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DP/AFG/72/003 .

AFGHANISTAN .

Technical report: Assessment of the development of the refractories industry

Prepared for the Government of Afghanistan
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of Miroslav Grylicki, expert in refractories

United Nations Industrial Development Organization
Vienna

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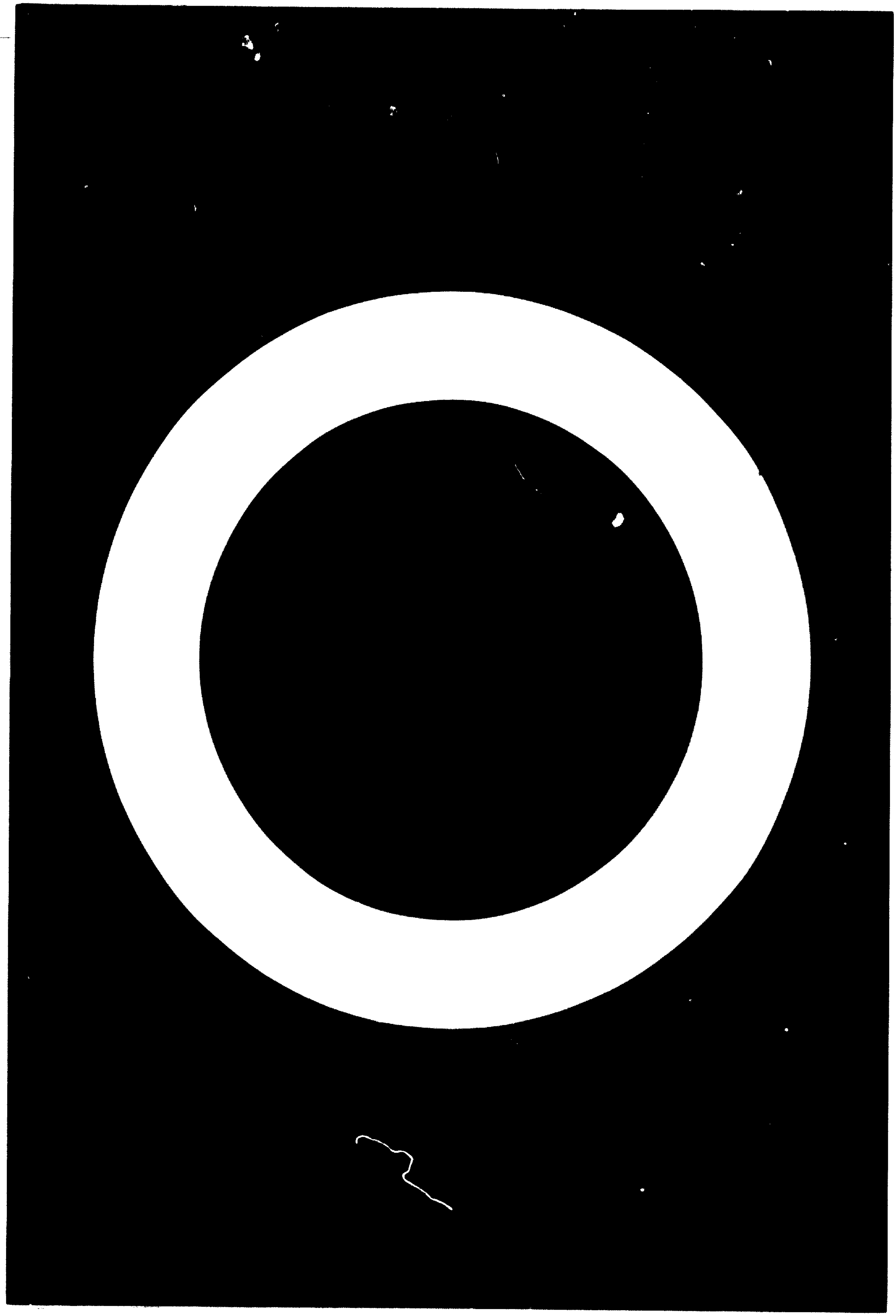


ABSTRACT

The mission covered by the present report forms part of a large-scale project entitled "Industrial Services" (DP/AFG/72/003), for which the Government of Afghanistan requested UNDP assistance in April 1972. The project was formally approved by UNDP in June 1975, with the United Nations Industrial Development Organization (UNIDO) designated as executing agency, and the Afghanistan Ministry of Mines and Industries as government counterpart agency.

Within its framework the mission to assess the development of the refractories industry took place from 12 July to 6 September 1978. The expert collected data on the development of industries requiring refractories such as the cement, the iron and steel, the copper smelting and the glass industry and gathered information from geological surveys on deposits of raw materials suitable for the production of refractories.

He concluded that by 1988 the requirement of the Afghanistan industry will be approximately 2,000 tons of alumosilicate and 2,500 tons of basic refractories and recommends developing the domestic refractories industry along the following lines:

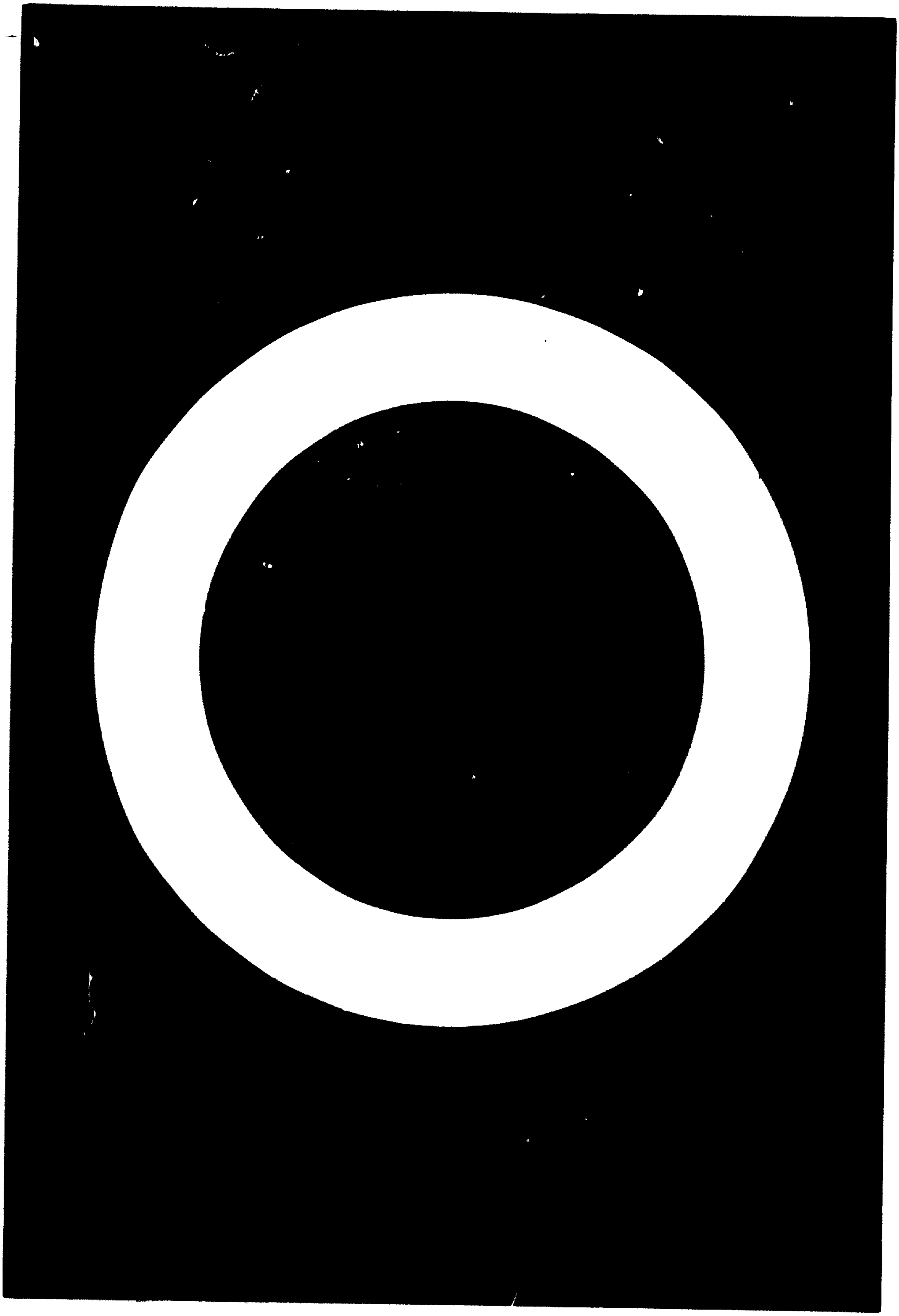
(a) Start under the next 5-year plan (1979-1983) the mining of the magnesite deposits at Achin and the processing of the ore to dead burned magnesite;

