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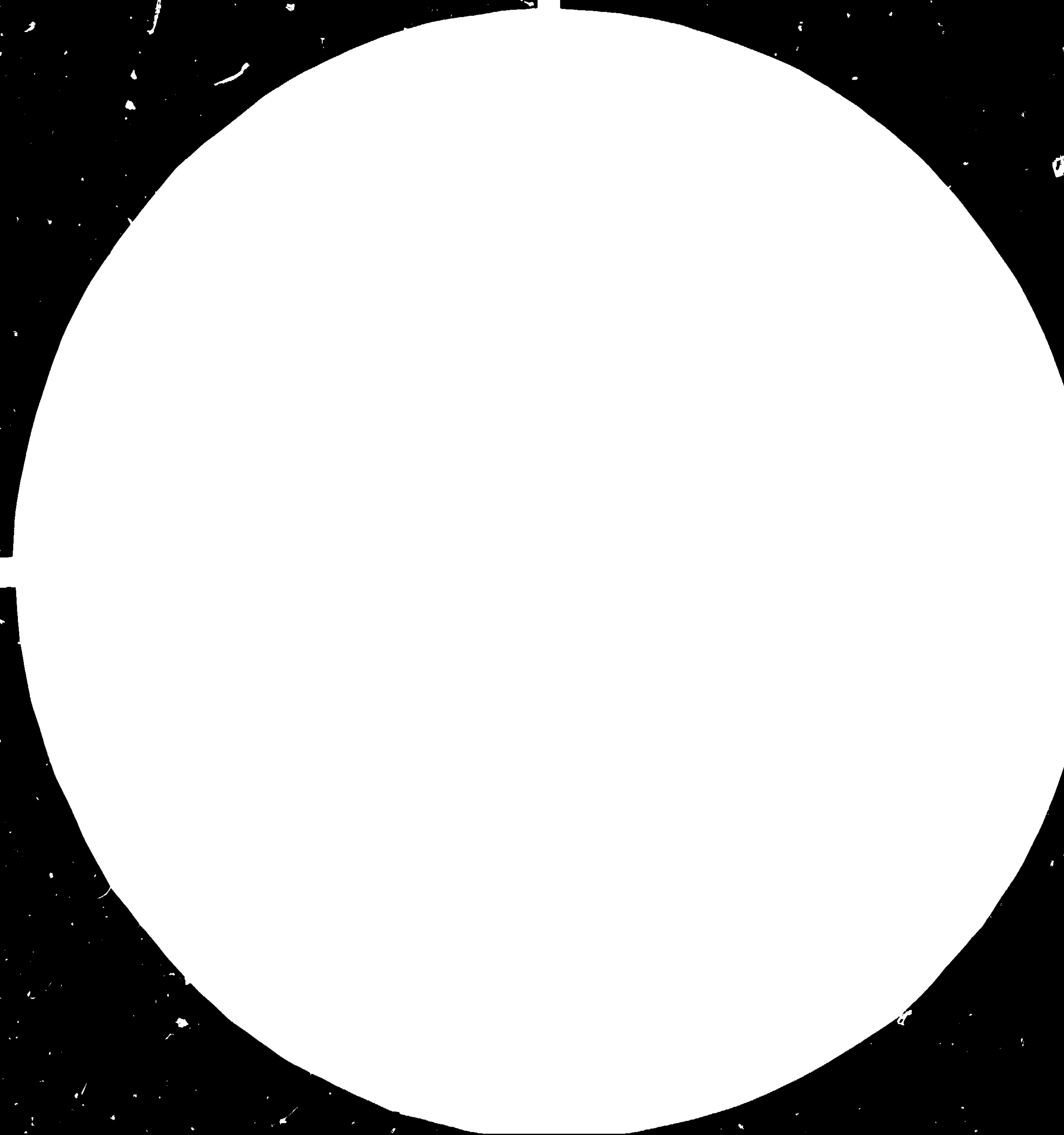

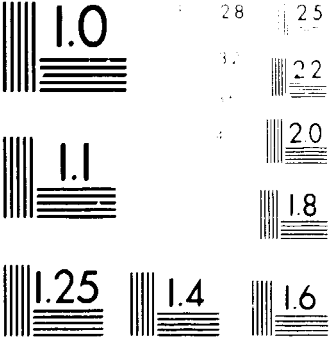
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22. October 1984
English

DEVELOPMENT OF A BASIC INDUSTRY
FOR THE PRODUCTION OF ALUMINA
FROM INDIGENOUS ALUMINOFERROUS ORES
STARTING WITH ALUNITE

14213

DP/IRA/84/002/11-01

ISLAMIC REPUBLIC OF IRAN.

Technical report: Application of industrial scale technology for processing aluminoferrous ores. - Establishment of the alumina raw materials testing LABORATORY

Prepared for the Government of the Islamic Republic of Iran
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Dr. Karoly SOLYMAR, consultant
in processing of aluminoferrous ores

United Nations Industrial Development Organization, Vienna, Austria

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

from:
Ms. G. Synek

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ABSTRACT

The consultant's activity reported in the followings has been connected with the project: "Development of a Basic Industry for the production of alumina from indigeneous aluminoferrous ores, starting with alunite", DP/IRA/84/002/11-01, and it is dealing with the following main subjects:

- Design and application of industrial scale technology for processing aluminoferrous ores;
- Establishment of a laboratory for testing and investigation of alumina raw materials.

The objective of the project is to produce alumina by processing domestic alunite and bauxite reserves for the utilization of the aluminium smelters in Iran. In order to attain this objective, the Ministry of Mines and Metals has set up an "Aluminium Raw Materials Programme" /ARMP/ which involves the geological prospecting and mining activities, the selection of the required samples, the establishment of a testing laboratory, and contracting feasibility studies for the production of alumina from aluminoferrous ores /starting with alunite/.

The consultant's activity extended for a 3 weeks' period only and he was working for 2 weeks /between 25 July and 8 August 1984/ in Iran, in close cooperation with ARMP /managed by M. Shehriari/ and with the consultant on materials testing /Dr. Conrad Douglas/. The consultant had the opportunity to discuss the ARMP in details with the Resident Representative of UNDP Mr. Snigh and his assistants too, and to pay visits to the ore deposit areas of bauxite and alunite.

The main conclusions and recommendations can be summarized as follows:

Considering the present conditions of the project it can be confirmed that the ARMP is in satisfactory progress. It is recommended, however, to pay more attention to bauxite prospecting and processing as real alternatives of the alunite program, moreover, to extend the assistance of UNIDO in purchasing the equipment for the testing labo-

ratory demanding hard curency; to organize the transfer of technology on materials testing /software/ and the related training programs for the staff members of ARMP.

Please consider that the present report and the report of the consultant on materials testing /Dr. C. Douglas/ have a complementary character of one another, therefore, it is recommended to study them together.

RECOMMENDATIONS

1. It is recommended to elaborate a feasibility study for processing bauxite parallelly with the feasibility study relating to the alunite processing, in order to decide the priority of setting up an industrial scale alumina plant.

2. The modified Bayer-process is recommended for processing diasporic-chamositic Iranian bauxites, characterized by the use of special catalytic additive, two-stage digestion /simultaneous processing of diasporic and boehmitic or gibbsitic ores/, intensive caustic soda regeneration. By the optimum selection of the digestion parameters, the chamosite remains more or les[illegible] active.

3. The establishment of the Aluminium Raw Materials Testing Laboratory is fully justified. UNIDO's assistance in the procurement and purchase of instruments and equipment which require hard currency is highly recommended.

4. For the main partner institutions VAMI /alunite processing/, the Jamaican Bauxite Institute /laboratory and pilot plant/ and ALUTERV--FKI /bauxit processing and transfer of technology for laboratory investigations/ are recommended.

5. Further detailed recommendations can be found in <u>Annex No.4</u> which was elaborated in cooperation with the UNIDO-consultant in materials testing /Dr. C. Douglas/.

