OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

09232

DP/ID/SER.B/195
19 October 1978
English

RESTRICTED

INDUSTRIAL UTILIZATION OF NON-METALLIC MINERALS, BELGRADE

DP/YUG/73/003

YUGOSLAVIA

Terminal report

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

United Nations Industrial Development Organization
Vienna

id. 78-7331

Explanatory notes

A comma (,) is used to distinguish thousands and millions.

A full stop (.) is used to indicate decimals.

Reference to "tons" are to metric tons, unless otherwise specified.

References to dollars ($) are to United States dollars, unless otherwise stated.

The monetary unit in Yugoslavia is the dinar. During the period covered by the report, the value of the dinar in relation to the United States dollar was approximately $US 1 = 18 dinars.

The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

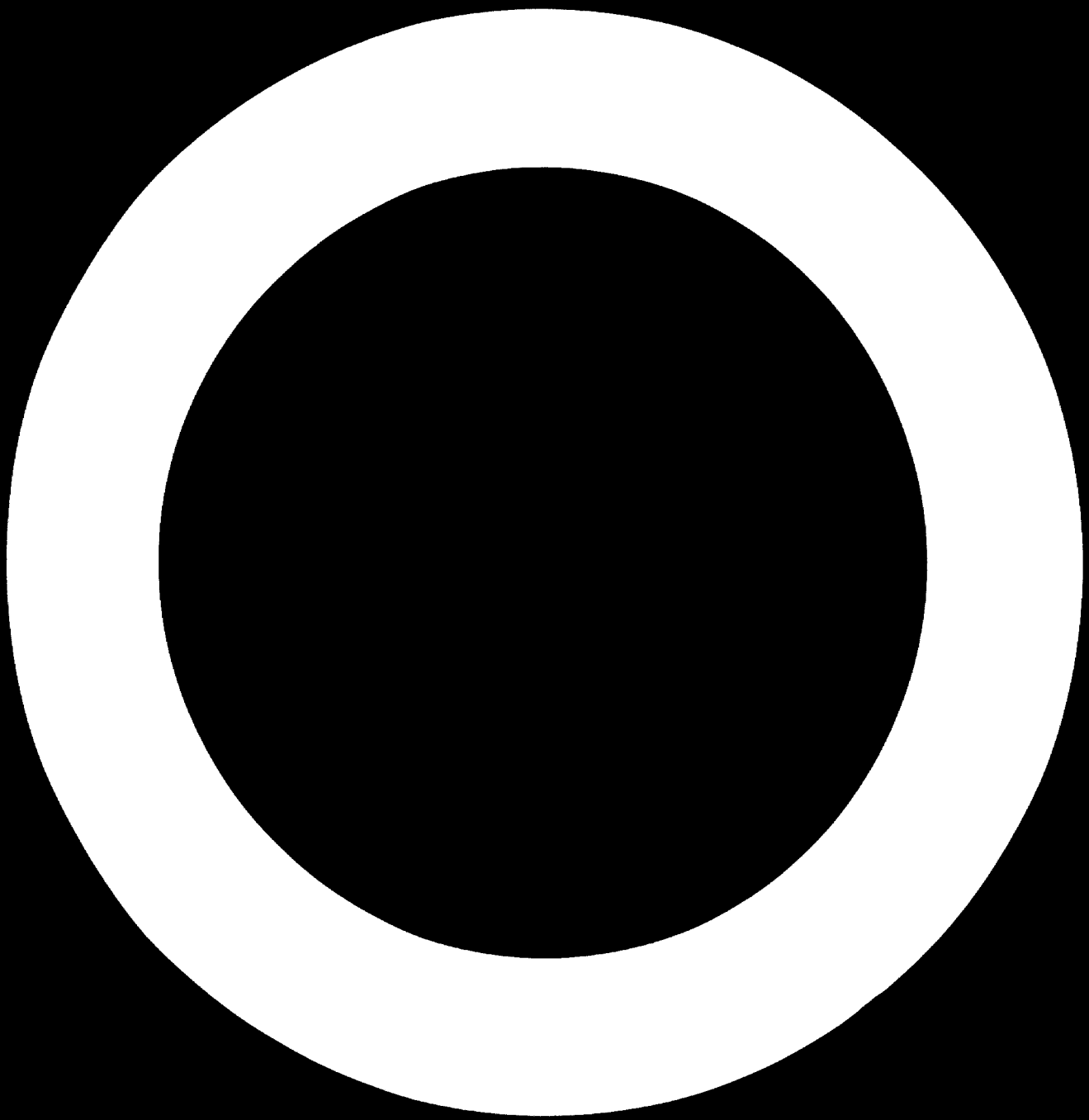
Mention of firm names and commercial products does not imply the endorsement of the United Nations Industrial Development Organization (UNIDO).