(b) Erect during the following 5-year plan (1984-1988) a plant for the production of basic refractories (magnesite and chromemagnesite) from dead burned magnesite and chrome ore, with a capacity of at least 3,000 tons/year;

(c) Carry out a further geological survey on depostis of fireclays and kaolins for the manufacture of alumosilicate refractories;

(d) Send future staff abroad for training in general ceramics technology, including technology of refractory materials.

The expert also recommends a follow-up mission during 1979.



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1. <u>INTRODUCTION</u>: As refractories we can define all nonmetalic inorganic construction materials, manufactured by methods of ceramic technology, which can withstand high temperatures, i.e. they do not lose their mechanical strength at high temperatures and shew sufficient corrosion and erosion resistance. Numerous modern industries require such materials for construction and lining furnaces, kilns and other equipment working at high temperatures, for example in cement industry, iron and steel industries, non-ferrous metal industries, glass industry, ceramic industries, thermal power plants and many others.

The main, actual users of refractories in Afghanistan is cement industry and, on a small scale, iron smelting plants. As the demand on refractories in the country has been compratively small up to now the whole requirement is covered only by import. There are however plans for near future to develop cement industry, to start manufacture of iron and steàl as well as copper from domestic ore deposits. There are also plans to start production of glass from domestic raw materials. In such situation erection of refractories industry in Afghanistan to cover the demand on refracteries seems to be unavoidable. The feasibility study of the development of refractories industry in this country has not been yet carried out and that was the reason to invite me to help in assesing the problem.

My job has been covered by the project DP/AFG/72/003 managed by Dr. Fawzi R. Fahmy, I started my duty in Kabul on 12th July 1978 after briefing at UNIDO in Vienna, and terminated it on 6th September 1978, going for debriefing.

The main objectives of my 8-weeks work in Kabul were to find actual and future requirement on refractories in the country, and to find out the possibilities of development of refractories industry, taking in account first of all geological survey on raw materials suitable for refractories production, technical possibilities of starting production of simple refractories in nearest future, as well as some aspects of training specialist for future refractories industry.

2. FINDINGS: My activities were directed into five main directions:

A) Having in mind existing refractories consuming industries (2 cement factories, metal smelting plant, 2 ceramic factories) I tried to collect informations on recent requirements on refractories in Afghanistan,

B) To asses the future demand on refractories I tried to obtain all informations on the development of cement industry, iron and steel industry, copper smelting industry, glass industry, and other industries requiring refractories.

C) I have focused my special interest on collecting all informations from geological survey, on the deposits of raw materials suitable for production of refractories. It was also important for me to find out the places of future geological survey and the prospects of finding interesting deposits.

D) I assesed the present situation on the possibility of starting the manufacture of simple refractories in the country, after some adoptation of existing plant.

E) Special interest, bearing in mind future development of refractories industry, should be devoted to training specialists.

For this reason I visited both Kabul University and Polytechnic Institute in Kabul to find out their programmes of training students, programmes of scientific research and plans for future. I tried also to find native specialists in Afghanistan, who might be as close as possible to the specialization of refractory ceramics.

2.1 Requirement on Refractories in Afghanistan

2.1.1 Estimated Requirement in 1978.

Present main users of refractories are 2 cement plants:

- Ghori, with 2 rotary kilns and the capacity of about 120,000 tons of cement per annum, and much smaller plant at
- Gebel Siraj, with 1 rotary kiln and the annual capacity of cement about 30,000 tons.

The refractory lining of the kiln in the last factory is solely made of fireclay shapes, and their requirement amount to about 80 tons of alumosilicate refractories per annum. It means that the average consumption of refractories in Gebel Siraj Cement Plant amounts to 2.67 kg/ton of cement. Alumosilicate refractories have been imported partly from Chechoslovakia and recently from Pakistan.

In Cement Plant Ghori there is another situation. They have two biger rotary kilns than in Gebel Siraj, and for lining sintering zone of the kilns they use also magnesite or chrome-magnesite shapes. The consumption of refractories in Ghori amounts to about 2.5 kg/t of cement and about half of that quantity should be magnesite or chromemagnesite refractories. It means that approximate total consumption of refractories of two cement plants amounts to about 230 tons of alumosilicate refractories and 150 tons of magnesite or chromemagnesite refractories.

Another important users of refractories are smelting plants, and especially Jangalak Metal Works in Kabul, where present annual requirement on refractories is following:
20 tons of fireclay shapes and about
39 tons or magnesite (including about
10 tons of chromemagnesite). This refractories are imported from USSR.

If we assume, that another, minor user of refractories require roughly estimated about 50 tons of fireclay refractories (alumosilicate refractories) and 30 tons of magnesite refractories per annum, the total present requirement should amount approximately to about 370 tons of alumosilicate refractories and about 240 tons of magnesite refractories,what should amount to about 130,000 US dollars per annum.

2.1.2 Expected Requirement in 1980

It is expected that in 1979 new cement plant in Herat will come into operation with the capacity of 210,000 tons of cement per annum, and the planned requirement on refractories about 1.1 kg/1 ton cement, i.e. 231 tons of refractories per annum (1). If we assume that it may be about 150 tons of magnesite refractories and about 90 tons of alumosilicate refractories the total expected requirement in 1980 could amount to 390 tons of alumosilicate refractories (fireclay bricks, high alumina bricks) and 390 tons of magnesite and chromemagnesite refractories (roughly estimated 220,000 US dollars).

2.1.3 Supposed Requirement in 1983

Unfortunately, up to the date of preparing my report no data have been available on the development of refractories consuming industries. Thus, only rough estimation could be done, based on some unofficial informations and suppositions, concerning 5-year plan.