Budapest, 22th October, 1984.

Dr. Karoly Solymar
UNIDO consultant in
processing aluminoferrous ores

INTRODUCTION

The aluminium consumption of Iran is about 120.000 tons per year actually, however, Iran's alumina requirements are likely to reach 600.000 to 2000.000 tons per year by the early 1990-ies, requiring foreign exchange expenditures of about US$ 200 million per year for its import. The Government of the Islamic Republic of Iran, therefore, has realized the utmost importance and urgency of the problem and now they give support and emphasis to the production of alumina within the country, out of their own alunite and bauxite reserves.

The explored reserves of alunitic ore located and geologically investigated in the north-western region of Iran amount to about 100 million tons and that of the estimated reserves to another 250 million tons, with an alunite content of 35-75 per cent /Al_2O_3 content is about 25 per cent on average/. This ore is suitable to be processed to alumina, sulphuric acid and potassium sulphate as fertilizer. The residue of high silica content originating in the process can be utilized for the production of building materials and heavy ceramics. Considering the possibilities of the utilization of the byproducts /H_2SO_4, K_2SO_4/ the maximum capacity of the plant can reach 200.000 tons per year of alumina. Considering the fact that the only plant in operation for processing alunite is located in the USSR and is based on the technology developed in the Institute of VAMI /Leningrad/, the feasibility study for processing Iranian alunitic ore will be prepared by this institute. The technology to be applied is the so-called "reducing-roasting" process. The construction of an industrial scale plant for processing alunitic ores is expected to be realized by the end of this decade.

Subsequently, the bauxite reserves would have to be exploited in order to meet the increasing alumina requirement of the country. According to the latest results of bauxite prospecting, the bauxite reserves in the north-eastern region of Iren amount to about 70-80 million tons. The quality of these reserves altogether is relatively low grade, due to the high silica content of the diasporic ore, however, the silica is mostly combined with the non-reactive chamosite and this mineralogical feature of the bauxite allows us to digest it by the Bayer process at an adequate caustic soda consumption. The recommended technology will be discussed in details in the report.

As a third raw material for alumina production, the alumosilicates with a silica content higher then 50 per cent can be taken into account. It seems to be justified already that this raw material is preferable to alumina for the production of ceramics and building materials, however, a comparative evaluation of this material form the aspect of alumina and cement production /by the self-desintegrating slag formation/ is also recommended.

The Ministry of Mines and Metals has set up an "Aluminium Raw Materials Management" /ARMP/ in 1981 with the following main activities:

a./ continuation of the necessary geological and mining work for producing the required samples of aluminoferrous ores;

b./ establishment of a testing laboratory;

c./ contracting feasibility studies for the production of alumina from aluminoferrous ores /alunite, bauxite and aluminosilicates, starting with alunite/;

d./ setting up alumina plants depending on the evaluations of the feasibility studies.

In order to carry out this tasks, the ARMP has been authorized to recruit the necessary technical staff and has been provided with the initial funds required for the construction of the laboratory and for the realization of its program. The laboratory facilities will be located on land possessed by the Ministry of Mines and Metals at Karadj, some 37 km from Teheran.

The activity of the consultant has been organized with great care by the project manager, Mr. Mohammad Shahriari and his colleauges involved in the ARMP. He visited some bauxite and alunite deposits /during 3 days of his staying there/ and had the opportunity to discuss the present conditions of the project in details with the ARMP personnel and with the representatives of two Iranian Consulting Firms responsible for the construction and utilities of the laboratory facilities.

The duration of the consultancy has been extended for 3 weeks /from 22 July until 11 August/, including briefing/debriefing and travels. The program of the consultant's activity is enclosed in Annex No.1.

The consultant had been engaged in the following tasks, according to the job description:

a./ Advise ARMP on the design and application of industrial scale technology for processing aluminoferrous ores;

b./ Investigate and evaluate the necessary conditions and requirements justifying the establishment of a laboratory for testing and investigation of alumina raw materials;

c./ Advise the partner organization on the design, construction and operation of the testing laboratory;

d./ Prepare a report containing conclusions and recommendations on the next action to be taken regarding the establishment of the alumina raw materials testing laboratory.

The senior partner staff - their name and specialization can be found in Annex No.2. In collaboration with the consultant on raw materials testing /Dr. Conrad Douglas/ and staff members of the ARMP, the questions concerning the equipment selection, installation, commissioning, semising and maintenance were discussed. The training requirements for the effective utilization of the laboratory facilities were also discussed and some recommendations were also made concerning the implementation of both local and overseas training.

I. DESIGN AND APPLICATION OF INDUSTRIAL SCALE TECHNOLOGY FOR PROCESSING ALUMINOFERROUS ORES

The AEMP is dealing with all of the three aluminoferrous raw materials:

- alunite /alunitic ore/,
- bauxite,
- alumosilicate,

in order to evaluate the conditions of their processing into alumina. Considering the peculiarities of the raw materials and the different technologies suitable for their processing, the reasonable alternatives for each raw material will be discussed separately. The recommended technology /-ies/ will be selected and discussed analysing the raw material characteristics /especially the chemical and mineralogical composition/ and recommendations will be given relating to the partner institutions and the follow-up actions to be taken. The main conclusions concerning the whole activity and priorities will be summarised in the last section of this chapter.

A. Alunitic ore

The Geological Survey of Iran /GSI/ estimates the resources of alunitic ores of more than 30 per cent of alunite content up to 602 million tons. According to the calculations of ALUMIRAN and MADANKAV /subcontractor of ALUMIRAN/ based on the same data and regarding a cut-off at 35 per cent Al_2O_3 content of the ore, the estimated resources reach 340 million tons. These data and the huge resources can justify the processing of alunitic ore. According to the conclusions drawn by the UNIDO consultants-geologists /Dr. E. Mack and Dr. I. Vörös/, the alunite resources belong to category R-3 relating to the UN classification. /"Undiscovered in situ resources that might exist based on geological extrapolation. R-3 indicate exploration opportunities, quantities known in ranges."/ The consultants-geologists recommended, therefore, "an extensive prospecting and exploration campaigne to permit a final decision for the optimum selection of the deposit, followed by mining exploration for computing a representative sample. The required time would be

2-3 years." The optimum selection of the deposit has a definitive importance relating to the economy of the processing. The priority of the processing of alunite or bauxite can be decided only after the completion of the Feasibility Studies for both raw materials and these studies must be based on the processing of the relatively best quality "representative" raw materials.

The composition of the alunite mineral can be characterised by the following formula:

$$/(K_2AlO_6)(OH)_{12}/ \cdot (SO_4)_4$$

where K may be substituted by the elements of Na, Sr, Pb, Ag, Y, Ce or other rare earth elements and Al^{3+} may be substituted by Fe^{3+}.

The alunitic ore containing 50 per cent or more alunite mineral can be considered as a raw material for complex processing. The only plant in operation all over the world is located in Kirovobad /USSR/ and its technology has been developed by the Institute of VAMI /Leningrad/. There are two variants of the complex processing, namely, the "roasting-reduction technology" and the direct leaching technology by ammonium-sulphate.

The latest development is the reducing-roasting method which has been applied in the Kirovobad plant instead of direct leaching. The foreign trade company VIO LICENSINTORG offers licenses for both methods developed in the USSR by the Institute VAMI.

The first method /the latest development/ effects the thermal reduction of alunite in special fluidized bed calciner and enables to produce high quality Al_2O_3 and byproducts such as K_2SO_4, H_2SO_4 V_2O_5 and Ga. The layout of this complex process is demonstrated in Fig 1.

The residue /dumped slurry/ can be used as building material.

