small in spite of the widespread distribution of phosphate.
- f) co-operation between raw material producers (Etibank), fertilizer manufacturers (eg. Azot Sanayii), fertilizer industry planners and the agricultural sector is very poor and must be developed. Independent planning and action in these sectors is most detrimental to Mazidagi assessment and development.
- g) Etibank with a mining responsibility has neglected the subsequent operations essential to effective commercialisation of the Mazidagi resource in line with project objectives and in the best interests of the Turkish economy.
- h) well qualified personnel are available within Etibank to assess and develop Mazidagi phosphate but there is an apparent lack of background technical information available to them.
- i) there is a complete lack of experience in phosphate within SEAPG making the Mazidagi project all the more difficult to assess.
- 1) on a comparative basis and on available cost data development at Mazidagi would appear to be unattractive economically and the cost of competitive phosphate will be very high.
- j) the development will be more difficult and less economic as a consequence of climatic and regional considerations the latter consideration however adding to its national significance and importance.

k) mineral exploration leads to many mineral discoveries only a small percentage of which can be economically exploited. It is essential therefore to generate critical decision making data in evaluation and to act realistically and accordingly.

l) in planning Mazidagi assessment attention should have been given early to identifying the most critical areas of the project which then should have been given appropriate priority.

m) good use could have been made of the computer in assessing field data and in making economic analyses.

n) a more conventional and logical approach to the assessment would have enabled the viability of the project to be determined at successive stages and appropriate decisions to have been taken. This is essential so that uneconomic projects can be terminated early.

o) the method of costing used by the SEAPG on Mazidagi leaves much to be desired and should at least be supplemented by the DCF method which has many advantages.

p) the exploration and assessment approach used by Etibank and MTA is commendable but better use could have been made of the data generated and in planning the evaluation. A closer and continuing working relationship between MTA and SEAPG should have been maintained. In addition when identified, anomalies should be investigated and reconciled.

q) although detailed sampling has been conducted at Mazidagi there is a lack of full analyses on which the true value and potential of the phosphate can be assessed. While of prime importance P_2O_5 is only one parameter on which to assess quality.

r) on the basis of world fertilizer trends, SPO projections, industry plans and the geographical location of Mazidagi development must be directed towards the production of high analysis fertilizers.

s) more complete analyses will be required to control mining and beneficiation operations and product quality even in the case of the existing "pilot" operation.

t) there is a total lack of technical information on the quality of Mazidagi phosphate in so far as its suitability as a fertilizer feedstock is concerned.

u) the character of Mazidagi phosphate is not well understood in the fertilizer industry contributing therefore to the lack of action in preparation for or investigating the possibilities of using it as a feedstock.

v) the Turkish fertilizer industry is not sophisticated especially in some areas and production from Mazidagi must not produce additional difficulties in the production areas. Supply of inferior rock in place of imports could have a serious effect on the efficiency and productivity of fertilizer plants.

w) while established standards exist for phosphatic fertilizers in Turkey (TSE TS 566/UDK 631.85) there is no evidence that these standards can be met from Mazidagi rock as feedstock.

x) the "pilot" operation at Mazidagi is a high grading operation not in the best interest of Mazidagi and Turkey and not capable of producing a consistent and high quality phosphate product.

y) the present difficulties in this plant relate to the mistake of proceeding to plant construction from small scale testing and demonstrate materials handling, engineering, climatic and operational difficulties that can be expected at the site particularly under winter conditions.

z) this plant will serve little useful purpose in the pilot sense and has more of a production than an experimental role.

aa) the "pilot" operation does not represent a logical approach to upgrading Mazidagi run of mine rock as separation based on selective crushing and sizing is insufficiently positive to yield a consistently good product at acceptable recovery.

bb) wet processing, many unit operations and a complex but flexible flowsheet would appear essential for dealing with the numerous "ore types" resulting from non selective mining at Mazidagi.

cc) such processing if at all possible must include early rejection of diluting material (low grade/barren) by mechanical or electronic rather than hand picking means.

dd) highest priority must be given to the source, quality, quantity and cost of water for such processing.

ee) the GEOMIN evaluation as detailed in their contract document should provide all the necessary technological and economic data necessary to make a decision on the future of Mazidagi.

ff) the GEOMIN contract must be kept on schedule and it must be ensured that the work is sufficiently complete for a decision to be taken on the Mazidagi project. This work must include adequate pilot planting and fertilizer production testing on beneficiated rock.

3. Miscellaneous

a) throughout the assignment language presented a general difficulty although this was not evident between the Expert and the Counterparts. This restricted access to detailed project and related information and inhibited communication with SEAPG staff and many outside contacts.

b) the above difficulty unfortunately limited the educational role of the Expert within SEAPG and a lack of English prevented dissemination of much of the technical literature relating to "phosphate" and so important in assessing and implementing Mazidagi development.

c) while the co-operation and assistance of all concerned with the Experts wellbeing (particularly Counterparts) was excellent as were office and site facilities the lack of secretarial services at times proved frustrating and reduced the productivity and increased the work load of the Expert.

d) feed back from reports, meetings, distribution of technical information, discussions and recommendations was disappointing throughout the assignment and therefore the impact and/or the contribution of the Expert was difficult to assess.

e) delivery of equipment for the assignment and the release of same from Customs presented problems and considerable delays which fortunately in this particular assignment did not adversely affect progress.

IV. RECOMMENDATIONS

1. Requiring UNDP/UNIDO Consideration/Action

a) it is recommended that a technical Information Facility should be established within the Etibank SEAPG to permit a better understanding of the total concept of phosphate evaluation, development, and utilization. Such a collection should contain books, journals, periodicals, technical reports and conference proceedings covering a wide field but with a specific orientation towards phosphate and phosphatic fertilizer technology.

The collection already initiated by UNIDO should be properly administered, developed, and updated on a continuing basis by Etibank and further supported as considered necessary by UNIDO in order to provide an up to date background against which the Mazidagi project can be assessed and if desirable developed.