ABSTRACT

The project entitled "Industrial utilization of non-metallic minerals" (DP/YUG/73/003) arose from a request made by the Government of Yugoslavia in 1973 for United Nations Development Programme (UNDP) assistance in studying the feasibility of increased exploitation of non-metallic mineral resources. The request was approved in July 1974 for a duration of four years with the United Nations Industrial Development Organization (UNIDO) serving as executing agency and the Institute for Technology of Nuclear and Other Mineral Raw Materials, Belgrade (the Institute), as the government co-operating agency.

The main conclusions of the report include the following:

1. The project contributed to the solution of a number of technical and technological problems in dressing and beneficiation of non-metallic raw materials.
2. As a result of these solutions three existing plants were reconstructed and two new plants were built.
3. Basic research was carried out on certain problems concerned with the manufacture of synthetic refractory materials, fused refractories, and on the manufacture of pyrometric cones.
4. The project demonstrated the need for continuing attention to technical and technological problems and the need for continuing basic research, especially into the possibilities of domestic industrial utilization of available non-metallic mineral resources.
5. The project contributed directly and indirectly to supporting the development objectives for the non-metallic minerals sector of the Yugoslav National Programme (YNP).



CONTENTS

INTRODUCTION

Yugoslavia, and in particular the Socialist Republic of Serbia, possesses large deposits of non-metallic minerals of considerable potential value.

Up to now deficient technology has inhibited economical exploitation of these deposits. The general progressive technological development of the country, however, has increased the demand for non-metallic raw materials to such a degree that in 1973 the Government of Yugoslavia asked UNDP to help study and develop improved technologies for dressing and utilizing these minerals. The Government request was approved in July 1974 for a duration of four years, with UNIDO serving as executing agency and the Institute as the government co-operating agency.

UNDP assistance was mainly utilized for procurement of basic equipment and technical literature, for recruitment of international experts and consultants, and for training. The government contribution was mainly used to support locally recruited personnel, including the director and co-director of the project, and for maintenance of the existing premises and equipment of the Institute. The project director, as a leading staff member of the Institute, co-ordinated the activities of the Institute's subsections with the activities of the experts and consultants who participated in the project.

From the start, highest priority was given to studying siliceous raw materials, especially quartz, for use in ceramic, glass, alloy casting and steel production. Later, attention was given to other non-metallic minerals such as kaolins, fire-clays, ceramic white-burned clays, mineral pigments, chalk, phosphates, magnesites, bentonites, bauxites, alunite, feldspar, and limestone. By the end of the project it could be said that the study included all non-metallic raw materials found not only in Serbia but in the country as a whole.

The goal of the project was to help the national economy in accordance with the objectives of the YNP. Implementation of the project should help to cut imports of non-metallic raw materials to Yugoslavia as a whole and to Serbia in particular. It could also help create job opportunities for local manpower by supporting YNP goals for expanding existing industries and creating new ones.

The Serbian Government budgeted 7,015,000 dinars for project activities; UNDP/UNIDO allocated $465,172. The project received assistance solely from UNDP/UNIDO and from the Government.

Implementation of the project was programmed from 1 January 1974 to the end of April 1978. In general this corresponded to the timetable of the YNP.

The following documents were prepared in the course of the project: a project proposal (1973), semi-annual progress reports, technical reports (see Annex III), preliminary terminal reports (April 1976, March 1977, October 1977), a preliminary report of findings and recommendations (December 1977), and a proposal for a second stage of the project (January 1978). These reports are on file at UNIDO headquarters and at the UNDP office in Belgrade.