The theoretical background and the process stages of both complex technologies are discussed in section XX. "complex processing of alunites" of the technical book "Alumina production" /in Russian, Publisher: Metallurgizdat Moscow, 1978, Authors: A.I. Lainer, N.I. Eremin, Ju.A. Lainer, I.Z. Pevzner, pp. 291-307/

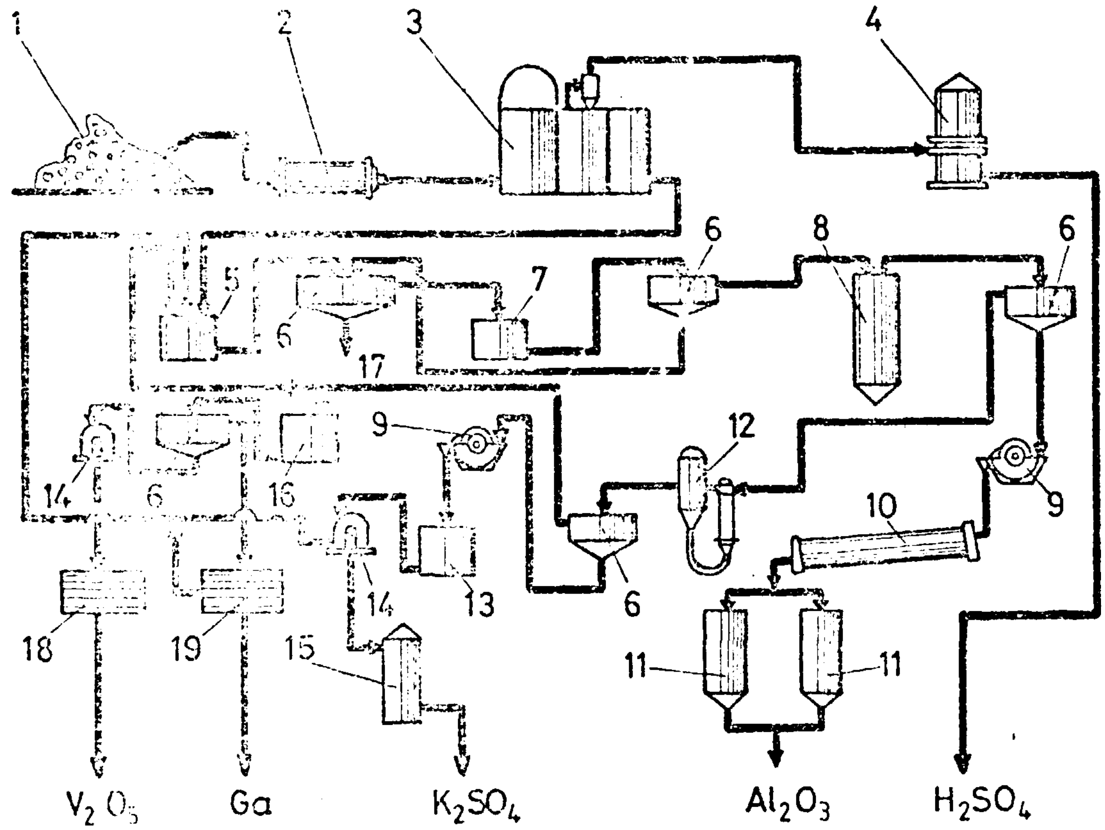


Fig.1 Flow diagram for processing alunite raw materials

1. alunite ore
2. ball mill
3. roasting-reduction apparatus
4. contact apparatus
5. lixiviation mixer
6. thickener
7. desiliconization stirrer
8. decomposer
9. drum filter
10. calcination furnace
11. aluminium oxide silos
12. evaporator
13. conversion reactor
14. centrifuge
15. furnace
16. crystallizer
17. slurry (to be dumped)
18. production of vanadium pentoxide
19. gallium production.

I translated this text from Russian into English for the staff members of ARMP.

The main characteristic data relating to both processes are given in Table 1.

Table 1. Characteristics of the complex processing technologies of alunitic ores developed by Institute VAMI
/calculated for alunitic ore containing 50 per cent alunite producing one ton of Al_2O_3/

Processing method	Roasting reduction	Direct leaching
Consumption:		
Alunitic ore, tons	6.6	6.0
KOH, kg	350	1200
Electric power, kWh	1200	400
Steam of 7 bar Gcal	3.0	3.5
Fuel, kg	600	150
Obtained products:		
Al_2O_3, kg	1000	1000
K_2SO_4, kg	1200	2500
H_2SO_4, kg	900	-
V_2O_5, kg	0.8	0.8
Ga, kg	0.1	0.1

It is recommended to consider both variants for complex processing of the Iranian alunitic ore in the Feasibility Study to be prepared by the Institute VAMI because of the missing sulphuric acid production /less complicated technology/ and much lower energy consumption and relatively simple equipment in the case of direct leaching. The disadvantages of this process are the following: the high consumption of KOH and the economic utilization of the large amount of K_2SO_4 obtained.

Considering the present conditions of prospecting alunitic ores it seems to be very difficult to select the "representative" sample /250 tons/ for the pilot plant investigations to be carried out in the Pilot Plant of VAMI in Leningrad in 1985/86 with the aim to determine the basic data for the Feasibility Study, however, it is reasonable to organize this work as soon as possible. Therefore, a relatively "characteristic" sample can be accepted for this purpose.

The alunite /alunite ore/ can be used not only for alumina production /with its byproducts/ but for a lot of other purposes as well - like sorbents, coagulants, cements, insulators, etc.

The different possibilities of the utilization of alunite are discussed in a technical book published in Russian by the Institute for Chemistry of the Scientific Academy of UZBEK SSR, edited by H.R. Rustskov /Publisher: FAN, Taskent 1981. 192 pages/: "Physical-chemical background of the utilization of alunites".

It is recommended to evaluate the results published in this book comparing them with the results of chemical, mineralogical and texture investigations of some selected characteristic Iranian alunitic ore samples and to prepare a special report for ALUMIRAN. Taking into account the requirement of the knowledge of Russian language and the availability of experiences in material testing, ALUTERV-FKI can be recommended /Budapest, Hungary/ as partner organization for undertaking this task.

Although the flotation is proposed by the Soviet experts for dressing alunitic ore, the simple physical methods may also be successful under given conditions. Consequently, selective grinding and classification /eventual attrition/ can be prferred to carry out the control tests for the beneficiation of Iranian alunitic ore samples. The ore dressing of alunitic ore can economically be adapted during processing.

B. Bauxite

The former investigations detected bauxites in different territories of Iran and some data are available mainly relating to the Kerman, Behbahan, Yazd, Do-Polan and Shiraz deposits. In the last years the prospecting activity organized by ALUMIRAN has been concentrated on the [illegible], Shirin Abadsiah Rudbar and Ganu regions of the Elburz-Mountains. The bauxite resources of the above mentioned regions of the Elburz-Mountains can be estimated to belong to category R-3 of UN classification, from 64 up to 93 million tons based on the data of prospection works completed by the ARMP staff according to the conclusions of UNIDO consultants-geologists.

The bauxite of the Elburz Mountains is mainly of diasporic-chemositic type, similarly to some other Iranian bauxites. There is no information about any bauxite occurence of the same type all over the world. Although there are significant diasporic bauxite resources in Greece, the Soviet Union, China, Rumania, Yugoslavia and Vietnam as well and this type of ore is processed in industrial scale in the first four countries mentioned in the above, however, their chamosite content does not exceed 1-2 per cent and the only chamositic bauxite deposit occurring in the USSR has a boehmitic character. The experiences gained in their processing, however, can be utilized and be more or less adapted to the Iranian diasporic-chamositic bauxite.