The production of Metal Works of Jangalak should rise from 500 tons to 1,000 tons per annum, and consequently refractories consumption would rise to about 40 tons of alumosilicate refractories and about 80 tons of magnesite and chromemagnesite refractories.

I do not expect any changes in consumption of refractories in other industries, because there are not yet grounded plans to erect new industries or essentially develop existing industries which require refractories. It means that estimated consumption of alumosilicate refractories per year should not exceed 450-500 tons, and magnesite (including chromemagnsite) refractories about 500 tons per year.

2.1.4 Expected Requirement on Refractories in 1988.

In the middle of the next 5-year plan noticed changes on refractories requirement should be expected. Mining of copper ores will be developed and copper smelting plant will be erected. One should expect also erecting glass factories. Mining of iron ores and essential developing iron and steel industry should not be expected neither during first nor during second 5-year plan. One should assume that some of the existing iron and steel smelting plants (e.g. Jangalak Factory) will be extended and that the requirement on refractories will rise.

There are however first of all plans to extend production of cement to at least about 1,000,000 ton/year (e.g. Kandahar cement plant). If we assume that the production of cement in 1988 will be 1,000,000 ton/year and that the requirement on refractories will amount to 2,000 ton/year (1,000 ton fireclay and 1,000 ton magnesite refractories) that the total production of iron and steel smelting plants will rise to 5,000 ton/year and the demand on refractories will consequently rise to 200 ton/year of alumosilicate and 400 ton/year of magnesite refractories, that copper smelting plants will require about 1,000 t/y of basic refractories and 500 t/y of alumosilicate refractories, that glass plants will require about 80-100 ton/year of silicate refractories and other industries approximately about 200 ton/year of alumosilicate refractories the total demand for refractories in 1988 should be about 2,000 ton of alumosilicate refractories (fireclay and high alumina refractories, including small amount of silica refractories) and about 2,500 tons of basic refractories (magnesite and chromemagnesite refractories). The above mentioned figures can vary, depending on the applied technologies on the production capacity of plants and on used equipment.

2.2 Domestic Raw Materials for Manufacture of Refractory Materials in Afghanistan

There are two main groups of refractory materials commonly used in cement industry, iron and steel industries, copper smelting and glass industry, as well as in other less refractory-consuming industries: alumosilicate refractories, based on processing fireclays or kaolins (sometimes with addition of alumina, to raise the content of Al_2O_3) and another group, so called basic refractories, suitable especially for high temperature processes in metallurgy and in cement kilns based mainly on magnesime oxide (obtained by calcining magnsite) and sometimes with addition of chrome ore (so called chromemagnesite refractories).

2.2.1 Clays suitable for manufacture of Fireclay (Chamotte) bricks

The most commonly used and the most easy to manufacture (from the technological point of view) are alumosilicate refractories. They could be manufactured either from good quality fireclays or kaolins, homogenous; containing 30-39% Al_2O_3, less than 5% Fe_2O_3, and less than 4% of K_2O+Na_2O. They should not contain coarse grains of quartz. What is the situation in Afghanistan?

Many deposits of clays for building industry and pottery industry have been geologically sruveyed (2) but there are only 3 very short notices concerning small deposits of clays serveyed in 67 and 65 that are called "refractory", but without any background informations. To obtain more precise and up to date informations I had a talk with the Chief of USSR geological team in Afghanistan Mr. Zaytsev (in presence of my counterpart Dr. Aini). The obtained informations on fireclays and kaolins in Afghanistan are not very encouraging. The surveyed deposits of kaolins have primary character and they vary in their chemical and minrological composition. The found deposits are rather small and further geological survey is necessary, especially in northern provinces of Afghanistan. The only detailed information on refractory clays and kaolins which I managed to obtain concerned deposits of kaolin in the region of Doab-Tala-Barfak (3). Earlier informations (2) on the mentioned deposit qualify it to the deposits of porcelain and pottery clays, and describe it as an upper Triassic kaolinized bed, over 1,000 m. long, up to 250 m. wide and 20 m. thick. Currently exploited by the Kunduz and Kabul factories to make porcelain goods. Speculative reserves of the white, roasting kaoline are 100,000-150,000 tons. However Klimov (3) in his report says that there are slight prospectives of the occurence of high quality primary kaolins. Tala-Barfak deposit is very inhomogenous and complex. General resources are estimated at 58,826 tons (white kaolin only 13,772 tons). The deposits could cover only the requirement of ceramic industry for 20 years. Three samples of Tala-Barfak kaolin were investigated on their refractory properties in USSR in 1966 (4). It was found that only two of them had refractory prospectives and are suitable for manufacture of fireclay (chamotte) bricks. According to the opinion of Soviet geologists there are only slight prospects of finding deposits of high quality fireclays or kaolinitic clays in the region of river Surkhab (3). To complete all information on the deposits of refractory clays I should also mention about the deposits of low grade fireclays found by Meshkovski (3) 10 km. south-west of the Bazari-Tala. The deposits have been roughly estimated on 385,000 tons but no information on their quality has been included. General conclusion on prospects of finding large deposits of high quality refractory clays in Afghanistan was rather pesimistic. Basing on the above mentioned information one can conclude that there is not advisable to start manufacture of high quality alumosilicate refractories (fireclay or chamotte refractories, high allumina refractories) in Afghanistan as long as large deposits of good quality fireclays or kaolinitic clays are not found.

2.2.2 Magnesites

One of the most important and most valuable material, which has high refractory properties and serves in modern industries (e.g. iron and steel industry and cement industry) is magnesium oxide (MgO). Because of its high refractoriness (melting point about 2600°C) and other advantages it is often used for manufacture of refractory linihgs in many furnaces and kilns, especially in so called "heavy industry". The main source of magnesium oxide (called also "magnesia" or "periclase") are magnesites. Unfortunately there are only few deposits of magnesites in the world which are suitable for manufacture of good quality magnesia refractories or, as they are very often called "magnesite refractories". Thus, magnesites can be regarded recently as a deficitic raw material. The requirements, concerning chemical and minerological composition of good magnesites are fairly high. Pure magnesite ($MgCO_3$) contains 47.6% MgO and 52.4% of CO_2, which volatilizes on firing. For the sake of good behaviour in service of refractories made from magnesites they should contain as less as possible of silica

(SiO_2), and calcia (CaO), and only limited content of iron oxide (Fe_2O_3). The molar ratio of CaO: SiO_2 should be less than 2. So called "dead burned magnesite" (fired at temperiture as high as 1600-1750°C) should contain at least 91% MgO and not more than 5% of sum of $SiO_2 + Fe_2O_3$. High quality dead burned magnesite, containing not less than 98% MgO is fairly expensive, and according to Neilson and Gannon (5-6) it should be valued at around 250 US dol. per tonne.

According to the results of geological survey, cited by Griffis and Neilson (6), and most recent and detailed data published in 1977 in the report prepared by Soviet geologist (7) there are in Afghanistan rich deposits of magnesites, located in the vicinity of the village Achin, in the northern foothills of the Spinghar Range, about 72 km. south-east of Jalalabad in the Logar Province. Although first information on Achin magnesites I found in Canadian reports (5-6) the main source of information on magnesite deposits in Afghanistan is the most recent and detailed report issued by Soviet Geologists (7). Both Canadian (6) and Soviet (7) geologists agree that Achin deposits of magnesites can be regarded as large and of great industrial and economic value. Having in mind that data presented by Soviet geologist are more recent and precise, and contain all results of their 3-years survey on Achin deposits the Soviet report (7) can be regarded as the main bese in assesment of the feasibility of creation of refractories industry in Afghanistan.