I. TECHNICAL AND TECHNOLOGICAL FINDINGS AND RECOMMENDATIONS

Beneficiationand dressing of non-metallic raw materials is a chain of many operations that starts with geological prospecting and ends with industrial production of dressed raw materials. Since the same raw materials must be differently processed to meet the needs of different consumers, it is essential to develop flexible processing technologies. While the project was primarily concerned with dressing and beneficiation of non-metallic raw materials, some attention was necessarily given to related production problems in industrial utilization of these raw materials.

Dressing and beneficiation problems dealt with are summarized in table 1, production problems in table 2. Problems were classified as basic (priority 1) or secondary (priority 2).

Table 1. Dressing and beneficiation problems

Raw material	Deposit site(s)	Problem	Priority
Alunite	Macedonia	Beneficiation; utilization	1
Bentonite	Bentokos, Kosovo	Dressing and beneficiation; utilization	1
Chalk	Gramada Niš	Production	1
	"Pomoravlje" Niš	Beneficiation; utilization	1
Clay, refractory	Rudovci, west and south deposits Rudovci-Podina	Dressing	1
Diatomaceous earth	Not specified	Research: 1) extent of deposits 2) utilization	2
Feldspar	Arandjelovac basin	Beneficiation	1
	Vlaško Polje "Stale"	Beneficiation	1
Kaolin	Bare deposit, Arandjelovac basin	Beneficiation	1
Magnesite	Korlače (Strezovci)	Beneficiation	1
Phosphate	Bor	Beneficiation	1
Pigments, mineral	Not specified	Dressing and utilization	2
Quartz sand	Vlaško Polje "Stale"	Beneficiation	1
	Arandjelovac basin	Beneficiation	1

Table 2. Production problems

Product(s)	Problem	Priority
Ceramics	Utilization of short firing cycle equipment	2
	Mullite development in firebrick production	2
Fused refractory grains	Production and utilization of fused grains of mullite-corundum	1
	Production of fused Mg Cr grains	
	Production of fused quartz	
Limestone, milled	Production of finely milled limestone for use as a filler	2
Pyrometric cones	Demonstrating feasibility of production in Yugoslavia	1
Synthetic refractories	Utilization of mullite in producing high quality firebricks from indigenous raw materials	1
Waste products	Utilization of kaolin waste	1
	Utilization of kaolinite from quartz sand waste	2

A. Dressing and beneficiation problems

Alunite. The study of beneficiation of alunite ore was prompted by reports of the occurrence of an extensive deposit of alunite in Macedonia. The Institute made preliminary tests which showed that the flotation method helps increase the recovery of alunite from 35% to 80%. The concentrate was leached with sulphuric acid and sodium hydroxide to separate the components. The Institute's report indicating the feasibility of beneficiating Macedonian alunite was handed over to the "Feni" company and a contract for trial production is expected shortly. Alunite production is potentially very important because Yugoslavia is one of the few countries reportedly having extensive deposits of this ore.

Bentonite. Samples from bentonite deposits in Serbia served as the basis for the study of beneficiation of local bentonites. Bentonite is also said to occur over wide areas of Yugoslavia. Following the Institute's recommendations a new factory with a capacity of 200,000 tons per year of dressed bentonite is being considered for construction in the near future. Cost of the factory is estimated at about US $12.5 million; bidding for the necessary machines and equipment has already started. Yugoslavia should make every effort to utilize its extensive deposits of this raw material which can be utilized for iron pelletizing, drilling injections, drilling mud, decolorants, and water purification. The production of this new factory, for example, would obviate bentonite imports to Yugoslavia in the future.

Chalk. The problem of beneficiating chalk was solved experimentally in the laboratory of the Institute. Because of the very satisfactory experimental results, pilot plant and medium-scale production were begun at the "Pomoravlje" factory, Niš. Institute staff continue to collaborate closely with the factory on such questions as quality control and production processes. Increased chalk production at the "Pomoravlje" plant is expected in the near future.