Depending on the future of Mazidagi this collection could be maintained in the SEAPG or incorporated in the Etibank Research and Development Section should this be developed. (Refer assignment finding 2, report DP/TUR/74/030/MHB/2 and Appendix 7a).

b) in view of the lack of experience in phosphate evaluation, mining, beneficiation, and utilization within SEAPG in Ankara and in Mazidagi the staff of which has sound scientific, technological and engineering training and competence it is recommended that selected staff members should be encouraged and enabled to visit overseas phosphate operations and associated laboratory and research facilities. In particular short term fellowships should be offered in 1977 for this purpose; one to a senior staff member (2-3 months) and another to a junior staff member for a shorter time (1-2 months) and on a more local basis. (Refer assignment finding 1 and Appendix 7b).

c) as a consequence of the total lack of Research and Development work being undertaken by the fertilizer industry it is recommended that this work should be initiated immediately and should later be incorporated

into the proposed "Fertilizer Research and Training Centre". Initially work should be directed at establishing and developing the fertilizer production characteristics of Mazidagi rock and investigating alternative and newer fertilizer production methods which may be applicable. (Refer assignment finding t, Reports DP/TUR/74/030/MHB/A and MHB/4 and Appendix 7c/d).

d) in order to develop this work it is further recommended that a UN Fellowship be provided to enable a chemist/chemical engineer from the fertilizer industry (eg Azot Sanayi) to work in a Fertilizer Research Centre or Association and to study and become acquainted with the work being done, its application, and the equipment and experimental and analytical procedures involved. (Refer report DP/TUR/74/030/MHB/A and Appendix 7 c/d)

e) should the establishment of a Fertilizer Research and Training Centre be confirmed as a UNDP/UNIDO project in the forthcoming Country Programme it is recommended that consideration be given to engaging the Expert (or an alternative Expert) for planning the requirements for raw materials and fertilizer production evaluation within this centre. (Refer report DP/TUR/74/030/MHB/A and Appendix 7e).

f) it is recommended that consideration be given to the provision of equipment to complement that already provided by UNIDO under Project DP/TUR/74/030 and to make the laboratory at the Mazidagi site more effective in sample preparation, analytical work and raw material and process assessment which will become more important as operations continue and/or expand. (Refer assignment finding s and Appendix 7f).

g) because Mazidagi assessment will continue until at least the end of 1977 and during this time critical periods will be reached it is recommended that UNIDO's involvement be continued. As a consequence of the understanding the Expert has for the project it is recommended that he return for a short assignment (4 weeks) when the final GEOMIN proposals are submitted to Etibank and that a shorter engagement may be considered at an earlier stage. Etibank should request this. (Refer assignment finding ee and ff and Appendix 7 g).

2. Requiring Etibank Consideration/Action

a) it is recommended that SEAPG should take a more realistic approach to the economic evaluation of the Mazidagi project in which established economic and technical practices are incorporated. This should include DCF analysis with associated risk and sensitivity analyses and a continuing revision as more data becomes available. Only in this way can sound decisions on which to proceed with or terminate a project be taken.

b) Etibank should work more closely with MTA responsible for exploration work and those enterprises in the fertilizer planning, producing and utilizing sectors and vice versa, and it is recommended that this co-operative approach be actively pursued.

c) because of the shortcomings in information on and direct experience in phosphate within the SEAPG it is recommended that Etibank support the proposals for Information Services, the development of Research and Development facilities and overseas travel for staff to improve capability.

d) as the assessment of Mazidagi has been both expensive and drawn out it is recommended that outstanding work be expedited and that an early decision be taken on receipt of the GEOMIN report.

e) because of the very critical nature of the GEOMIN study it is recommended that Etibank ensure that this remains on schedule, is exhaustive in its detail and conclusive in its findings and resultant recommendations.

f) further it is recommended that Etibank supports the need for an independent assessment of the GEOMIN work at its conclusion.

V. ACKNOWLEDGEMENTS

The Expert wishes to record the co-operation shown by all Staff members of the Etibank South East Anatolia Phosphate Group and particularly that of the Project Counterparts Mr. Arif Saatci and Dr. Nijat Gursoy. The consideration given by Etibank Staff generally and particularly at the Masidagi project site is gratefully acknowledged as is that experienced at other places visited.

Thanks are also due to the UNDP Staff for assistance and kindness in dealing with personal and professional matters. The help of Mr. R. D. Lalkaka, Senior Industrial Development Field Adviser is specifically acknowledged.

VI. APPENDICES

1. Project Personnel

- a) Professor M. H. Buokenham UN Technical Expert in Phosphate
 Beneficiation Plants.
- b) Dr. Nijat Gurscy Director, Etibank SEAPG, Project
 Counterpart.
- c) Mr. Arif Sastoi Assistant Director, Etibank SEAPG,
 Project Counterpart.

The above-mentioned were assigned to the project throughout.