Achin deposits of magnesite, accompanied by minor admixture of talc, are estimated on 66,295,000 t. Achin magnesites does not contain iron oxide, however the presence in them of silica (SiO_2) and calcea (CaO) may be regarded, to some extent, as disadvantageous. Silica bearing mineral is talc whereas for the presence of calcea some admixture of dolomite is responsible. Both unwanted minerals can be however removed by selection or by flotation.

Magnesite is very important raw material for the production of basic refractories and 90% of the world output, which amounts to about 12 mil. tons/year, is used for the purpose of refractories industry.

Technical evaluation of Achin deposits has indicated that the mining of magnesite should be very seriously taken into account. The access to the deposits is easy. Mining could be carried out by open pit method and for the preparation of the first, simple stage of mining only small means are necessary. From the main road Kabul-Jalalabad (at Tor-Kham) there is unpaved road, (about 30 km.) accesible during the whole year to Achin deposits. The distance by road from Achin to Jalalabad is 70 km, and to Kabul 220 km.

Achin magnesites are not monomineral but contain admixtures of talc and dolomite. Minerological investigations showed that two varieties of magnesite can be distinguished:

I. Coarse and medium grained magnesites, with low content of talc containing:

Magnesite	97-99.5%
Talc	0.3-2.5%
Dolomite	0.2-1.0%
Calcite	0.1-0.2%

II. Coarse grained magnesites, containing considerable amount of talc, dolomite and fine grained magnesite:

Magnesite	80-90%
Talc	10-15%
Dolomite	4-2%
Calcite	0.3-0.5%

Chemical composition of the ore, for samples containing more than 40% MgO varied within the following limits: MgO 40.01-47.12% (av. 43.86%), SiO_2 0.10-25.00% (av. 5.38%), CaO 0.10-8.10% (av. 2.58%), R_2O_3 0.10-0.93% (av- 0.87%), parts insoluble in HCl 0.97-37.84% (av. 8.03%). The full chemical analysis of 12 representative samples is as follows (7):

Components	Minimum Content %	Maximum Content %	Average %
SiO_2	1.30	8.54	3.40
CaO	0.35	2.10	1.12
MgO	44.10	47.37	45.46
Al_2O_3	0.10	1.25	0.45
Fe_2O_3	0.05	0.39	0.15
FeO	0.07	0.37	0.14
TiO_2	0.01	0.06	0.01
P_2O_5	0.04	0.23	0.12
MnO	0.03	0.08	0.04
Loss on ignition	44.54	51.00	48.74
SO_3	0.08	0.35	0.21
Na_2O	0.04	0.04	0.04
K_2O	0.04	0.04	0.04

Average density is 2.93 t/m^3. The chemical analysis of 456 samples has indicated that considerable amount of them (90%) contain more than 40% MgO, and that content of CaO is less than 6.0% and SiO_2 less than 8.2%. Some parts of deposit (about 60% of the volume) are even of better quality and they contain over 44% MgO, less than 2.5% CaO, and less than 4.3% SiO_2.

The mined ore can be easily manually selected and enriched in pure magnesite. For example manual selection of ore containing 42.68-45.23% MgO, 1.94-2.40% SiO_2 and 0.35-2.45% CaO yielded 71.5-86.0% of concentrate, containing 44.96-45.36% MgO, 1.94-2.40% SiO_2, and 0.35-1.40%. The quality of concentrate fully matches the standards for the raw materials for refractories industry. As the result of enriching by flotation two concentrates can be obtained: magnesite concentrate and talc concentrate, i.e. that almost the whole ore can be utilized.

For the estimation of reserves Russian geologists assumed (7) that: a) only the ore containing over 40% MgO should be taken into account, b) minimal thickness of magnesite layers should exceed 2 m, c) maximal thickness of dolomite and talc interlayers should not exceed 2 m.

The final estimation of reserves:

Reserves Thousands of tons	MgO	Content %			
		SiO_2	CaO	R_2O_3	Insoluble in HCl
66,290.5	43.87	5.33	2.59	0.87	8.26

If we assume that from that reserves we could obtain at least 75% of magnesite concentrate (I do not take into account talc concentrate, which is of minor importance), containing 45% of MgO and further we calcine that concentrate, we could obtain about 25,000,000 tons of "dead burned magnesite". If we further assume, that the price for that product would be between 150-200 US dollars/ton it means, that the value of the Achin deposits after processing them only into "dead burned magnesite" should be at least 3,700-5,000 mil. US dollars.

According to the mentioned report (7) there are indications that in Paktia province also large occurences of magnesites exist, similar to the Achin deposits.

To have definite opinion of the technical value of Achin magnesites the detailed technological investigations of them are necessary, and especially determination of sintering properties and thermomechanical properties of refractory bricks made of them.

2.2.3 Other raw materials for refractories industry.

2.2.3.1 Chrome ores (chromites)

Among varieties of basic refractories, for which the main component is magnesium oxide, considerable role play the so called "chrome-magnesite" refractories, i.e. refractories made from dead burned magnesite with some addition of chrome ore.

Logar Valley deposits of chrome ores have been known for almost 20 years (5,6). They are suitable for manufacture of refractories. However mining them is more complex problem. As the main user of chrome ores is metallurgical industry it should be expected that mining Logar chrome ores will start in the future, either when domestic metallurgical industry is developed or when export possibilities will justify it. I estimate, that for the manufacture of chrome magnesite refractories not more than 10-20% of chrome ore in comparison with the used quantity of magnesite will be necessary. Thus, this quantity can be transported directly to the future refractories plant. The price of refractory grade chromite (30-44% Cr_2O_3) in 1975 was about 15-25 US dollars (it is only about 1/10 of the price of dead burned magnesite).

2.2.3.2 Bauxites:

Good bauxites can be regarded as a source of alumina (Al_2O_3) for the manufacture of higher quality alumosilicate refractories (high alumina refractories).

Deposits of bauxites in Afghanistan have been surveyed and described by Japanese geologists (9). According to their information and information obtained from the head of Soviet geological team Mr. Zaytsev the surveyed deposits of bauxites in Afghanistan can not be taken into account as a source of raw material for refractories industry for many reasons, and among them because of their poor quality.

2.2.3.3 Quarzites:

Quarzites serve as a raw material for manufacture of so called "acid refractories" or "dinas refractories". They are applied mainly for lining ovens in coke industry and to some extent in glass industry. Their application is rather limited.

Unfortunately, only deposits of siliceous sand-stones have been found in Afghanistan (2). One of them is at Farkhar in Takhar Province, where two sand-stone beds, 1.2-8.0 km long and 50-120 m thick, assaying 95.0-97.3% SiO_2, were found. Another one, at Hajigak, in Bamyan Province, with speculative reserves of 650,000 tonnes, containing 93.66-97.31% SiO_2, were found. Unfortunately the mentioned deposits are not homogenous, and according to the results of the investigations of the technological properties of two samples of Hajigak sand-stone (10) they are suitable only for manufacture of lower grade dinas refractories.

For the mentioned reason and because there is no demand on this kind of refractory materials in the country they will not be taken into account in my report.