Chamosite is an alumosilicate containing Fe^{2+} and Fe^{3+} in an octahedron bed /berthierine/ which cannot be characterized by a standard composition because of the very wide possibilities of substitution of ions in its lattice. The exact determination of the composition of a given chamosite sample needs very sophisticated chemical and mineralogical investigations. Chamosite is alumosilicate, i.e. half of the silicon in the tetrahidral layer is replaced by aluminium in coordination IV. /the SiO_2 content of kaolinite is 46 per cent, that of the chamosite is 20 per cent/ and the octahedral "gibbsite" layer is filled by bivalent cations, mainly Fe^{2+}, furthermore, Mg^{2+}, Ca^{2+}! This chamosite - contrary to kaolinite - can completely or partially be inert in the Bayer process even at 250 °C and in the presence of a catalytic additive like CaO required for processing diasporic bauxites. However, in the further geological history of the deposit, under the changed conditions, a part of the Fe^{2+} can be oxidized into Fe^{3+}, destroying the crystalline structure thus increasing the reactivity of the chamosite in the Bayer process. The addition of lime to the slurry, fortunately, has a protecting effect against the oxidation of chamosite.

The oxidation process takes place on the surface, therefore, it is a real assumption that the deeper, unaltered part of the bauxite deposits can be considered to contain less or no kaolinite at all, on the one hand, mainly non-reactive /non-oxidized/ type of chamosite and more diaspore, on the other. This question is emphasized in the report of UNIDO consultants-geologists and it is extremely important if considering the economy of the whole project.

/For further information relating to the diasporic-chamositic bauxites see Annex No.3 items 3-7./

Considering the difficulties arising from the changing composition and reactivity of the chamosite and the missing exact physico-chemical methods suitable for the direct determination of this parameter, it is recommended to apply the so-called "Technological mapping". It means that a very large number of bauxite samples should be used for standardized digestion tests /the conditions to be determined by preliminary research work/, thereafter the main technological data /preferably bauxite consumption per one ton of Al_2O_3/ should be registered on the map instead of the values of the chemical composition or other characteristics.

It is reasonable to deal with the beneficiation of this bauxite as well, in order to reduce the amount of the bauxite to be processed and that of the generated red mud. Selective grinding, classification, attrition, high intensity magnetic separation can be preferred first of all for ore dressing.

The ore quality of the bauxite regions of the Elburz Mountains can be characterized by the investigations of ARMP - based on 400-500 samples for each deposit /Table 2/.

Selected samples /1-1 from each deposit/ were handed over for preliminary tests in November 1963 to ALUTERV-FKI, Budapest, on the occassion of Group Training for Alumina Production held in Hungary. The main data of the investigation relating to the chemical and phase analysis, furthermore, the technological behaviour of these samples are also summarized in Table 2 . These data are collected from the "Informative Report on Preliminary Technological Tests with Iranian Diaspore-Chamosite Containing Bauxites", prepared free of charge by ALUTERV-FKI and forwarded to the Manager of ARMP and UNIDO officers, respectively.

Table 2. Main data of the chemical, mineralogical and technological investigations of the bauxite samples collected in the bauxite region of the Elburz Mountains, based on the data of ALUMIRAN and ALUTERV-FKI, respectively.

I. Average data of 400-500 samples from each deposit, according to ARMP			
Component	Jajarn	Siah Rudbar	Ganu
Al_2O_3, per cent	46.6	44.0	49.0
SiO_2, per cent	13.3	18.0	14.4
Modul /Al_2O_3:SiO_2/	3.504	2.440	3.403
II. Data of the selected samples determined by ALUTERV-FKI			
Al_2O_3, per cent	43.7	45.5	49.0
SiO_2, per cent	12.5	16.2	14.4
Modul /Al_2O_3:SiO_2/	3.496	2.809	3.403
<u>Al_2O_3 per cent in</u>			
Diaspore	30.3	30.8	36.6
Boehmite	-	2.0	-
Kaolinite + Halloysite	-	5.6	8.8
Chamosite	13.4	7.1	3.6
<u>SiO_2 per cent in</u>			
Kaolinite + Halloysite	-	6.6	10.3
Chamosite	12.5	9.6	4.1
<u>Fe_2O_3 per cent in</u>			
Hematite	5.5	-	15.5
Chamosite	21.7	21.6	3.5
Total:	27.2	21.6	19.0

Table 2. /cont./

Component	Jajarn	Siah Rudbar	Genu
TiO_2 per cent	4.9	2.9	3.9
CaO per cent	0.2	0.1	0.6
MgO per cent	0.1	0.9	0.4
L.O.I. per cent	10.3	11.0	11.3

III. Data of the technological tests determined by ALUTERV-FKI

Conditions of the digestion tests:

Temperature	250 °C
Retention time	90 minutes
Catalytic additive, as CaO	3 per cent, 6 per cent, resp. /dry bauxite/
Digesting liquor	205 gpl Na_2O caustic 97.2 gpl Al_2O_3

Specific consumption per one ton of alumina	Jajarn	Siah Rudbar	Genu
Maximum yield of Al_2O_3, %	67.1	61.6	74.9
Bauxite, t	3.41	3.57	2.72
Red mud formation, t	2.76	2.76	1.70
Bound losses of NaOH, kg /in red mud/	224	460	244
Chamosite mineral in the red muds, %	50.0	8.5	20.3
Chamosite mineral in the original bauxites, %	52.7	42.6	13.5
Hematite mineral in the formed red muds, %	14.0	25.4	21.9
Hematite mineral in the original bauxites, %	5.5	-	15.5

The data determined by ALUTERV-FKI confirm that the selected samples from the Siah-Rudbar and Genu regions containing boehmite and kaolinite were partially oxidized, and the Al_2O_3 content of the sample of the Jajarm deposit revealed a relatively low value. It can be supposed that the average composition of all the three deposits will be better, considering the available Al_2O_3 and the reactive silica content.

The conditions of preliminary technological tests have been selected with the aim to achieve the maximum yield of Al_2O_3, therefore, they were not the optimum ones from the aspect of chamosite. It is clear from the presented data that the reactivity of chamosite was quite high in case of the Siah-Rudbar sample, medium in case of the Jajarm sample and minimum in case of the Genu sample. The ratio of chamosite mineral in the red mud and bauxite, respectively, can be considered as the indicator for reactivity. Some parts of the hematite in the red muds are originated from the decomposition of chamosite.

The reactivity of chamosite depends on the following factors:

1. The grade of oxidisation;
2. Digestion temperature;
3. Retention time at the maximum temperature /digestion/.

As these values are increased, the reactivity of chamosite will also be higher, therefore, it is necessary to determine the optimum standard conditions for the evaluation of the ore deposit in the earlier phase of prospecting already, and to use them for the technological mapping. It means that the preliminary selection of the processing technology is required.

The data presented in Table 2 indicate the presence of low grade bauxite with an extremely high amount of red mud originated during the processing. The expected specific consumption of bauxite and caustic soda are also too high. However, the smaller reactivity of chamosite /especially in the sample gained from the Genu deposit/ makes the reasonable processing of this bauxite possible by the modified Bayer-technology.

The diasporic bauxites have the following diadvatageous technological characteristics as compared to the boehmitic ores:

- less favourable digestibility;
- lower equilibrium solubility;
- abrasive character.

In order to compensate for these disadvantages, the use of special catalytic additives, the two-stream digestion technology /"sweetening" by boehmitic or gibbsitic bauxite/ and the selection of abrasion-resistant equipment are recommended.

The effect of a special catalytic additive /based on CaO/ as compared to the traditional method /CaO addition/ is demonstrated in Fig 2. based on the data gained at the processing of Lang Son bauxite in this case /Al_2O_3 50.3 per cent, SiO_2 7.3 per cent, Fe_2O_3 25.6 per cent/.