2. Equipment Component (UNDP, UNIDO financed)

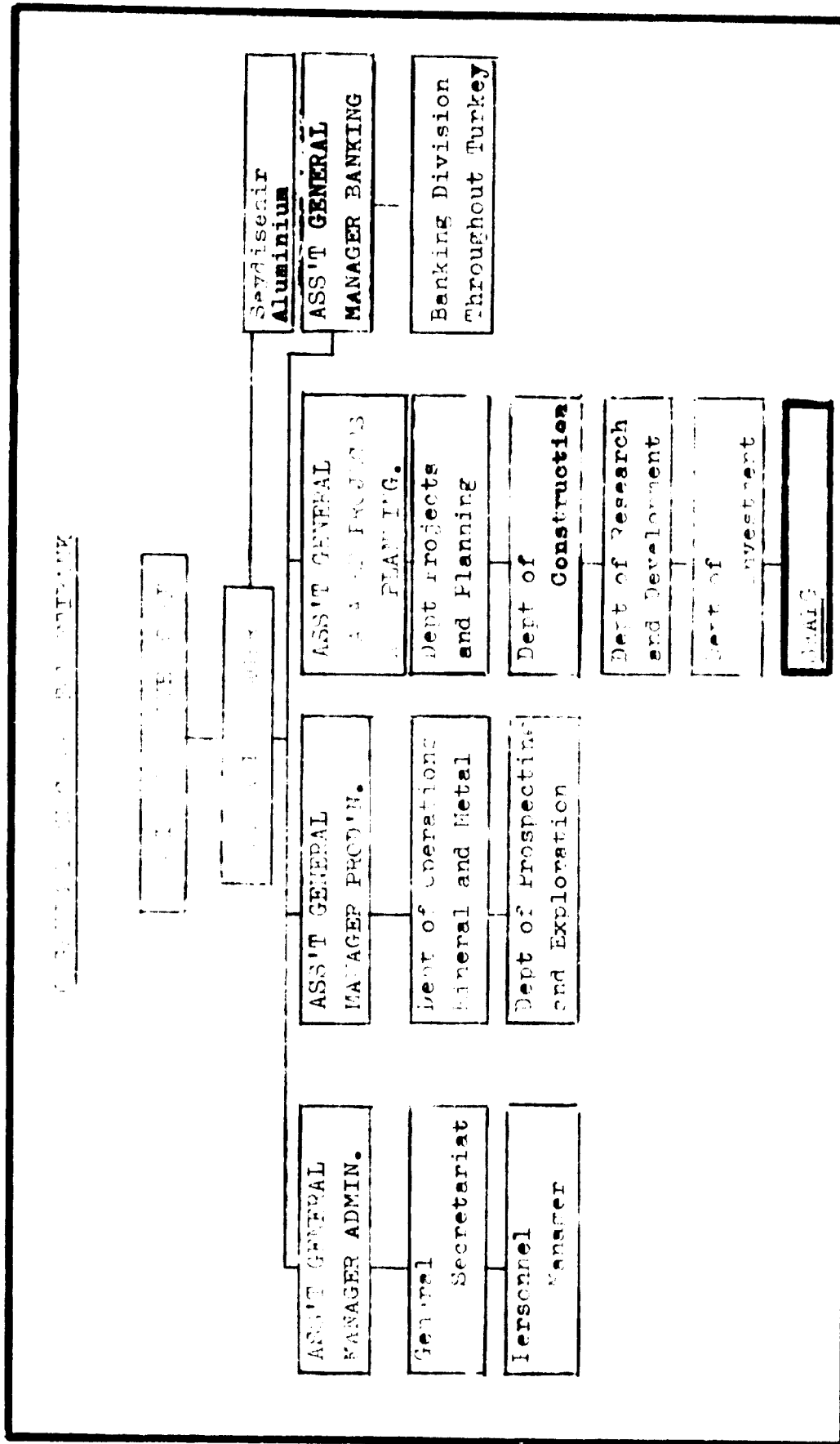
- a) Denver Equipment Co. Laboratory Flotation Machine with Reagents. .
 *\$ 2052US
- b) Denver Equipment Co. Laboratory Disc Grinder. *\$2278US
- c) Griffin International Portable pH Meter and Accessories. *\$207US
- d) Collection of Miscellaneous Technical Books. \$2000

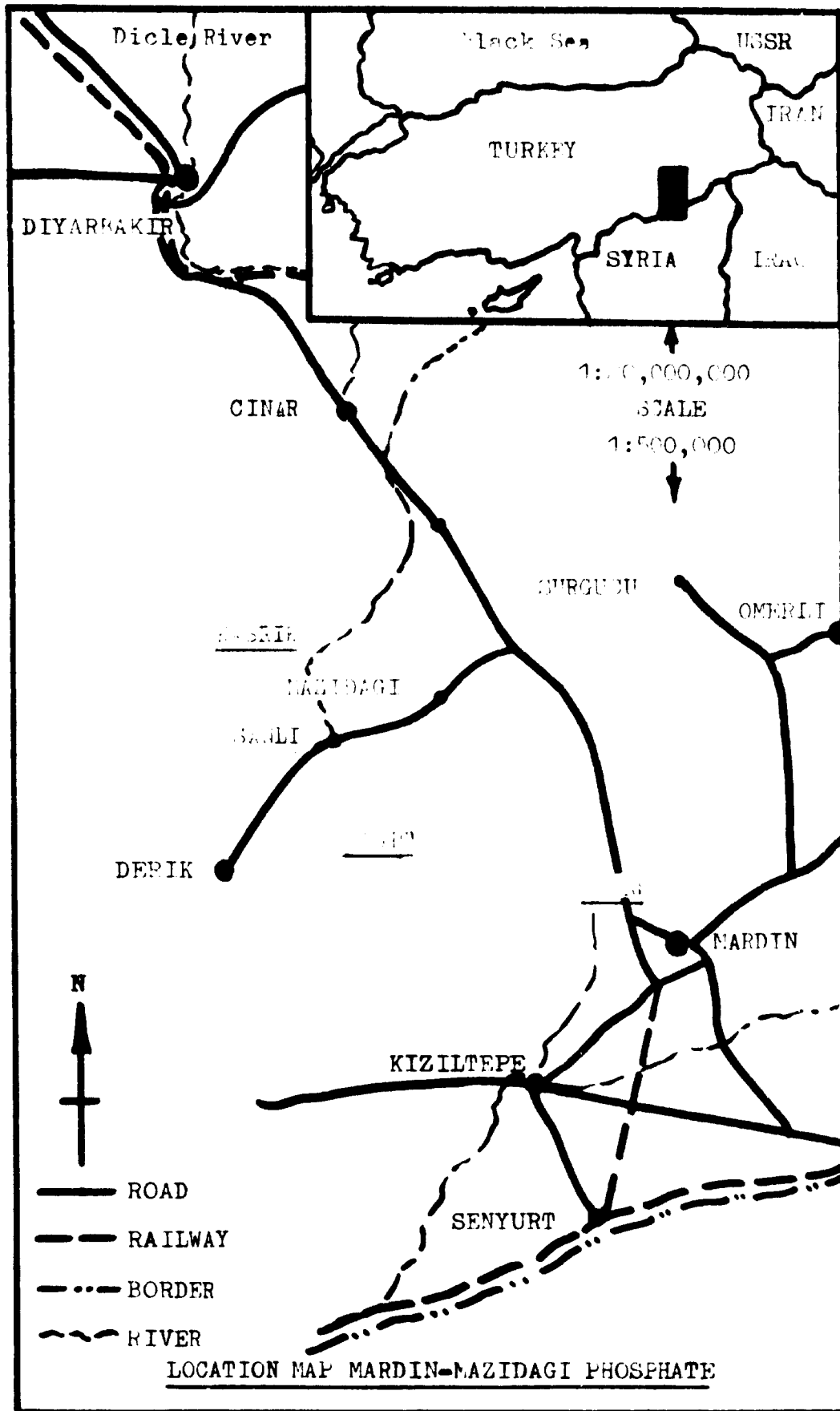
Note: Items a, b and c were requisitioned before Experts
appointment and Item d was requisitioned on Experts
recommendation.