Clay, refractory. Dressing refractory clay from the west and south parts of the Rudovci deposit is less a technical problem than an economic one. Since the clay has metallic impurities (iron, calcium, and magnesium oxides) dressing was recommended either by magnetic separation followed by homogenization or by blunging, hydrocycloning, and electromagnetic separating. The latter method produces excellent technical results but its economic feasibility is questionable because the price of one ton of the dressed clay is increased to about 500 dinars. But the quality of clay dressed this way is better than the quality of any other clay now produced. This means that it can be used to produce new higher quality products. Simple magnetic separation followed by homogenization produces a refractoriness of only SK 18 to SK 26 (1,580°C) which is the lowest permissible limit for refractory products. Dressing based on blunging and hydrocycloning, however, produces a refractoriness of SK 34 (1,780°C). This problem will also have to be considered in connection with clays mined in the future from the deposit at Rudovci-Podina.

Diatomaceous earth. Reportedly deposits of diatomacceous earth occur over wide areas of Yugoslavia. The sample studied was shown to be suitable, after beneficiation and appropriate processing, for use, for example, in the production of filter aids, thermal insulation products, and catalyst carriers. These results suggested that its production could be profitably expanded.

Feldspar, Kaolin, and quartz sand. Beneficiation of quartz sand and feldspar from the deposit at Vlasko Polje - Štale. The basic problem was how to dress the raw material in such a way as to provide quartz sand suitable for use not only in the metallurgical industry but also for possible use in other industries. Because the raw material is actually a mixture of quartz sand, sodium and potassium feldspar, and small amounts of heavy minerals and other impurities, the flotation processes were recommended for dressing it. The quartz obtained is of very good quality for use in the ceramic and lower quality glass industries. The feldspar, a mixture of sodium and potassium feldspar in the ratio 1.5 : 1 was recommended only for producing low tension electroceramics, sanitary and utility ware, and floor tiles. It might also be used in the

production of coloured glass containers. For the production of all kinds of glazes, table porcelain, and high tension electroporcelain the feldspar is not suitable because of its sodium oxide-potassium oxide ratio and high impurity content. However, in such cases where quartz sand is mixed with feldspar optimal dressing would eliminate impurities only and not attempt to separate both components since most products requiring feldspar also require silica.

The Institute prepared a technical report and four alternative pre-feasibility studies of beneficiation of kaolin, feldspar, and quartz sand from the kaolinized granite of the Bare deposit, Arandjelovac basin. In these studies only two thirds of the raw material (dressed kaolin, feldspar, and quartz) were regarded as saleable products, while one third (mica, a mixture of fine quartz and feldspar with kaolin and impurities) was regarded as waste. It was however recommended that mica be used either for the production of light insulating bricks or for the production of welding electrodes and that the fine mixture of remaining minerals be used for the production of wall and floor tiles. The study shows that a dressing capacity of 20,000 tons of kaolin, giving also about 19,000 tons of potassium feldspar (ratio 3:1) with 10%-11% alkali and about 19,000 tons of quartz sand is feasible and viable. Contrary to expectations none of the dressed products except quartz could be used in the refractory industry because the dressed kaolin retains traces of feldspar. However, the dressed feldspar is of very good quality and its 3:1 ratio of potassium oxide to sodium oxide would permit its use in the production of glazes. Since raw materials of low refractoriness cannot be used by the "Šamot" Arandjelovac in the production of fibrebricks further investigation seems unlikely. In the interest of fully exploiting this deposit the Institute recommends that potential consumers of these dressed raw materials (such as the electroporcelain plant at Arandjelovac and the ceramics works at Mladenovac) be made aware of their availability.

Magnesite. Beneficiation of magnesite from the serpentinite deposit at Korlaće was done by leaching with hydrochloric acid. The results showed that this method is technically suitable because it produces magnesium chloride. How to purify this semiproduct for industrial use is a problem requiring further research.

Phosphate. Beneficiation of low grade phosphate ore was investigated experimentally in the laboratory of the Institute. The results showed that low-grade ore with 10%-12% phosphorous pentoxide can be dressed up to 33% phosphorous pentoxide. A pilot plant test at the deposit by RTB Bor, confirmed these results and a preinvestment study was made which has served as the basis for discussing investment and funding plans.