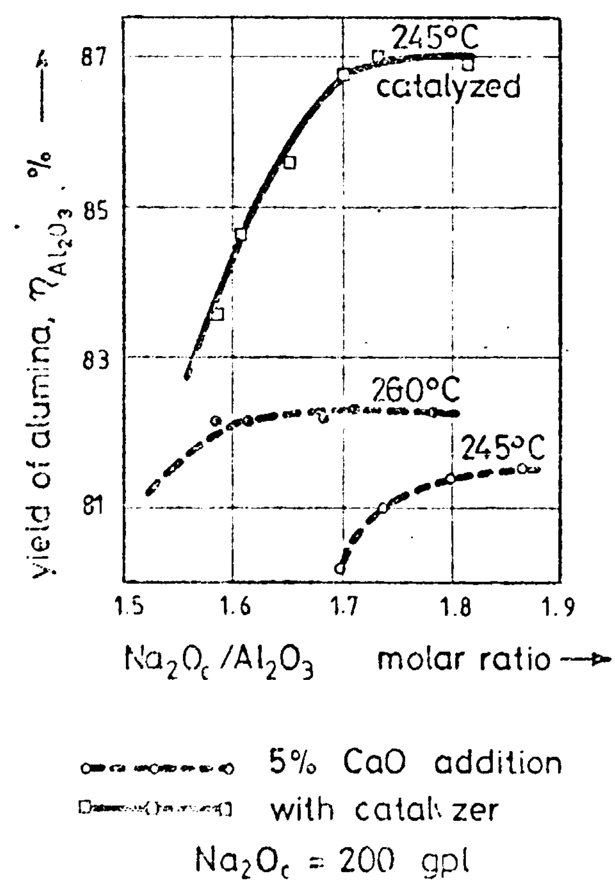
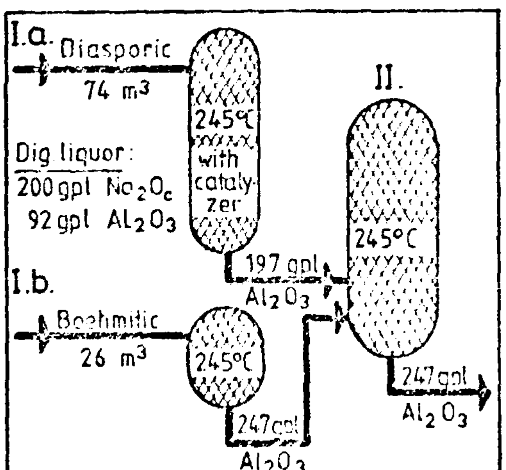


Fig 2 - Digestibility curves of LANG SON bauxite /Vietnam/

The distribution of the Al_2O_3 content among the different minerals was the following: in gibbsite - 2.5 per cent; boehmite - 2.8 per cent; diaspore - 38.2 per cent; corrundum - 0.3 per cent; kaolinite - 4.7 per cent; chamosite - 1.2 per cent; goethite - 0.6 per cent. The very hard bauxite shows similar characteristics to the Iranian diasporic bauxite. The new process developed and patented by ALUTERV-FKI can be successfully applied for the Iranian diasporic-chamositic bauxites as well. By means of this process the maximum yield of alumina can be achieved at the lowest digestion temperature, and in the shortest retention time, so it ensures the most perfect protection of the chamosite!

The preliminary technological tests show that the expected liquor productivity will be about 25 per cent less, as compared to the boehmitic bauxites. In order to compensate for this disadvantage, the "two-stage digestion" can be recommended, according to the method developed by ALUTERV-FKI for the simultaneous processing of diasporic and boehmitic ores. The theoretical flowsheet is presented in Fig 3. The essence of this technology is the fact that



Bauxite	Dissolved Al_2O_3 %		
	Stage I	Stage II	Total
Diasporic	50.0	–	50
Boehmitic	26.2	23.8	50
Σ	76.2	23.8	100

Fig 3 - Two-stage digestion for processing diasporic and boehmitic bauxites the diasporic slurry will be saturated by boehmitic /or gibbsitic/ bauxite. The given ratio between the diasporic and boehmitic /or gibbsitic/ bauxites /50-50per cent/ can be modified up to 75-25 per cent. In connection with this important possibility, it is recommended to consider the simultaneous processing of another Iranian boehmitic ore /e.g. Dc-Polan/ with the diasporic-chamositic one. Furthermore, a smaller quantity of imported bauxite /e.g. from India/ can also be considered for this purpose.

The expected large amount of the originating red mud, moreover, the caustic soda losses require the high efficiency of the settling-working area /special equipment and the use of syntethic flocculant/, and the application of an intensive caustic soda regeneration system. Experiences of processing medium grade bauxites are being accumulated in the Hungarian alumina plants.

The processing of the diasporic-chamositic bauxite of the Elburz Mountain can be justified under the conditions mentioned in the above, however, a lot of work and actions are necessary in the fields of protection, sampling, ore reserves evaluation and tecnological tests, so as to select the most economical processing technology. The technological tests should be carried out simultaneously with the prospecting activity.

For the process technology, the modified Bayer-process is recommended. The combined Bayer-synter process can not be accepted, owing to the unreactive chamosite content. The synter process has an extremely high energy consumption, and there are no up to date equipment available. According to the world tendencies, no new alumina plants are going to be built for the synter or the combined technologies.

C. Alumosilicates

The Islamic Republic of Iran has large deposits of alumosilicates containing 51-56 per cent Al_2O_3 and 25-27 per cent SiO_2 on an average. The mineral phases in the ore are as follows: kaolinite, muskovite, pyrophyllite, illite, quartz, hematite. This raw material is preferable for the production of ceramics and building materials, as compared to alumina. The world review of the expected utilization conditions of non-bauxitic raw materials for alumina production is given in the articles of Nunn, R.F. et.al. and Bengtson K.B., resp. /see Annex 3, items 1 and 2/, and in the article of Prof. S. Ziegenbalg: "Position and Trends in the Development of Acid Processes for Alumina Production" /Alumina Production until 2000. Proceedings of ICSOBA Symposium 1981. pp.43-66./

It has to be mentioned, however, that high grade calcite is also available in Iran, being very important and necessary for the alumina production by the modified Bayer-technology /for digestion and caustic soda regeneration as well/, therefore, it is recommended to study the limestone mining and burning conditions /selection of the deposit and plant/.

D. Conclusions

The elaboration of a feasibility /opportunity/ study for processing bauxite is recommended parallelly with the feasibility study relating to the alunite processing, in order to decide the priority of setting up an industrial scale alumina plant.

The main tasks of the alunite project are the following:

- optimum selection of the deposit;
- evaluation of the beneficiation of the alunitic ore /simple physical methods are preferred/;
- preparation of a Feasibility Study by VAMI based on pilot plant experiments. /The comparative evaluation of both complex technologies - reducing roasting and direct leachig, resp. - is recommended;
- preparation of a special report by ALUTERV-FKI for ALUMIRAN relating to the evaluation of the published data for physical-chemical investigation of alunitic ores compared with that of Iranian samples.

The modified Bayer-process is recommended for processing diasporic-chamositic Iranian bauxite, characterized by the use of special catalytic additive, two-stage digestion /simultaneous processing of diasporic and boehmitic or gibbsitic ores/, intensive caustic soda regeneration.

It is necessary to determine the optimum standard conditions of the digestion, for the real evaluation of the ore deposits by means of the "technological mapping".

It is recommended to study the beneficiation of the bauxite so as to reduce the specific bauxite consumption and the amount of the originating red mud.

In the field of the Bauxite Project, the following preliminary work should be performed by the selected subcontractor:

- detailed chemical-mineralogical analysis of the bauxite samples /30-40 samples at least from each deposit/;
- determination of the digestion parameters for the "technological mapping" from a few relatively characteristic samples;
- technological mapping for the selected samples /30-40 samples from each deposit/;
- Bench scale technological testing, preparation of the Prefeasibility Study;
- technological tests with representative samples, preparation of the Feasibility Study.

II. ESTABLISHMENT OF THE ALUMINA RAW MATERIALS TESTING LABORATORY

We have found this part of the Project in good progress. The design of the laboratory building has been prepared by two professional firms, namely, by the Architecture Consulting Eng. and by the Energy Consulting Eng.