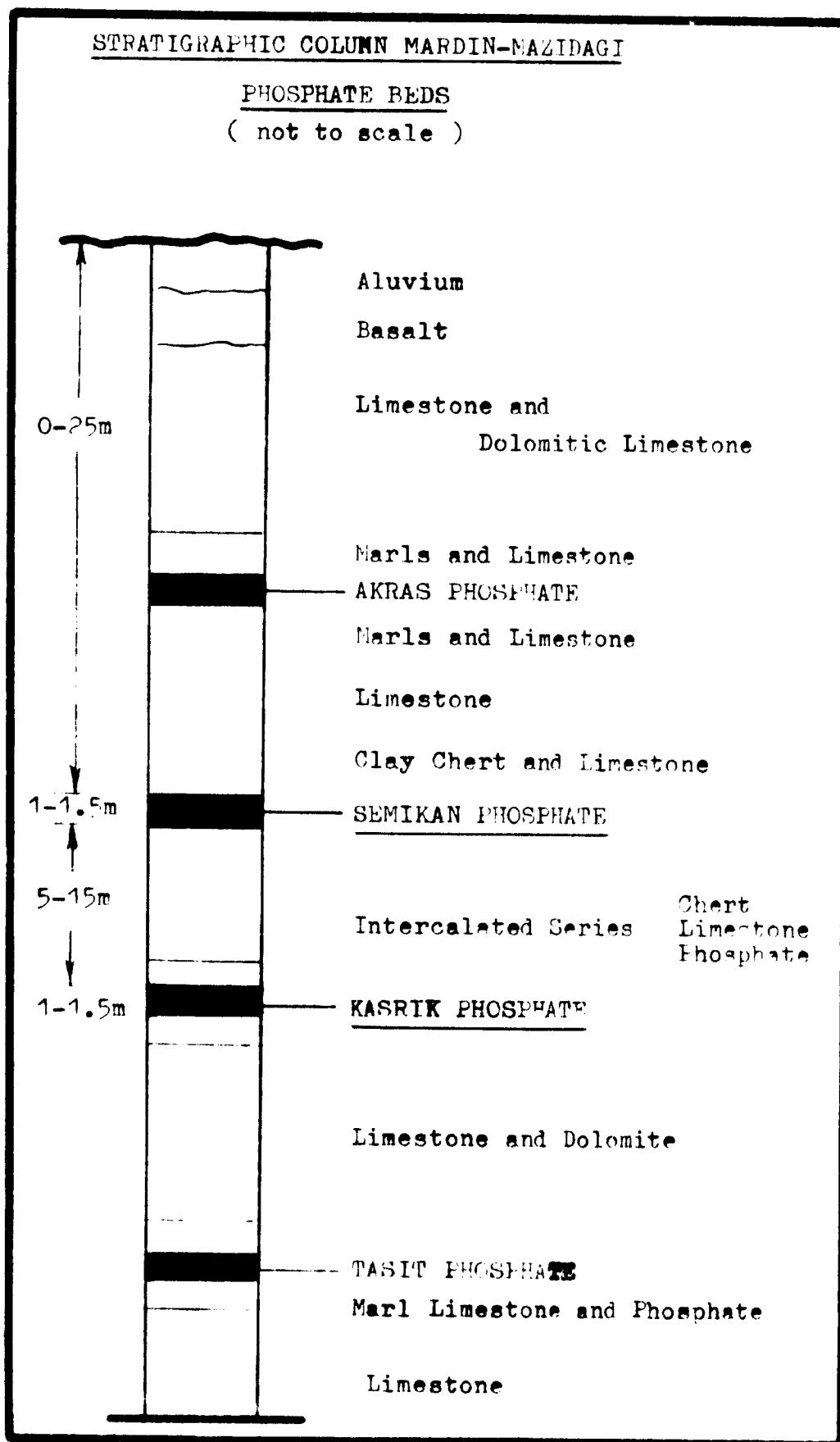
* These costs do not include freight estimated at about
US\$670.