2.2.3.4 Dolomites:

Dolomitic refractories, because of their peculiar properties have only limited application, mainly in steel industry. There are plenty of deposits of dolomites in the world. Thus, they should not be considered as the object of international trade. It can be expected that in the future, when the steel plant is erected, they may find some application in Afghanistan.

2.2.3.5 Short summary on the availability and suitability of domestic raw materials for manufacture of refractories in Afghanistan.

Among deposits of many raw materials there have been up to now found and surveyed deposits of great importance for future refractories industry in Afghanistan: first of all large deposits of magnesites, and of secondary importance (from the point of view of their application for manufacture of refractories), chromites. It is highly advisable to start as soon as possible mining magnesites, burning them to obtain "dead burned magnesite" partly for export and partly for domestic use.

2.3 <u>On technical possibility of adaptation of existing plant to manufacture of refractories</u>.

There exist in Kabul Ceramic Factory, which may be interisting from the point of view of adapting it to the purpose of refractories industry. I met General Director of that factory Dipl. Eng. Abdul Rahman Qazi Khani, and also able and well oriented in ceramic technology (trained in Japan) Mr. Mir Hamza, as well as Mr. Abdul Aziz Amarkhail. The small ceramic factory started its work 22 years ago, designed and equipped by Japanese specialists. The products of the factory are mainly china ware and electrical insulators, as well as small quantity of low quality fireclay bricks (refractories!). Their annual output of fireclay bricks is around 20,000 pieces = 68 tones. For the manufacture of fireclay bricks low grade kaolins and fireclay from Tolokhan and Tala Barfak are used. The manufactured bricks because of their very poor quality have limited application, and are used for lining stoves, e.g. for steam boilers and in other instalations, where temperature do not exceed 1200°C.

There is in the factory equipment suitable for manufacture of refractory fireclay bricks of higher grade, if factory is provided with better raw materials than up to now. There are 3 friction presses, and 2 chamber furnaces of 25 m^3 volume, fired by means of oil burners. It is only a matter of rising temperature of firing from recent 1250°C to at least 1350°C, and of course adopting better technology. If necessary, there is also a place to extend the factory. There is still only a problem of finding deposits of proper fireclays in Afghanistan, to provide factory with good quality raw material.

2.4 Problems of research and training (specialization) in the field of refractory ceramics

To find people who might be connected with general problems of ceramic technology, as well as equipment suitable to carry out some research and testing in this field I visited Chemical and Minerological Laboratory at the Ministry of Mines and Industries, Polytechnic Institute and University in Kabul. Unfortunately, I could not find any specialist in technology of ceramic materials (refractories technology may be regarded as a part of general technology of ceramics).

Chemical and Minerological Laboratory in the Ministry of Mines and Industries (President of Geological Survey Dr. Mohammad Tahir Gerowal) is well equipped for chemical and petrographic analysis. However, in my opinion it should be provided in equipment for DTA and TG analysis, as well as in X-ray diffraction to enable them carrying out full routine mineralogical analysis of all rocks. They also should be provided with high temperature laboratory furnaces (up to 1400-1650°C), to enable them some simple experiements connected with high temperature changes of some raw materials.

In my opinion, the Laboratory is ready to carry out chemical and minerological analysis of refractories and their raw materials.

During my visit at Polytechnic Institute and talk with the President of the Institute I found that they are involved in ceramic problems only to small extent. At the Faculty of Engineering (Dr. Mohamad Din) only some research has been done on application of ceramic materials as building materials. I proposed to the President to start as soon as possible training students at the Dept. of Chemistary in general technology of ceramic materials (including technology of refractories) as part of the specialization in inorganic technology. As an example for that I mentioned section of Ceramic Building Materials at the Institute of Inorganic Technology at the Technical University in Gdansk, where I give lectures and do research in this field.

My visit at Kabul University gave even less interesting results. I found that only Dept. of Civil Engineering is well equipped for testing ready made ceramic materials, i.e. from the point of view of their application (e.g. testing machines for crashing strength measurements).

From the results of the above mentioned visits one can conclude that no educational and research institution in Afghanistan has been up to now concerned with technology of ceramics, and that there is urgent need to start as soon as possible organizing at least proper specialization at the Dept. of Chemical Technology of the Polytechnic Institute in Kabul.

During my talks with many people in the Ministry of Mines and Industries, at Polytechnic Institute and at the Kabul University I have found one person who, in my opinion, can be trained in technology of general ceramics, including technology of refractory ceramics. He is Mr. Ghulam Farouq Delawar (Dipl. Chem. Eng.) from the Dept. of Technique of the Ministry of Mines and Industries. He has completed studies in inorganic chemical technology at the Dept. of Chemistry of the Technical University in Cracov, Poland. He can obtain the proposed specialization during 10-11 months training, according to the programme carried out at the specialization of Technology of Building Materials at the Institute of Inorganic Chemistry and Technology, Faculty of Chemistry of the Technical University in Gdansk, Poland. He understands, speaks and writes Polish without difficulty.

I am grateful to my counterpart Dr. Aini (geologist) for his assistance during my work. His energy and acquaintances helped me greatly in my difficult job. I should acknowledge also the assistance of other counterpart Mr. Ghulam Mohammad Alefi (economist), who helped me during first days of my assignement.

3. Recommendations

3.1 Mining of Achin magnesites should be put into the current 5-year plan. Yearly output of magnesite should be adjusted rather to export possibilities than to internal requirement, which is not high. There is rising demand on magnesite in the world. Therefore no difficulty could be expected with exporting it. The mine of magnesite in Achin should be connected with necessary equipment for enriching it and burning at high temperature. It is purposeful that the processes of enrichment and burning should be done in Achin. Technical and economic reasons justify such solution. If we assume that in effect of enrichment we obtain 750 kg of concentrate from 1,000 kg of ore and calcining it yealds in about 350 kg of dead burned magnesite it means, that from each ton of mined magnesite we obtain about 1/3 of "dead burned" magnesite and consequently, both operations i.e. enriching and burning should be performed near the future mine. To manufacture of 1 ton of dead burned magnesite 200 kg of oil or about 450 kg of coal are necessary. It means that from economical point of view it is purposeful to transport even 500 kg of coal to Achin, than 2000 kg of magnesite to be enriched to the place where coal or oil are available. The value of dead burned 98% magnesite at the end of 1975 was about 250 US dollars/ton.

Concluding my first recommendation I understand, that the first step to erect refractories industry in Afghanistan should be mining and processing of magnesite deposits at Achin, as soon as possible. The processing plant should be as close as possible to the mine. Processing of magnesite should be performed in three stages: 1) manual separation of magnesite from dolomite, 2) flotation of magnesites contaminated with talc, 3) dead burning of magnesite concentrates obtained in the first and second operations.

At the beginning the whole production of dead burned magnesite should be exported. For one ton of "dead burned" magnesite one can buy 1-2 tons of ready made fireclay or high alumina bricks or shapes or 0.5-1 ton of magnesite or chrome-magnesite refractories (addressed to Afghan Govt./UNDP/UNIDO).