The UNIDO study /UNIDO/I.O.466, 15. Sept. 1981/ "Profile of Transferring Technology in Testing, Investigation and Evaluation of Bauxite", edited by myself was used as a basic material for the principal design. I had the pleasure to see the successful utilization of our study.

I was in close cooperation with the consultant on materials testing /Dr.C.Douglas/, with the staff of ARMP managed by M. Shahriari and with the represenatatives of the consulting firms in this matter.

Our common recommendations made together with Dr.C.Douglas have been accepted in the completed design and they are enclosed to my report as Annex 4.

The establishment of the Laboratory is fully justified by the expected work to be carried out in the future in the ARMP. The Iranian partner firms and the staff of ARMP are prepared to undertake all of the tasks connected with the establishment of the Testing Laboratory, however, the assistance of UNIDO and its consultants is recommended in the procurement and purchase of instruments and equipment, in the transfer of technology /software/ and in the organization of training programs. The assistance of subcontractors is also recommended, first of all in the field of the transfer of technology and that of the abroad training program.

Relating to the list of instruments and equipment included into Annex 4 it must be completed by the following items:

- Infrared Spectrometer;
- BET Specific Surface Area Measurement Equipment;
- Particle Size Analyser;
- Soft gamma ray Model Settler;
- Roasting rotary kiln.

The estimated cost of all the listed equipment is about 1.6-1.7 million US$ /the related software is not included/.

It has to be mentioned that the preparations for the installation of the Neutron Activation Bauxite Analyser and for the organization of the connected on-site training are in progress.

It is necessary to prepare /to select/ "standard samples" from each kind of raw material /alunite, bauxite, alumosilicate/ and to send them to the selected subcontractor for investigation by means of the different physical, physico-chemical, chemical and textural methods /XRF, XRD, IR, TA, SEM, BET, Grain size/, in order to use them as comparative standards in the future activity of the ARMP Testing Laboratory.

The thermal analysis /TA/ and XRD analysis form an entity in the field of the complex phase analysis. The software is available at ALUTERV-FKI. It is recommended to combine the purchase of the instrument with the related training, concerned not only with the operation but with the given application of the instrument as well.

III. ADVICE FOR THE PARTNER ORGANIZATIONS

The Iranian professional consulting firms are able to manage the design and construction of the Alumina Raw Material Testing Laboratory in close cooperation with each other. The staff of ARMP managed by Mr M.Shahriari is capable to operate this facility successfully. In this field it is recommended to cooperate with the Jamaican Bauxite Institute and ALUTERV-FKI, Budapest, respectively.

The Institute of VAMI, Leningrad, is suggested to be entrusted with carrying out the detailed technological tests required for the alunite project, and with the preparation of the Feasibility Study for bauxite processing. The preliminary activities in this field can be carried out by ALUTERV-FKI.

In the utilization of alumosilicates, Mansfeld Kombinat, FNE, Freiberg, GDR is recommended as partner organization which has an operating pilot plant for processing clays by acidic methods /HCl and/or H_2SO_4 resp./ at the Lauta Aluminium Works.

For the beneficiation of the raw materials the cooperation with the following institutes is recommended:

- MECHANOBR, Leningrad /alunite/
- ALUTERV-FKI, Budapest /bauxite/
- RUDARSKI INSTITUT, Beograd /pilot tests/
- FORSCHUNGINSTITUT /FIA/, Freiberg, GDR /pilot tests/

The study-tour of the project manager's team of ARMP to the JBI, Kingston and the participation of selected staff members of the ARMP in the workshop at JBI /in early 1985/ is highly recommended.

The participation of the project manager's team of ARMP is recommended on the following international technical conferences held in 1985:

- Light Metals Conference on the occassion of the 114th AIME Annual Meeting /Bauxite- Alumina Sessions/ New York, February 24-28, 1985.
- I. World Congress on Non-Metallic Minerals, Beograd, Yugoslavia, April 15-19, 1985.
- ACHEMA 85. Internationales Treffen für Economische Technik. Frankfurt am Main /FRG/, June 9-15, 1985.
- International Symposium on Bauxite Prospecting and Mining, October 2-5, 1985. Tapolca, Hungary /organized by ICSOBA and the Hungarian Aluminium Corporation/

The common recommendations of the UNIDO consultants relating to the partner organizations can be found in Annex 4.

Program of the consultant

22th July	Travel from Budapest to Vienna
23th July	Briefing at the UNIDO Headquater at Vienna
24th July	/same as above/
25th July	Arrival to Teheran. Accomodation in Hotel Lalek /International/ office holiday
26th July	Informative talk at AIDMIRAN. Confirmation of the program in Teheran
26th July	Holiday. Sightseeing in Teheran. Studying the laboratory project
28th July	Visit to the site of the laboratory at Karadj. Visit to the UNDP office. Evaluation of the laboratory project. Translation of the literature relating to alunite processing from Russian into English for the staff of the project.
29th July	Discussion of the ARMP at the UNDP office with Mr. SINGH, Krishen G.Resident Representative, together with Mr. SHAHRIARI, M. Meeting with the consulting engineers in the field of the construction of the laboratory building - Translation from Russian into English.
30th July	Discussion about the selection and utilization of the laboratory equipment with the staff of ARMP: Neutron Activation Bauxite Analyser, X-ray Diffractometer and XRF, Infra Red Spectrometer, Thermo-Analyser.
31st July	Discussion with the staff members of ARMP. Alunite program: selection of equipment and their use in raw materials investigations. Translation from Russian into English. Arrival of the consultant in materials testing /Dr.C.Douglas/ to Teheran. Confirmation of the further common program.
1st August	Visit to the bauxite areas with Mr. M.SHAHRIARI and Dr.C.Douglas.
2nd August	/same as above/
3rd August	Holiday. Report writing: common recommendations /with Dr.C.Douglas/

4th August	Discussion on the laboratory building and equipment's selection with the ARMP staff members. Discussion on the project status at the UNDP office /together with Dr.C.Douglas/ with Mr.K.G. SINGH.
5th August	Visit to the alunite area. Discussion.
6th August	Discussion on laboratory. Report writing.
7th August	Meeting with the consulting engineers. Final comfirmation of the construction of the laboratory building. Final discussion of the project status at the UNDP office /with Mr.K.G.Singh and Dr.C.Douglas/. Comments on the common recommendations handed over to Mr.K.G.Singh.
8th August	Flight from Teheran to Vienna.
9th August	Debriefing at the UNIDO Headquarter in Vienna.
10th August	/same as above/
11th August	Travel from Vienna to Budapest.

Senior partner staff, their names and specialization

I. Senior partner staff of ALUMIRAN Co.:

/Alumina Raw Materials Programme, Gharani Ave. Bimeh Alley No.9, Teheran, Telephone: 833252-3, Telex No.: 212334 NISC-IR/

1.	SHAHRIARI, Mohamad	Project manager of ARMP
2.	SAYAR, Mahmood	Chem. Eng., in charge of Alunite Project
3.	HASSANZADEH, Ebrahim	Chem. Eng., in charge of alumosilicates and Laboratory Project
4.	AZARANG, Mahmood	Chem. Eng., Alunite Project
5.	MALEKMOHAMADI, Aman	Mining Eng. /Alunite, Alumosilicates Project/
6.	JOUIZADEH, Shahriar	Mat.Sci.Eng. /Alumosilicates Project/
7.	SHAHRUKHI, Kiumarce	Chemist /Wet chem. Anal. Lab./
8.	HABIBI, Javad	Geologist
9.	KUZEH KANANI, Farideen	Geologist
10.	HEMATI, Kholamreza	Geologist