Pigments, mineral. A few small mineral pigment deposits have been found in Yugoslavia. After dressing the samples were tested in the production of colours and laquers. It was found that both colour intensity and particle sizes compare favourably with mineral pigments now imported.

B. Production problems

Ceramics. The capacity of the ceramic factory at Kikinda was increased by using equipment from Italy with a short 20 minute firing cycle. Because the factory had no experience with such a short firing cycle, it requested assistance from the Institute both on firing problems and on such questions as body composition and suitable glaze application. It is expected that the investigation of these problems will continue.

The Arandjelovac "Šamot" factory had a problem with the production of fire-bricks because the bricks expanded when grog from the rotary kiln was used. This problem resulted from mullite development during firing. A very exact method for testing the percentage of mullite in fired grog was recommended and accepted and is now used for quality control in the factory.

Fused refractory grains. Fused refractory grains and bauxite were also subjected to laboratory investigation. Since the experiments on production of fused grains of mullite-corundum, carried out in close collaboration with the refractory manufacturers, were successfully completed, the Institute may take up work on their utilization in the manufacture of high grade alumina and high quality refractories, including castables, mouldables, and ramming masses. This will help manufacturers to diversify their production, match international quality standards, and reduce imports in this field. Experimental production of fused corundum grains was also encouraging. The results showed the high potential value of the white bauxite found in Yugoslavia.

In collaboration with Magnohrom and Bauxite Cetinje successful experiments on the production of fused magnesium chrome grains were conducted at Cetinje in the 1,500 kW furnace. Experiments were then begun on quartz fusion. Amorphous quartz is required by "Šamot" Arandjelovac for the production of nozzles for continuous steel casting. The preliminary tests were made on inadequate equipment; investigation with adequate equipment should be continued intensively with a view to producing grog. Successful grog production would represent a new product for the Yugoslav refractory industry.

Limestone milled. The limestone and marble factory at Venčac wanted to increase the production of finely milled (below 30 microns) limestone to be used as filler. There is a great demand for this kind of filler in Yugoslavia. Additional technologically new and economically viable equipment was discussed and recommended.

Pyrometric cones. The project demonstrated the feasibility of economically producing pyrometric cones in Yugoslavia and production of industrial type pyrometric cones (60 mm high) is planned in the course of the coming year. On the basis of its experiments the Institute produced a trial batch of 100 kg. It was shown that the refractoriness compared favourably with imported cones.

Synthetic refractories. Synthetic refractory products like mullite were studied because of the interest of refractory producers in standardizing methods for production of high quality firebricks which would contain a high concentrate of mullite from indigenous raw materials. The characteristics, selection, and preparation of indigenous alumina and bond clay for two kinds of synthetic firebricks with 50% and 80% alumina were investigated experimentally. Trial production produced good results and industrial production is planned.

Waste products. Investigation of the kaolin waste from quartz sand dressing at Rgotina, Zaječar showed that the kaolin is of good quality and could be used to replace or partly replace imported kaolins. Further investigation is needed to study the feasibility of utilizing recovered kaolin in the ceramic industry because manufacturers are reluctant to substitute new and untried local raw materials for familiar ones.

The deposit at Rgotina will soon be superseded by the neighbouring deposit at Biela Rjeka which has the same geological composition so that the same results obtained from Rgotina can be expected from this new deposit.

Oblaci - Biela Rjeka is a promising new deposit of quartz sand. After washing the waste seems to be a good source of kaolinite. The kaolin particles (below 20 microns) are of good quality and could be used in the paper industry because of the low iron oxide content. Separation of the kaolin particles by hydrocyoloning and centrifugation was recommended. However, some parts of the deposit have a higher iron oxide content and should be dressed electromagnetically. Further tests should be made to find a suitable magnetic separator. The possible utilization of these kaolin particles in the ceramics and rubber industries should also be studied.

C. Staff and equipment

Staff. Since the Institute's previous experience was primarily with dressing metallic ores it was necessary to provide supplementary training for staff concerned with the project and supplementary equipment for investigating non-metallic mineral ores.