3.2 Second step in development of refractories industry in Afghanistan should be erection of plant manufacturing basic refractories, namely magnesite and chromemagnesite refractories. It should be erected not earlier than mining of chrome ores strats in Logar Region and when first steps in development of domestic steel industry are taken. The location of the plant should be close to the main users of basic refractories, i.e. steel and copper industries. There are indioations, that "heavy industry" will be developed most probably in the northern region of Afghanistan, where deposits of fuel are available. The alternative is Kabul Region, which is not far from the deposits of iron and chrome. If we join northern region of Afghanistan and Aohin with a streight line we can find that region of Kabul is also on this line. Of course in this all predictions and assumptions one very important factor should be taken into account: terrain difficulties. The output of the proposed plant should be at least 5,000 tons/year (or more, if domestic requirement and export possibilities justify it), (Afgh. Govt./UNDP/UNIDO).

3.3 Intensive geological survey should be carried out first of all from the point of view of finding high quality fireclays and kaolins for manufacture of alumosilicate refractories (Afgh. Govt./UNDP/UNIDO).

3.4 It is impossible even to imagine the development of refractories industry without having specialists. First of all some people with technical university education should be as soon as possible trained in technology of building ceramics including refractory ceramics. I recomend to train Mr. Ghulam Farouq Delawar (dipl. chem. eng.) from the Dept. of Technique of the Ministry of Mines and Industries. He completed his studies at the Dept. of Chemical Technology (Inorganic Technology) of the Technical University in Cracov (Poland) and I have found very advisable for him to take specialization "Technology of Mineral Building Materials" (with the technology of Refractory Materials) at the Institute of Inorganic Chemistry and Technology at the Faculty of Chemistry of the Technical University in Gdansk (Poland), where lectures are given on this subject. There is also intensive laboratory, technological and in-plant training, as well as scientific and technological research in this field. The programme, joining both training in the technology of mineral building materials (including geology and minerology, processing of minerals, testing of raw materials and products, technology of general and refractory ceramics), as well as in refractory materials is unique, and is adapted to educate specialists who can work both in building industry and in other ceramic industries (e.g. glass industry, refractories industry etc.). The necessary time to obtain specialization should be 11 months (including in-plant training).

Two or three young people should be sent as soon as possible to study at a technical university (e.g. at the Technical University in Gdansk) in full programme (4 1/2 years studies) to obtain M.Sc. diplomas in the above mentioned specialization and first of all knowledge and experience for future work in technology of manufacture ceramic materials (including technology of refractories).

The programme of studies at the Faculty of Chemistry of the Polytechnic Institute of Kabul should be adapted to the contemporary and future requirement of ceramic industries (e.g. cement and concrete industry, building bricks, refractories industry and application of refractories, glass industry, and porcelain industry as well as others) and the problems of processing minerals and ores in Afghanistan. Again, as a good example of such program I indicate the program of studies in the specialization on Technology of Mineral Building Materials at the Technical University in Gdansk (Poland).

The Chemical and Mineralogical Laboratory at the Ministry of Mines and Industries, as well as some laboratories at the Polytechnic Institute should be adapted to carry out some routine and special methods of testing ceramic materials, and among them refractory materials. It is also time to prepare program of research on processing of some domestic nonmetalic ores. (Afgh. Govt./UNDP/UNIDO).

3.5 I find it advisable to come to Afghanistan in the nearest future (in 1979) for the period of 2-3 months to help on :

a) solving technological problems connected with processing of Achin magnesites to "dead burned" magnesite,

b) solving technological problems connected with processing of chromite ores to chromemagnesite klinker,

c) preparing program of studies with the specialization of the Technology of General Ceramics with the Technology of Refractory Materials at the Polytechnic Institute in Kabul or Kabul University,

d) adapting the Laboratory at the Ministry of Mines and Industries to carry out some routine and special methods of testing ceramic (and among them refractory ceramic) materials,

e) preparing program of research on processing some domestic monmetalic ores to ceramic and refractory materials.

In fulfilling my duty very helpful is my knowledge of English, Russian, and German. (Afgh. Govt./UNDP/UNIDO).

3.6 It is necessary to organize a small section in the Ministry of Mines and Industries (1-2 specialist) who will be concerned with all problems of refractories. They should be well oriented in the demand on refractories in the country, on deposits of raw materials suitable for manufacture of refractories, on future development of industries requiring refractories etc. They should collect all necessary information and data and advice on problems of importing refractories to Afghanistan, (Afgh. Govt./ UNDP).

Annex I

JOB DESCRIPTION

DP/AFG/72/003/11-06/C/31.6.A

POST TITLE	Refractory Brick Expert
DURATION	Two months
DATE REQUIRED	April 1978
DUTY STATION	Kabul; with travel within the country.
PURPOSE OF PROJECT	To assist the Government in preparing an assessment on the development of refractory brick industry.

DUTIES

The expert will be a member of an international team of experts and will work under the supervision of the Project Co-Ordinator - Industrial Services Project, Ministry of Mines and Industries. Specifically the expert will be expected to:

1. Assist and advise in collecting information for the elaboration of techno-economic feasibility study on raw materials such as clays, kaolin, bauxite, magnesite and dolomite in the country and its suitability for production of refractory bricks necessary for cement, iron smelting and metal working industries.

2. Prepare a survey of the prementioned raw materials, its geology, reserves, physical and chemical properties to suit the refractory brick industry.

3. Prepare a complete market analysis of the existing cement plants requirements of refractory bricks and forecast the requirements of cement, iron smelting and metal working industries over the next ten years.

The expert will also be expected to prepare a final report, setting out the findings of his mission and his recommendations to the Government on further actions which might be taken.

QUALIFICATIONS	Expert in Geochemistry with relevant experience in cement industry.
LANGUAGE	English

BACKGROUND INFORMATION

The country has two existing cement plants, at Ghori and a small facility at Gebel-Siraj. The capacity of the two plants amounts to 175,000 tons per year. A third factory is under construction in Herat and is expected to produce 210,000 tons per year as from 1980. A fourth cement factory is under cohsideration to be situated in Kandahar with a capacity of 500,000 tons per year. The Seven Year Plan has attached considerable importance to construct iron smelting and metal works industries.