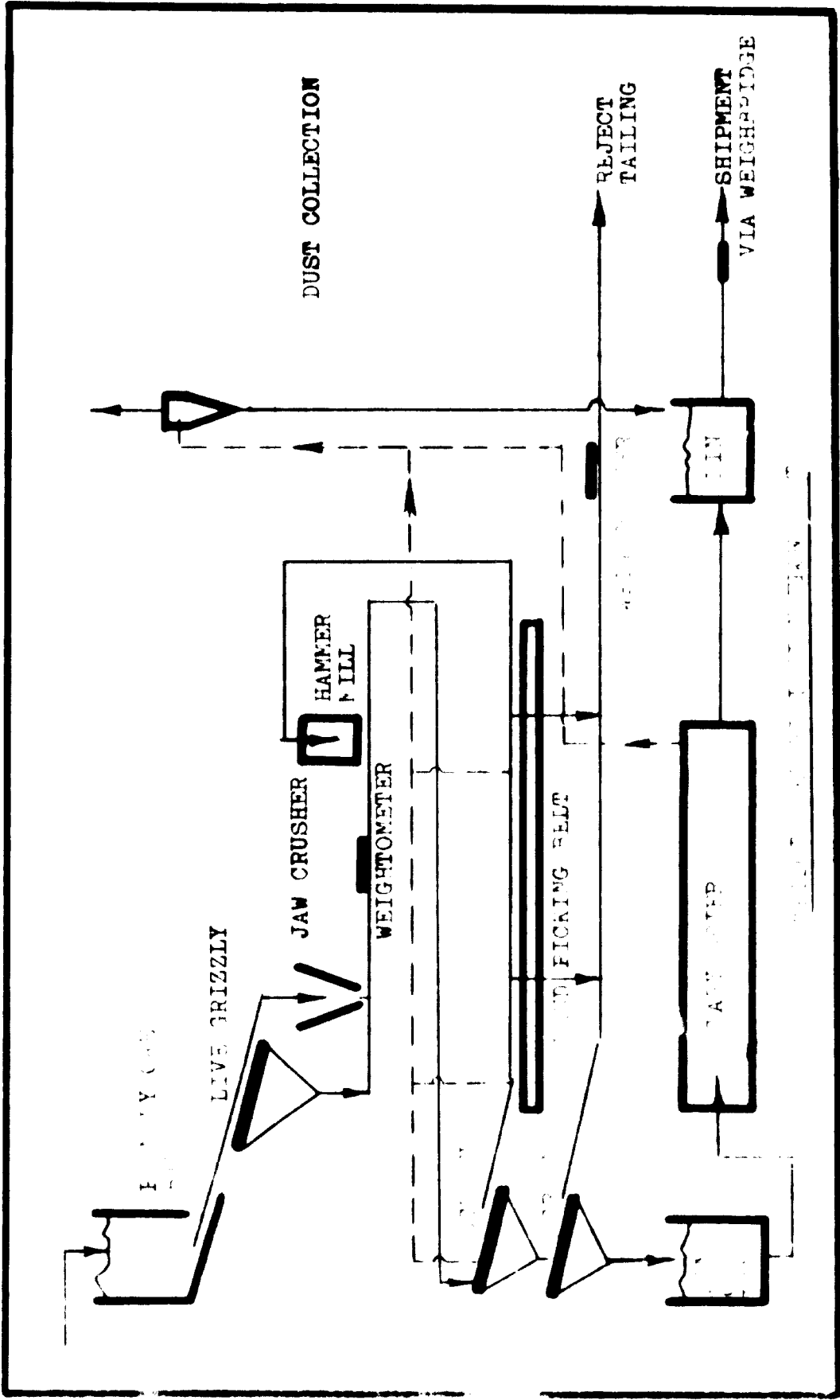
3. Illustrations and Figures

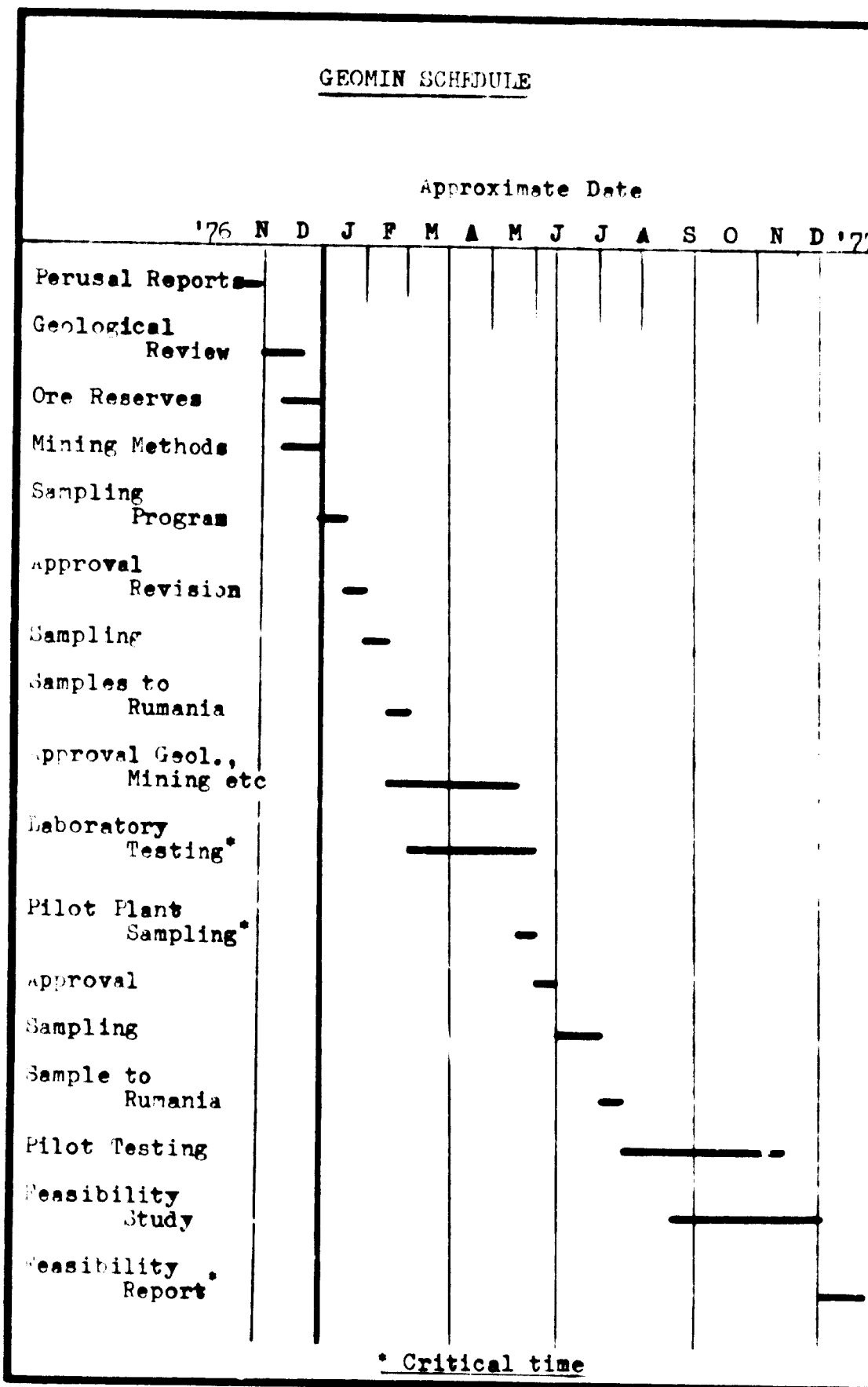
- a) Organization Chart for Etibank
- b) Location Map Mardin - Mazidagi Phosphate
- c) Stratigraphic Column Mardin - Mazidagi
- d) "Pilot" Beneficiation Flowsheet.
- e) GEOMIN Schedule