International experts and consultants were recruited according to the needs of the project. With their assistance the Institute's specialists in metallic minerals were able to reorient their experience to dealing with the problems of economical exploitation of non-metallic mineral resources. This training was supplemented by four study tours: to Italy (1976), to the Federal Republic of Germany (1977), to the German Democratic Republic (1977), to the Czechoslovak Socialist Republic (1978).

The study tour to Italy had six participants who visited the Istituto di mineralogia e petrografia, Rome, where problems of ore dressing and samples preparation as well as utilization of results were discussed. The participants also visited the Laboratory for Treatment of Raw Materials, where they observed work on the problems of dressing and beneficiating kaolin from Sardinia. In the Istituto statale dell' arte ceramica, Faenza, they investigated various ceramics problems including testing equipment. The participants visited five plants including factories producing sanitary ceramic ware, refractory products, and heavy clay ceramic products. The trip lasted 14 days.

Eight participants visited the Federal Republic of Germany. They inspected three institutes dealing with ceramics and synthetic refractory minerals and the kaolin dressing factory at Hirschau. The trip lasted 16 days.

Two participants visited the Institute for Refractory Industry, Meissen, and a factory for basic refractories in Aken in the German Democratic Republic. The trip lasted five days.

Eleven participants visited the Czechoslovak Socialist Republic. Five of the participants were specialists in dressing non-metallic minerals; six were specialists in ceramic technology. Each group studied and discussed their respective problems with Czechoslovak counterpart specialists. The trip lasted 7 weeks.

Equipment. Since the Institute had little equipment suitable for testing non-metallic raw materials, UNIDO purchased and supplied the project with the necessary equipment (see Annex II). UNIDO also made every effort to provide current professional literature for the use of both local and international staff during the operation of the project.

II. GENERAL CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

1. Research carried out during the project resulted in the new investments summarized in table 3.

Table 3. New investments

Investment	Site	Purpose	Estimated cost
New plant	Bentokos, Kosovo	Dressing bentonite: capacity: 200,000 tons yearly	$12.5 million
New plant	Rgotina-Oblaci	Dressing quartz sand	$5 million
Reconstruction of existing plant	Rgotina	Expand capacity	$1 million
Reconstruction of existing pilot plant	Cetinje	Production of electromelted mullite	$750,000
Reconstruction of existing plant	Gramada Niš	Chalk production	$300,000

2. During the project the Institute, as the counterpart organization, was able to increase collaboration with other institutes in Yugoslavia dealing with metallic as well as non-metallic raw materials. This is of great importance because the waste after dressing metallic ores is often a source of non-metallic raw materials which can be further dressed and successfully used by industry.

3. During the project the Institute gradually assumed a leading role in technical matters connected with the beneficiation of non-metallic raw materials. An important factor in this development was the transfer of responsibility for research problems from individual specialists to research teams set up to work on specific problems but including specialists from many disciplines. This change helped to increase the quality of research to such a point that solutions submitted to the Research Council of Serbia were regarded as final and were recommended for processing and utilizing the raw materials in question.

4. The project demonstrated that optimal industrial exploitation of Yugoslavia's non-metallic mineral resources cannot be expected without more basic research.

5. During the project the Research Council established a programme for research in non-metallic raw materials. The Institute was designated team leader and made responsible for collaborating with other institutes and university faculties throughout Yugoslavia.

6. As the result of training received during the project local specialists are now able to support local industries with a higher level of technological information and experience.

7. The project contributed to fulfilling the immediate and developmental objectives of the YNP. For example, it was shown that bentonite consumption can be covered by domestic production alone and that Serbia will be able to supply Yugoslavia's requirements for sheet glass, utility glass and glass containers from locally dressed raw materials.

B. Recommendations

1. While new problems in dressing and beneficiation will continue to arise in the future, more basic research should be undertaken on the industrial utilization of these raw materials in local enterprises. Such a global approach to Yugoslavia's non-metallic mineral resources would simultaneously reduce the need to import non-metallic raw materials and would increase the capacity and product range of Yugoslav industry.