Annex II

LOCATION OF RAW MATERIAL DEPOSITS AND OF HEAVY INDUSTRY REQUIRING REFRACTORIES

Fig. 1 Location of main deposits and plants

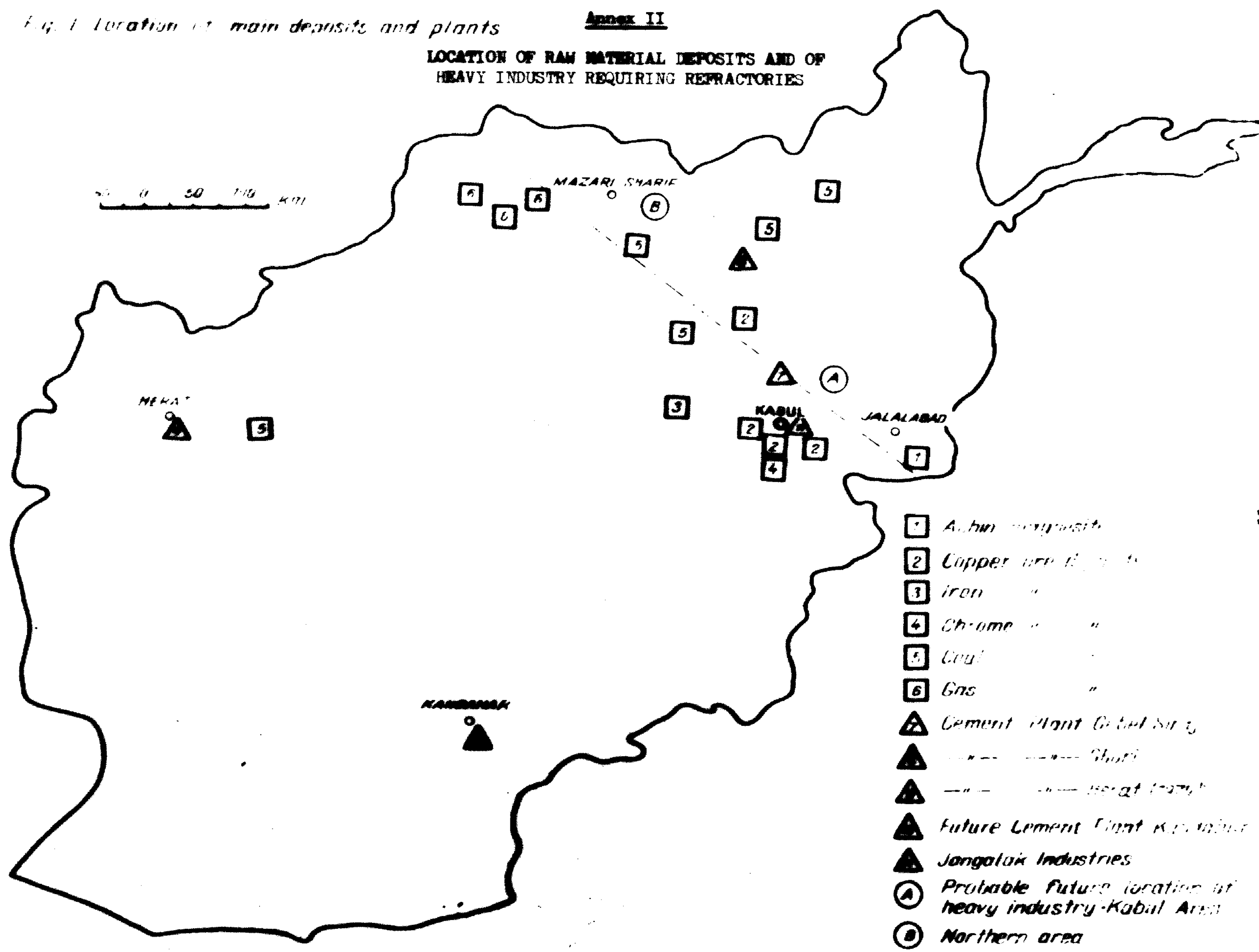


Fig. ... variant I
Location of heavy industry and requirement on basic refractories.