4. Visit Made

- | | | | | |
|----|----------------|----------|--------|--|
| a) | April 1976 | Masidagi | 4 days | Familiarisation visit and field assessment with Counterpart Arif Saatci |
| b) | May 1976 | Kutahya | 1 day | Discussions of Research programmes and capability with Asot Sanayii |
| c) | August 1976 | Masidagi | 4 days | To assess site progress and to inspect "pilot" beneficiation plant construction. |
| d) | August 1976 | Iamsun | 1 day | Reviewing TSP technology and rock requirements at Asot Sanayii works. |
| e) | September 1976 | Masidagi | 4 days | Testing and commissioning of pilot beneficiation plant with Counterpart Arif Saatci and Etibank Chief Engineer, A. Yildirim. |
| f) | October 1976 | Masidagi | 2 days | Inspection of site area with UNDP/UNIDO Senior Industrial Development Field Adviser, R.D. Lalkaka. |
| g) | November 1976 | Yarimca | 1 day | Reviewing technology and rock requirements at Gubre Fabrikalari TAS Works. |
| h) | November 1976 | Bandirma | 1 day | Reviewing technology and rock requirements at Gubre Fabrikalari AS Works. |
| i) | November 1976 | Masidagi | 4 days | Assessing and discussing phosphate reserves with GEOMIN geologists, Alacem geologist and Counterpart Arif Saatci. |
| j) | November 1976 | Masidagi | 3 days | Considering and discussing mining and beneficiation practices applicable at Masidagi with GEOMIN mining and beneficiation engineers, Alacem engineers and Counterpart Arif Saatci. |

5. Meeting Attended

- a) United Nations Seminar on Economics of Mineral Engineering, Ankara, Turkey. 5-15 April 1976.

6. Assignment Reports and Abstracts

- a) DP/TUR/74/030/MEB/1
7 April 1976
- Preliminary Evaluation of and General Observations on Reserve Estimations, Mardin-Masidagi Phosphate Deposit.

Abstract: Initial appraisal of Masidagi phosphate reserves following examination of available documentation. Conclusion that quoted reserves were optimistic and practical and economic constraints should have been incorporated in the assessment.

- b) DP/TUR/74/030/MEB/2
1 May 1976
- Information Services-Book Proposals for Etibank Phosphate Group (with Book Proposals).

Abstract: Following the early identification of a need for technical information available to SEMPG to assist with Masidagi assessment and development and to enable it to be put in proper perspective recommendations and a book list were made.

- c) DP/TUR/74/030/MEB/3
10 May 1976
- Report on Visit to Masidagi Phosphate Deposit and Related Matters.

Abstract: A reappraisal of the phosphate reserves following a site visit together with an overview of the project. Confirmation of the low reserves and a need for fertiliser production studies.

- d) DP/TUR/74/030/MEB/4
21 May 1976
- Fertilizer Production Research, Masidagi Phosphate (with Test Work suggestions).

Abstract: A proposal made for the initiation of fertiliser research and particularly work on Masidagi rock in order to make more meaningful reserves estimates.

- e) DP/TUR/74/030/MEB/5 Fertilizer Production Research Masidagi
11 June 1976 Phosphate (with Enclosures).

Abstracts: Brief proposals for testwork that should be undertaken initially as a consequence of recommendations in DP/TUR/74/030/MEB/4.

- f) DP/TUR/74/030/MEB/6 Engineering Services for Masidagi Phosphate
16 June 1976 Beneficiation Plant.

Abstracts: Assessment of proposals received for evaluating Engineering Services at Masidagi and recommendation on most suitable submission.

- g) DP/TUR/74/030/MEB/7 The Evaluation of Mining Projects using the
22 June 1976 Discounted Cash Flow (DCF) Method.

Abstracts: Illustration of the DCF method of project evaluation as applicable to Masidagi and the concepts of risk and sensitivity analysis.

- h) DP/TUR/74/030/MEB/8 Note on the Assessment of Masidagi Phosphate
29 July 1976 Reserves.

Abstracts: A proposal for the detailed examination of all Masidagi sampling data following indications of inconsistencies.

- i) DP/TUR/74/030/MEB/9 Report on Visit to Masidagi Phosphate Deposit.
31 August 1976

Abstracts: An assessment of Masidagi development with emphasis on mining and beneficiation policies.