II. Senior partner staff of the Architecture Consulting Eng. /SHAHR and BARNEMEH/:

1.	SOUKIASIANS, Ara	Eng.
2.	TAVAKOLI, Esmail	Eng.

III. Representatives of Energy Consulting Eng.:

1.	KHOEE, H.	Eng.
2.	SHARIFI, Y.	Eng.

List of papers selected and delivered for AEMP in Teheran

1. R.F.Hunn, P.Chuberka, L.Malm and A.V.San Jose: The Comparative Economics of Producing Alumina from US Non-Bauxitic Ores.
Light Metals 1979. Vol.2. pp. 283-334.
2. K.B.Bengtson: A Technological Comparison of Six Processes for the Production of Reduction-Grade Alumina from Non-Bauxitic Raw Materials.
Light Metals 1979. Vol.2. pp.217-282.
3. Z.Csillag, K.Čeh, A.Csordás-Tóth, D.Ivankovič: Role of Ore Dressing in Beneficiation of Monohydrate Bauxite.
Bauxite, Proc. of the 1984. Bauxite Symp. Los Angeles, Febr.27- March 1. 1984. Edited by L.Jacob. SME-AIME, New York 1984. pp. 708-726.
4. K.Solymár, J.Zámbó, P.Siklósi: Technological Evaluation of Monohydrate Bauxites.
Bauxite, Proc. 1984. SME-AIME, pp.727-746.
5. G.D.Coumoulos: Processing Diasporic Bauxites. The Greek Bauxite Case.
Bauxite, Proc. 1984. SME-AIME, pp. 747-774.
6. E.D.Sharko, V.A.Bronevoy, N.N.Tikhonov, L.S.Rudashevsky, V.V. Zuev: Mineralogical, Technological and Genetic Features of Chamositic--Boehmitic bauxites of the Paleozoic Age.
VAMI-PKI, Proc.3. pp. 93-103.
7. N.N.Tikhonov, L.S.Rudashevsky, A.B.Bykova, I.B.Firfarova: Main Features of the Digestion Technology of Chamositic Bauxites.
VAMI-PKI 3. pp. 229-233.

RECOMMENDATIONS

1 - The prefeasibility study for processing Bauxites should be undertaken concurrently with the feasibility study concerning Alunite processing. It is important to note that the relatively low - grade, Diasporic — Chamositic, Bauxite can be processed, effectively by the Bayer process with proper process Technology selection for example using catalytic-additives and two stream digestion (saturation of the liquor by — boehmite sweetening) and Caustic Soda regeneration Via Mud caustici-zation. It is also critical to note that the chamosite in this — Bauxite is largely unreactive.

2 - The Aluminium Raw Materials testing laboratory (ARMTL) should have the capability of determining the quantitative chemical and mineralogical composition of Bauxites, Alunites and Alumino - Silicate clays. It should also be capable of determining the Physico - Chemical — Characteristics and Morphological properties of these Ores and products, by - products, wastes and other raw materials used and / or — generated in Technological simulation studies. In addition it should be equipped to undertake the bench - scale simulation of the unit operations of the process technologies under consideration for the Alumino - Ferrous Raw Materials mentioned above.

3 - UNIDO's assistance in the procurement and purchasing of instruments — and equipment which require hard currency is highly recommended. A minimum of US$ 1,000,000 is required to pursue this activity in the first phase which should last until the end of 1986.

4 - Technology transfer (soft ware) and the organization of special — training programm for staff members of the laboratory - specially for orientation and effective utilization of the more technologically — advanced instruments is critically important and is recommended for — UNIDO's execution before the installation of the equipment.

5 - Maximum use should be made of the experience gained at the Jamaica — Bauxite institute (JBI), St/ Jam / 80 / 001 and in China, DP / CPR-80 / 047 and 81 (037), for manpower development and equipment —

selection, installation and commissioning and overall project organization and implementation. The study tour of the project manager's team to the JBI and the participation of selected staff members of the ARMP in the workshop which will be held in Kingston in the first quarter of 1985 when the operation of the pilot plant will be demonstrated is highly recommended.

6 - As counterpart organizations in the field of design and application of pilot plant and industrial scale technologies for processing Alumino - Ferrous Ores based on their experience, the following institutions are recommended :

(1) Alunite processing : Institute Vami. Leningrad USSR.

(2) Bauxite processing : A. Aluterv-FkI, BUDAPEST,The Eng.and Dev.-Centre of the HUNGARIAN Aluminium Corporation, HUNGARY, and

B. The Jamaica Bauxite Institute, Kingston JAMAICA .

(3) Utilization of Alumino - Silicates : Mansfeld Kombinat,FNE (Res. Institute of non - Ferrous - Metals) Freiberg. GDR.-

Hands - on training in the relevant disciplines are available these institutions. Furthermore they can assist with equipment selection, installation, commissioning and operation and overall planning and organization of prospecting and R & D programmes.

7 - From the discussions between the Iranian Consulting firms responsible for the design and construction of the ARMTL. and the ARMP staff and UNIDO Consultants it is evident that these firms can effectively implement the tasks for which they have been contracted by the ARMP.

8 - For the effective detailed prospecting and evaluation of the ore reserves it is recommended that the following equipment

BE PURCHASED A PRIORI :

a. FOR CHEMICAL ANALYSES :

1. BALANCES
2. INDUSTRIAL RAPID ANALYZER (NEUTRON ACTIVATION)
3. ATOMIC ABSORPTION SPECTROPHOTOMETER (AAS)
4. FLAME SPECTROPHOTOMETER
5. UV - VIS SPECTROPHOTOMETER
6. THERMATIC TITRATOR
7. XRF (Phillips - IF SUFFICIENT FUNDING IS AVAILABLE)

b. FOR MINERALOGICAL PHASE ANALYSES :

1. XRD (PHILLIPS)
2. THERMOANALYTICAL EQUIPMENT WITH GAS TITRIMETER (Q -1500 DERNATOGRAPH)

c. FOR MORPHOLOGICAL STUDIES :

1. OPTICAL MICROSCOPES
2. SCANNING ELECTRON MICROSCOPE (S.E.M.) WITH EDAX

d. FOR TECHNOLOGICAL TESTING :

1. ROTARY ALUMINIUM BLOCK DIGESTION SYSTEM WITH MINI AUTOCLAVE (45cc) BOMBS.
2. LEACHING ASSEMBLY
3. FURNACE (1600 C)
4. ONE (1) 7.5 LITRE AUTOCLAVE EQUIPPED WITH PRESSURE GAUGE AND TEMPRATURE CONTROLLER AND TWO (2) 2.0 LITRE AUTOCLAVES WITH SIMILAR ACCESSORIES.

4a. THE ABOVE LIST OF EQUIPMENT IS IN ADDITION TO BASIC AND GENERAL-PURPOSE EQUIPMENT SUCH AS BALANCES, GRINDING MILLS, SIEVES ETC. THE PRIORITY OF PURCHASING THE SEM AT THIS TIME IS FURTHER JUSTIFIED BY THE FACT THAT THERE IS NONE IN TEHRAN. PURCHASING OF THE XRD IS JUSTIFIED BY THE NEED TO ESTABLISH THE MINERALOGICAL COMPOSITION OF THE VARIOUS ALUMINO - FERROUS ORES AND TO DETERMINE THE DEGREE OF VARIATION FOR A GIVEN TYPE OF ORE. THE LATER CAN NOT BE THOROUGHLY EVALUATED IN A COUNTERPART LABORATORY

5. ONE (1) OIL BATH AND SIX(6) 250cc CAPACITY AUTOCLAVES FOR OPERATING TEMPRATURES UP TO 250 C (ABOUT 50 BARS)
6. DESILICATION / PRECIPITATION / CAUSTICIZIZATION, TEMPRATURE CONTROLLED WATER BATH UP TO 100 C EQUIPED WITH STIRRED VESSELS AND BUILT IN OSCIMHOTRANSMITTER FOR CONTINUOS CONDUCTIVITY MEASURMENT .
7. TWO (2) HIGH SPEED LABORATORY CENTRIFUGES UP TO 4,000 RPM
8. ONE (1) LABORATORY VACUUM FILTER AND ONE (1) LABORATORY PRESSURE FILTER.

e. DATA PROCESSING EQUIPMENT

1. ONE (1) MULTI - USER MICRO COMPUTER WITH SIX (6) TERMINALS WITH ONE TERMINAL FOR LIBRARY INFORMATION STORAGE AND RETRIEVAL EQUIPPED WITH MODEM FOR TIE IN TO INTERNATIONAL INFORMATION SYSTEMS.