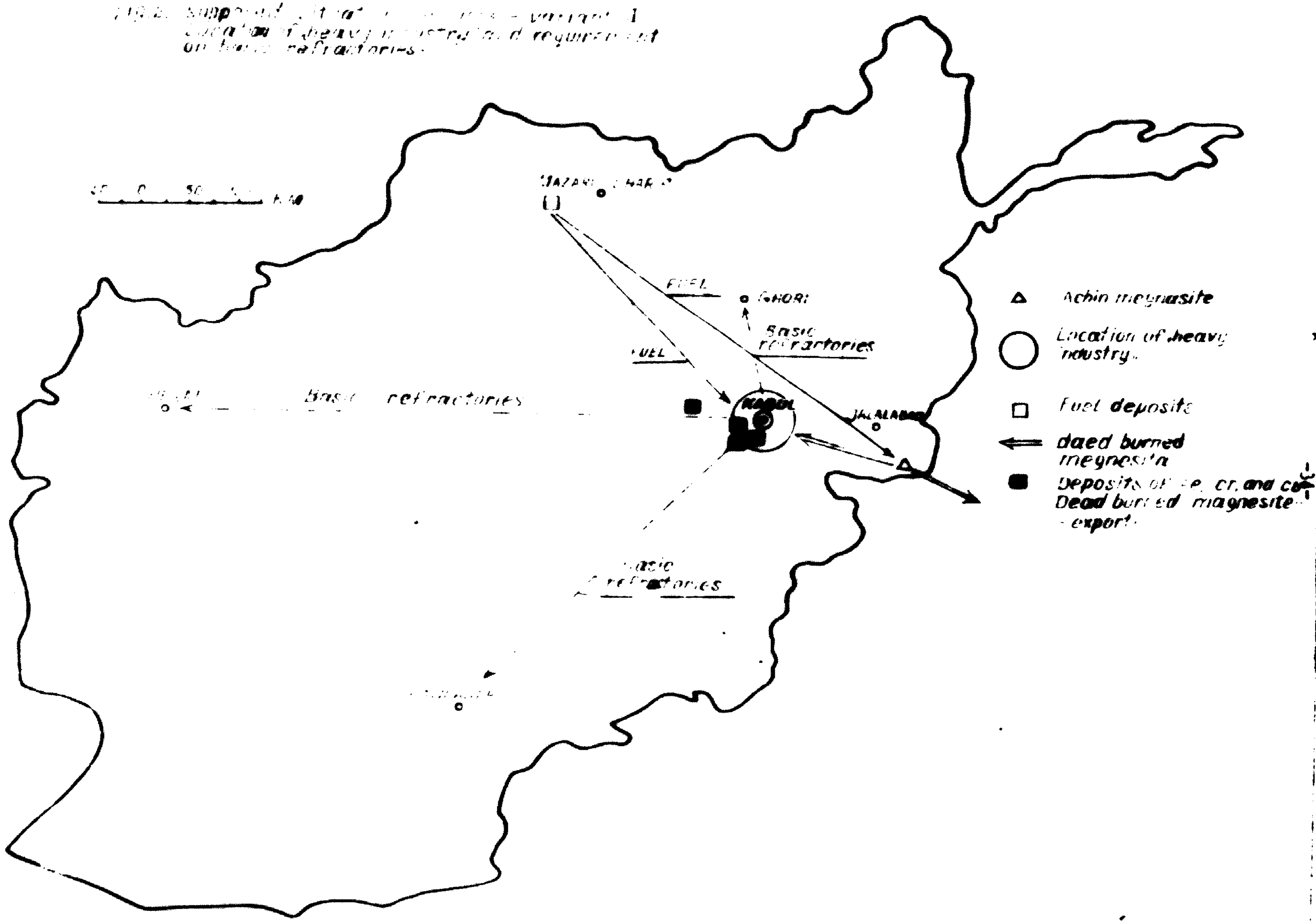
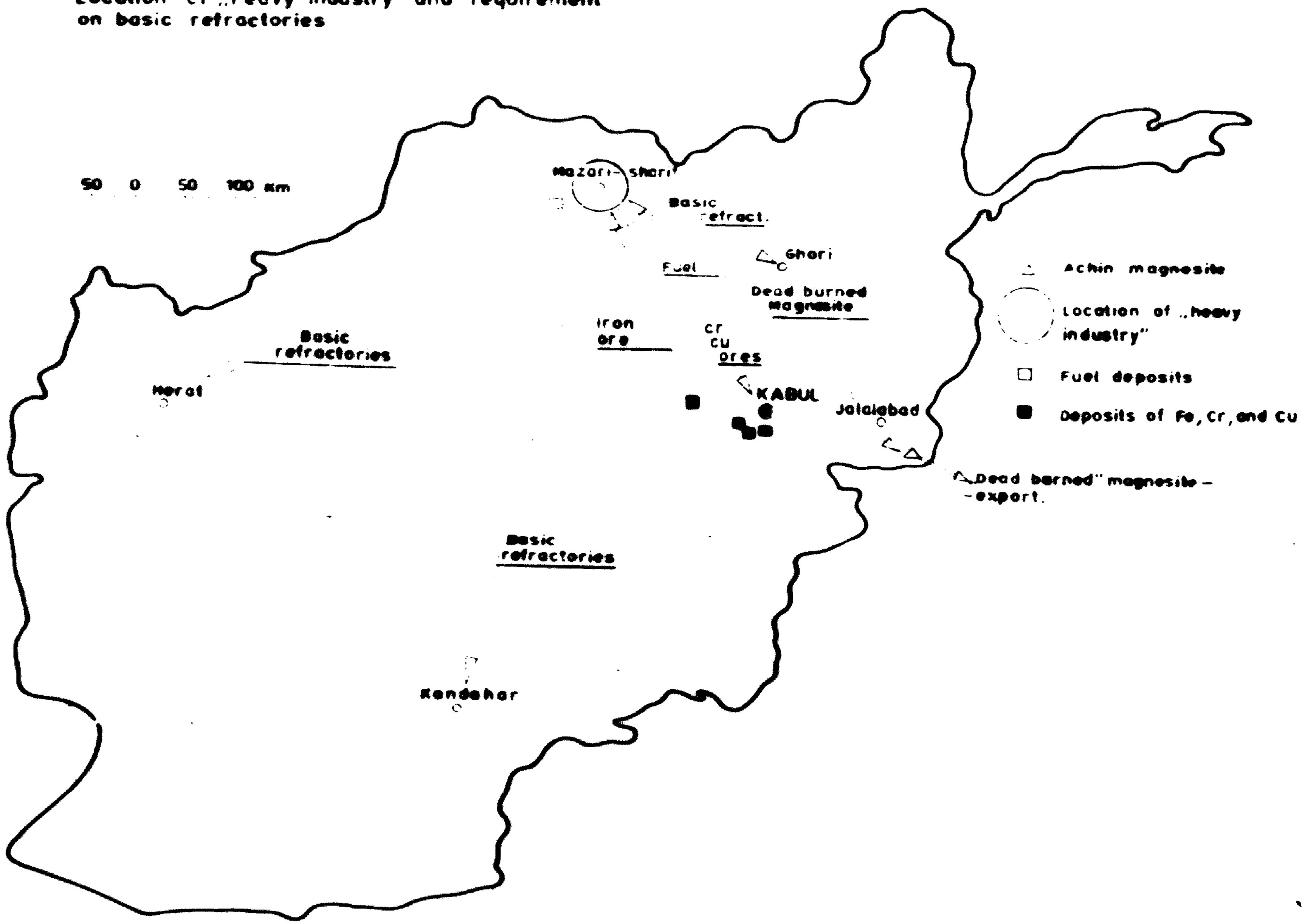
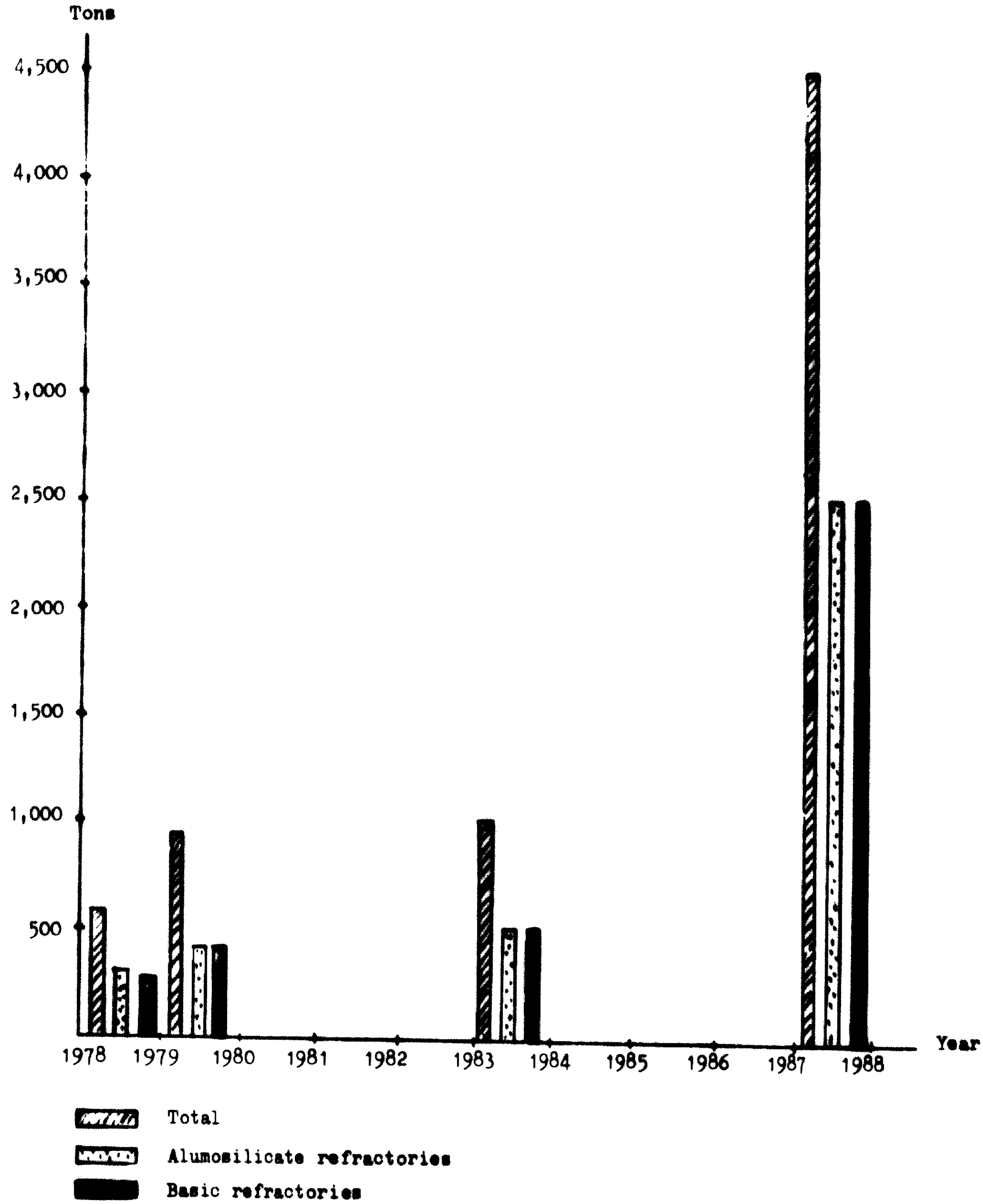


Fig.3 Supposed situation in 1988-variant II
Location of „heavy industry" and requirement
on basic refractories



Annex III

ESTIMATED REQUIREMENT OF REFRACTORIES, 1978-1988



Annex IV

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We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.

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