- j) DP/TUR/74/030/MEB/10 Report on Visit to Samsun Fertilizer Works
6 September 1976 of Asot Sanayi.

Abstracts: A discussion of phosphate rock requirements for high analysis fertilizer in the light of Masidagi analyses and Asot Sanayi (Samsun) experience.

r) SEMI-ANNUAL PROGRESS REPORT. Half yearly report to 30 September 1976.

Abstract: Formal summary of work progress against duties for first six months.

s) PROGRESS REPORT. 1 October to 19 November 1976.

Abstract: Brief review of Experts assignment work (7 weeks).

7. Elucidation of Recommendations

a) Information Facility SEAPG

The most important subject areas to be covered are detailed in Report DP/TUR/74/030/MB/2. Special emphasis should be given to the obtaining on a regular basis publications from such organizations as:

- the United States Bureau of Mines.
- the Tennessee Valley Authority
- the British Sulphur Corporation
- the International Superphosphate Manufacturers Association
- the Fertilizer Society of London
- CENFO
- the Sulphur Institute
- the United Nations

and for example the Fertilizer Association of India, the New Zealand Fertilizer Manufacturers Research Association and the Australian Mineral Development Laboratories.

b) UN Short Term Fellowships

(i) Senior Staff Member Etibank SEAPG.

This Fellowship should enable a suitably qualified English speaking mining/beneficiation engineer to study and experience first hand successful phosphate extraction operations in developed countries which have similarities to the Mazidagi prospect and to visit appropriate phosphate fertilizer research centers in order to study their organization functions and work programmes. Visits to the following are suggested:

- the International Mineral Corporation, Florida, USA.
- the San Francisco Chemical Company, Idaho, USA.
- the Tennessee Valley Authority, Alabama, USA.

- the Fertilizer Manufacturers Research Assn., Auckland, New Zealand.
- the Queensland Phosphate Pty Ltd., Queensland, Australia.
- Broken Hill South Ltd. (parent Co. of above) Adelaide, Australia.
- the Australian Mineral Development Laboratory, Adelaide, Australia.

(ii) Junior Staff Member Etibank SEAPG

This Fellowship should enable a suitably qualified mining/geological/beneficiation engineer to visit phosphate mining and beneficiation projects in appropriate countries near to Turkey and similar in character to Mazidagi. The following are suggested:

- Jordan : near Er Ruseifa and near El Hasa - Jordan Phosphate Mines Co.
 - Israel : eg Oran area - Chemicals and Phosphates Ltd.
 - Syria : Chadir-el-Hamel area near Palmyra.
 - Tunisia : Gasfa area - Compagnie des Phosphates et du Fer de Gasfa.
 - Morocco : eg near Khouribga and Youssoufia - Office Cherifien des Phosphates.
 - Egypt : the Abu Tartur deposit and El Hamarawein mine.
- and possibly Algeria : the Djebel Onk mine.

The Expert can assist in the placement in the Australian and New Zealand locations listed and could negotiate the USA visits on his way home at the completion of the present assignment.

o/d) Research and Development Work

Experimental work must be initiated to establish analytical and experimental procedures capable of evaluating the quality of Mazidagi phosphate relative to imported rock and to develop processing technology appropriate to this kind of feedstock. Test work has been outlined in reports DP/TUN/74/030/THB/4 and 5 and detailed in enclosures. For example

grinding response, rock reactivity, acid consumption, acid strength, and filtration characteristics and fluorine emission etc. must be determined and alternatives to sulphuric acid acidulation eg. nitric acid investigated. Even though meaningful samples may not yet be available experimental competence must be established and laboratory facilities built up for this work and to support the manufacturing plants.

Provision of a long term Fellowship (12 months) would appear necessary to develop this facility to any satisfactory degree and to enable a local contribution in this area in the proposed "Fertilizer Research Centre". The Director of the New Zealand Fertilizer Manufacturers Research Association has intimated that a "Fellow" would be most welcome and no better location for this experience is known to the Expert. A good working knowledge of English would be essential for such an appointee.

e) Fertilizer Research Centre

It is considered premature to make specific proposals relating to the concept of ^a Research Centre but for Terms of Reference use should be made of a paper on this subject (UNIDO/ITD 152), the Experts experience and experience gained from the Fertilizer Association of India and the Fertilizer Research Association of New Zealand.

f) Provision of Equipment

Until the future of Mazidagi is more firmly established site requirements for laboratory equipment are difficult to specify. It is suggested subject to revision and/or confirmation when necessary that existing facilities could be reinforced and extended in their application by the provision of:

- Tema or Rocklabs ring grinder for sample preparation prior to analysis.
- Atomic Absorption Spectrophotometer with necessary lamps (Fe/Al analyses).
- Specific Ion Electrode with expanded scale meter (for F analyses).
- Accessories for the existing Perkin-Elmer Spectrophotometer to increase capability (sample changer and recorder).

g) GEOMIN Programme

Should the GEOMIN contract (Appendix 3) remain on schedule then Phase 1 will be completed by December 1977. Two critical stages in this contract occur about May 1977 and December 1977. The first represents the completion of the bench scale beneficiation tests and sampling and planning for pilot scale tests and the second the completion of all test work and the presentation of a feasibility report on which the future of Mazidagi will depend. The Expert would be invaluable to Etibank to assess the work and proposals of Geomin particularly at the latter of these two stages. If necessary the earlier assessment could be made possibly without attendance in Ankara.