2. ONE (1) MICROFILMING EQUIPMENT FOR PROCESSING MAPS AND OTHER - DOCUMENTS. EQUIPMENT 1. AND 2.e ABOBE SHOULD BE SPECIFIED — AND IDENTIFIED AS SOON AS POSSIBLE FOR PURCHASING LATER IN RELATION TO THE PHASING OF THE SPECIFIC TRAINING PROGRAMME — (ACCORDING TO THE TIME SCHEDULE OF THE MASTER BAR CHART).

9 - IT IS RECOMMENDED TO SEPARATE THE COSTS OF TECHNOLOGY TRANSFER — (SOFT WARE) AND THE COST OF TRAINING AND FELLOWSHIPS FROM THE - EQUIPMENT COST (HARDWARE) WHEN CONSIDERING THE DIFFERENT SOURCES AVAILABLE FOR FINANCING.

10 - IN ORDER TO FACILITATE THE LOGICAL FLOW OF SAMPLES, OVERALL EFFICIENCY AND SAFETY IT IS RECOMMENDED THAT THE FOLLOWING GUIDELINES BE CONSIDERED IN THE MASTER LAYOUT OF THE LABORATORY :

a. THE KEY INSTRUMENTAL PHASE ANALYTICAL LABORATORY UNITS SHOULD - BE LOCATED IN THE SAME AREA.

b. ALL TECHNOLOGICAL TESTING UNITS SHOULD BE GROUPED IN THE SAME - AREA.

c. A ORE RESERVES SECTION CARRYING OUT THE FUNCTIONS OF PROSPECTING ETC. SHOULD BE CONSTRUCTED ON THE PREMISES OF THE ARMTL. THIS- WOULD ENHANCECOMMUNICATION PROMOTE GREATER INTERACTION AND IN - GENERAL INCREASE THE EFFICIENCY AND EFFECTIVES OF THE EXPLORA - TION PROGRAMME.

11 - FOR ALL RADIATION EQUIPMENT USING VARIOUS SOURCES, IT IS HIGHLY — RECOMMENDED TO OBTAIN THE EXACT SPECIFICATIONS FOR THEIR SAFE USE- AND HANDLING FROM THE COMPETENT AUTHORITIES AND EQUIPMENT SUPPLIERS AND TO PROCURE AN OPERATION PERMIT IN ADVANCE OF THEIR PURCHASE — AND INSTALLATION.

THE FOLLOWING EQUIPMENT ARE TO BE CONSIDERED FOR THIS PURPOSE :

a. XRD AND XRF,
b. S. E. M.
c. INDUSTRIAL RAPID ANALYZER TYPE MTA - 1527200 BY NEUTRON ACTIVATION,
d. SOFT GAMMA RAY ABSORPTION MODEL SETTLER.

12 - IT IS NECESSARY TO DESIGN A CENTRALIZED SYSTEM FOR THE PROVISION - OF THE COMMON SERVICES OF VACUUM AND COMPRESSED AIR TO EACH LABO - RATORY UNIT (AS NECESSARY). IT IS RECOMMENDED THAT THESE SERVICES BE HOUSED IN THE BUILDING PROPOSED FOR LOCATION OF THE STANDBY DIESEL ELECTRICITY GENERATOR.

13 - PROVISION SHOULD BE MADE FOR THE INSTALLATION OF THE FOLLOWING — SUPPORTING SERVICE FACILITIES :

a. A PHOTOGRAPHY LABORATORY (FOR S. E. M.)
b. A [illegible] [illegible] AND REPARING WORKSHOP
c. A [illegible] (MECHANICAL, ELECTRICAL) WORKSHOP.

14 - THE PROGRAMME OF LOCAL TRAINING OF ARMP STAFF ALREADY INITIATED BY THE PROJECT MANAGER IS SOUND AND EFFECTIVE AND SHOULD PROVE TO BE HIGHLY BENEFICIAL LATER. IT IS RECOMMENDED THAT THIS BE INTENSIFIED AND SYNCHRONISED WITH THE PLANNED ACQUISITION OF SPECIALIZED EQUIPMENT. THIS SHOULD BE FOLLOWED BY FURTHER TRAINING ABROAD RELATING TO THE CHARACTERISTICS OF THE GIVEN RAW MATERIALS AS DETERMINED BY THE SPECIALIZED ADVANCED EQUIPMENT BEFORE THE INSTALLATION OF SIMILAR EQUIPMENT IN THE ARMTL.

15 - IT IS RECOMMENDED THAT A MASTER BAR CHART BE PREPARED FOR THE ENTIRE PROJECT REFLECTING THE SEQUENCE AND SCHEDULE OF EACH MAIN ACTIVITY AND THAT THE MAIN ACTIVITIES BE BROKEN DOWN INTO DETAILED MINI BAR CHARTS FOR CONTROLLING AND MONITORING EACH ACTIVITY AND EVENT. THESE SHOULD BE REVIEWED AND REVISED ON A REGULAR BASIS BY THE PROJECT MANAGEMENT.

16 - QUOTATIONS FROM THE POTENTIAL EQUIPMENT SUPPLIERS BY UNIDO SHOULD BE OBTAINED AS SOON AS POSSIBLE FOR ALL OF THE EQUIPMENT, STARTING WITH THE MORE EXPENSIVE ONES, INDEPENDENTLY OF THE EXPECTED SOURCES OF FINANCING.

17 - PREPARATION AND DETAILED INVESTIGATION OF SOME SELECTED SAMPLES OF EACH RAW MATERIAL IS NECESSARY FOR THEIR USE AS STANDARDS IN THE QUANTITATIVE CHEMICAL AND MINERALOGICAL ANALYZES, MORPHOLOGICAL AND TECHNOLOGICAL TESTS TO BE CARRIED OUT IN THE ARMTL.
IT IS RECOMMENDED THAT THIS WORK BE PERFORMED IN ONE (OR MORE AS NECESSARY OF THE COUNTERPART FOREIGN INSTITUTIONS.). IN ADDITION A PROGRAMME OF COLLECTION OF STANDARD ALUMINO - FERROUS SAMPLES FROM DIFFERENT REGIONS SHOULD BE INITIATED.

18 - SIMPLE PHYSICAL ORE DRESSING METHODS ARE RECOMMENDED FOR ALUNITE AND BAUXITE BENEFICIATION. IT IS RECOMMENDED THAT THE NECESSARY EQUIPMENT BE INSTALLED IN THE ARMTL.
FOR THE BENEFICIATION STUDIES ASSISTANCE MAYBE OBTAINED FROM THE COUNTERPART INSTITUTIONS NAMED BELOW :

a. MECHANOBR, LENINGRAD, USSR (FOR ALUNITE)
b. ALUTERV - FKI, BUDAPEST, HUNGARY (FOR BAUXITE)
c. RUDARSKI INSTITUT, BEOGRAD, YUGOSLAVIA (FOR PILOT TESTING)
d. FORSCHUNGSINSTITUT FUR AFBEREITUNG (FIA), FREIBERG, GDR (FOR PILOT TESTING)

PREPARED BY :

KAROLY SOLYMAR
CONSULTANT IN THE PROCESSING
OF ALUMINO - FERROUS ORES

AND

CONRAD DOUGLAS
CONSULTANT IN MATERIALS
TESTING

TEHRAN 7th. AUGUST 1984