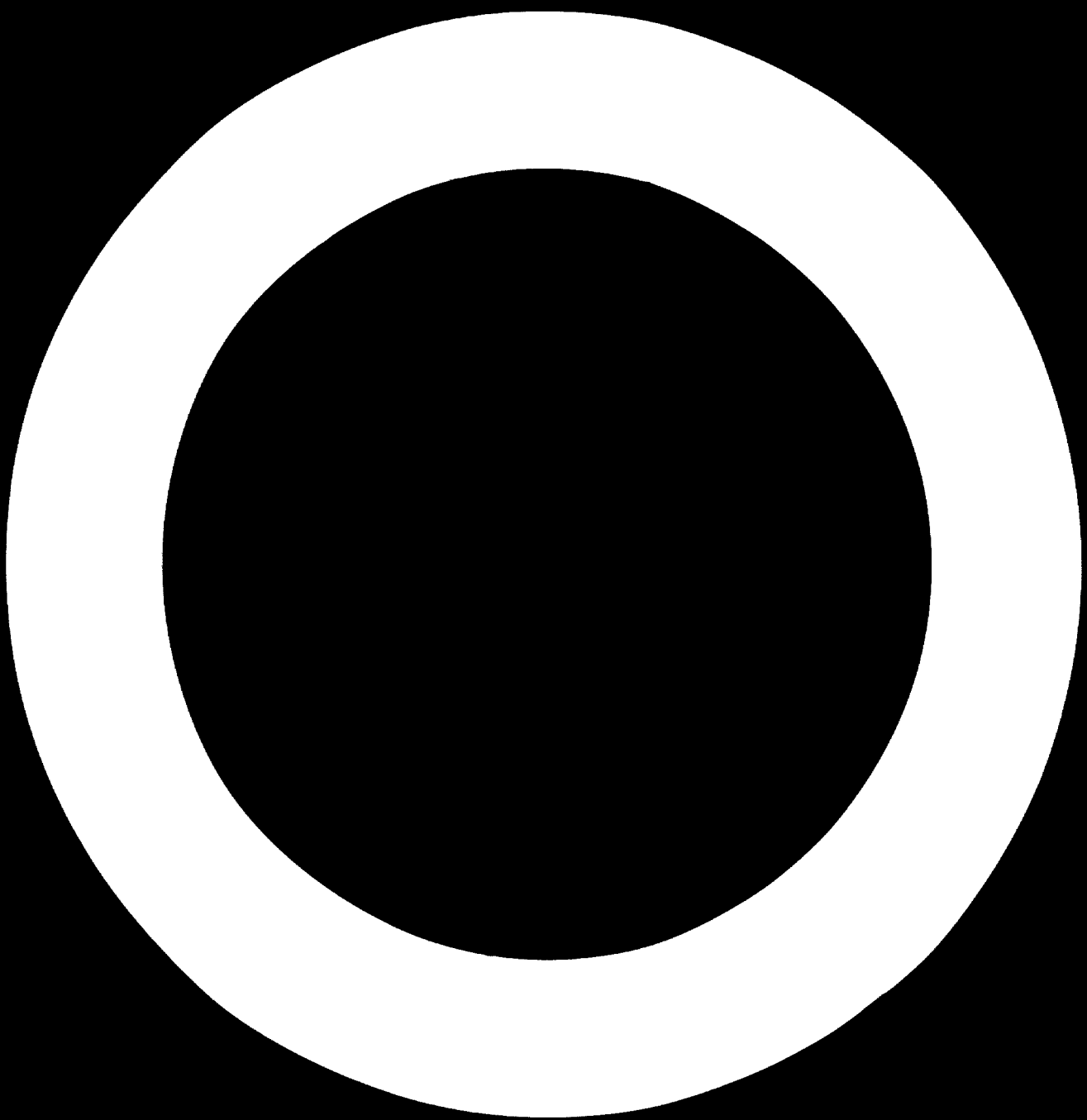
2. Interdisciplinary basic research teams to deal with specific problem areas should be set up in appropriate institutional environments. This would promote the success of the global approach to exploiting Yugoslavia's non-metallic mineral resources.

3. Special funds should be set apart to finance basic research. When funds for basic research are not available from either industry or government, the possibility of generating such funds in the research institutes or other appropriate institutions themselves should be investigated. As laboratory experiments and trial runs demonstrated, for example, one such possibility might be the manufacture of pyrometric cones, a delicate process requiring careful control at all stages of the production process, by the Institute.