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 - d) OECD 1970: The World Phosphates and Phosphatic Fertilizers Industry and the role of International Aid. Research Division Publication : CD/R/70.17, April.
 - e) MacKenzie BW 1970/71: Evaluating the Economics of Mine Development Canadian Mining Journal, Dec 70 and Mar. 71.
 - f) Hill JM 1971 : The Need for Reorganization of Turkey's Fertilizer Industry. USAID Publication, Ankara, Feb.
 - h) Spencer RN 1971: Multiple-Zone Mining plus Beneficiation of Western Phosphate Rock- a Cost Estimate and Comparison with Selective Mining. USBM RI 7512.
 - i) Ayiskan O 1973: Beneficiation of Turkish Mazidagi Phosphates. CENTO Symposium, Istanbul, Nov.
 - j) Lehr J and McClellan GH 1973: Phosphate Rocks: Important Factors in their Economic and Technical Evaluation. Ibid.
 - k) Onal G. 1973: Mazidagi Low Grade Calcareous Phosphate Ores Flotation. Ibid.
- Note: Other pertinent papers in this volume appear on p 76 (Dogan) and on p 181 (Notholt)
- l) Geerling MC et al 1973: Model for Establishing National Fertilizer Development Centre. UNIDO/ITD 152, Jan.
 - m) Keleti C et al 1974: Assistance to the Turkish Fertilizer Industry Project Findings and Recommendations. UNIDO Publication ITD 258, April.
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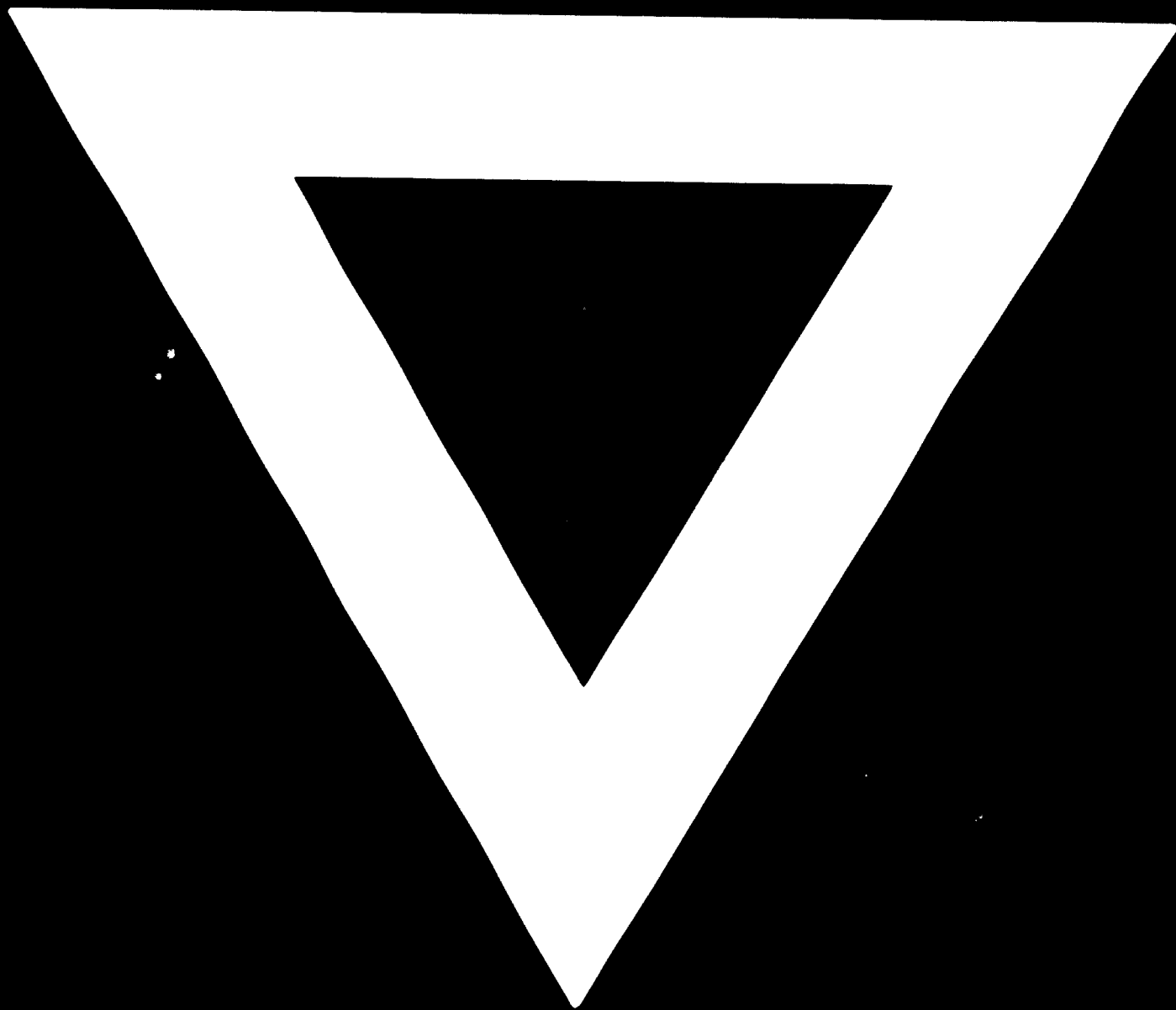
- o) Directorate Nitrogen Plants, Kutahya 1975: The History and the Present Developments of the Turkish Fertilizer Industry. CENTO Seminar, Ankara, Sept.

Note: Other pertinent papers in this volume appear on p 23 (Deliormanli) p 170 (Karademir and Erdir) and p 228 (Kiroglu) and in the 1974 CENTO Seminar, Islamabad publication p 75 (Bayraktar) and p 215 (Erdir).

- p) Hope R 1976: From Matrix to Fertilizers: Florida's Phosphate Industry Girds to Produce over 50 Million TPFY. Engineering and Mining Journal, Sept.
- q) Anon. 1976: Turkiyede Kimyevi Gubre Sanayii. Yapi ve Kredi Bankasi Report, August.
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- s) Anon. 1976: Egypt's Abu Tartur Phosphate Deposit. Mining Magazine, July.
- t) Cagatay M 1974: Fertilizer Supply and Demand Situation in Turkey. CENTO Seminar, Lahore, March.
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