4. Feasibility and pre-investment studies should be prepared as soon as possible after basic research has provided what appear to be viable solutions to given technical or technological problems. Such studies should be written in plain language and emphasize the results of laboratory testing and their practical applications. In this form the results of basic research could be quickly assessed by decision makers in local industry.

5. In addition to publishing research findings in technical and scientific journals, research institutes and other concerned institutions should take an active role in promoting knowledge of new techniques, technologies and products

to local industry. This could be done by organizing meetings or seminars to be attended by representatives of local industry, of the Chamber of Industry, and of the Government. Such meetings would also provide representatives of local industry with an opportunity to discuss new, current, or pressing technical or technological operating problems with research specialists in the areas concerned. At the international level similar meetings or seminars could promote multilateral co-operation. As a result of the study tour to Czechoslovakia, for example, a bilateral agreement for scientific collaboration between the Institute and the Czechoslovak Ceramic Works is now under consideration.



Annex I

STAFF

A. International staff

Dr. M.H. Buckenham, New Zealand, phosphate expert, December 1977

Dr. K. Engelthaler, CSSR, silica expert, December 1976-March 1977; November 1977

Dr. Sudhir Sen, India, clay expert, May 1975-April 1976; November 1976-October 1977

B. Counterpart staff

Blagoje Zogović, Project director

Dušanka Pupezin, Project co-director

Collaborators:

Nevenka Ćosović	Dragan Milić
Rade Ćosovoć	Siniša Milošević
Djordje Cvetanović	Marinko Miroljub
Nenad Djaković	Zora Potočnik
Životije Djordjević	Dragan Prodanović
Zora Djukić	Srbobran Rajić
Miroslav Dmitrović	Ljubomir Rikalović
Dragica Galović	Aleksandar Simić
Nadežda Gladović	Milica Simović
Radmila Ilinčić	Aleksandar Stojiljković
Radoslav Ivković	Magdalena Tomašević
Jelena Lučić	Radoslav Vasiljević
Miloš Maksimović	Milorad Veselinović
Danka Maršićanin	Radomir Vuković

C. Fellowships/Study tours

1. Place: Italy
   Date: 11 December 1976-24 December 1976
   Participants:

Milan Djukić	Magdalena Tomašević
Dušanka Pupezin	Dragoslav Trunić
Aleksandar Stojiljković	Blagoje Zogović

2. Place: Federal Republic of Germany
   Date: 8 March 1977-24 March 1977
   Participants:

Borivoje Desivojević	Ljubomir Rikalović
Jelena Lučić	Aleksandar Simić
Dušanka Pupezin	Radomir Vuković
Natalija Rajković	Blagoje Zogović

3. Place: German Democratic Republic
   Date: 4 July 1977-8 July 1977
   Participants: Aleksandar Marićić
   Zora Potočnik

4. Place: Czechoslovakia
   Date: 4 March 1978-25 April 1978
   Participants: Djordje Cvetanović
   Radmila Delibašić
   Milan Desivojević
   Nenad Djaković
   Jelena Lučić
   Miroljub Marinko
   Dragorad Martinović
   Dragan Prodanović
   Milorad Radaković
   Ljubomir Rikalović
   Blagoje Zogović

Annex II

EQUIPMENT

A. Equipment provided by UNDP/UNIDO

1. Laboratory mixer for dry and semidry materials
2. Laboratory filter press unit with necessary tanks and homogenizer
3. Laboratory ball mill with silex lining and non-metallic balls
4. Laboratory press, type Ll
5. Testing machine for CCS and strength of rupture
6. Laboratory kiln for testing PCE, complete with transformer and standard cones
7. Laboratory kiln for RUL testing including registration of temperature and deformation of sample
8. DTA and TGA testing equipment
9. Laboratory extrusion machine PZVM 8 b
10. Electrovibrator, laboratory type
11. Laboratory Rillem's equipment
12. Laboratory cyclosizer
13. Differential colorimeter
14. Wet gravimetric concentrator and electrostatic separator
15. Landrover car, type 88

B. Equipment provided by the Government

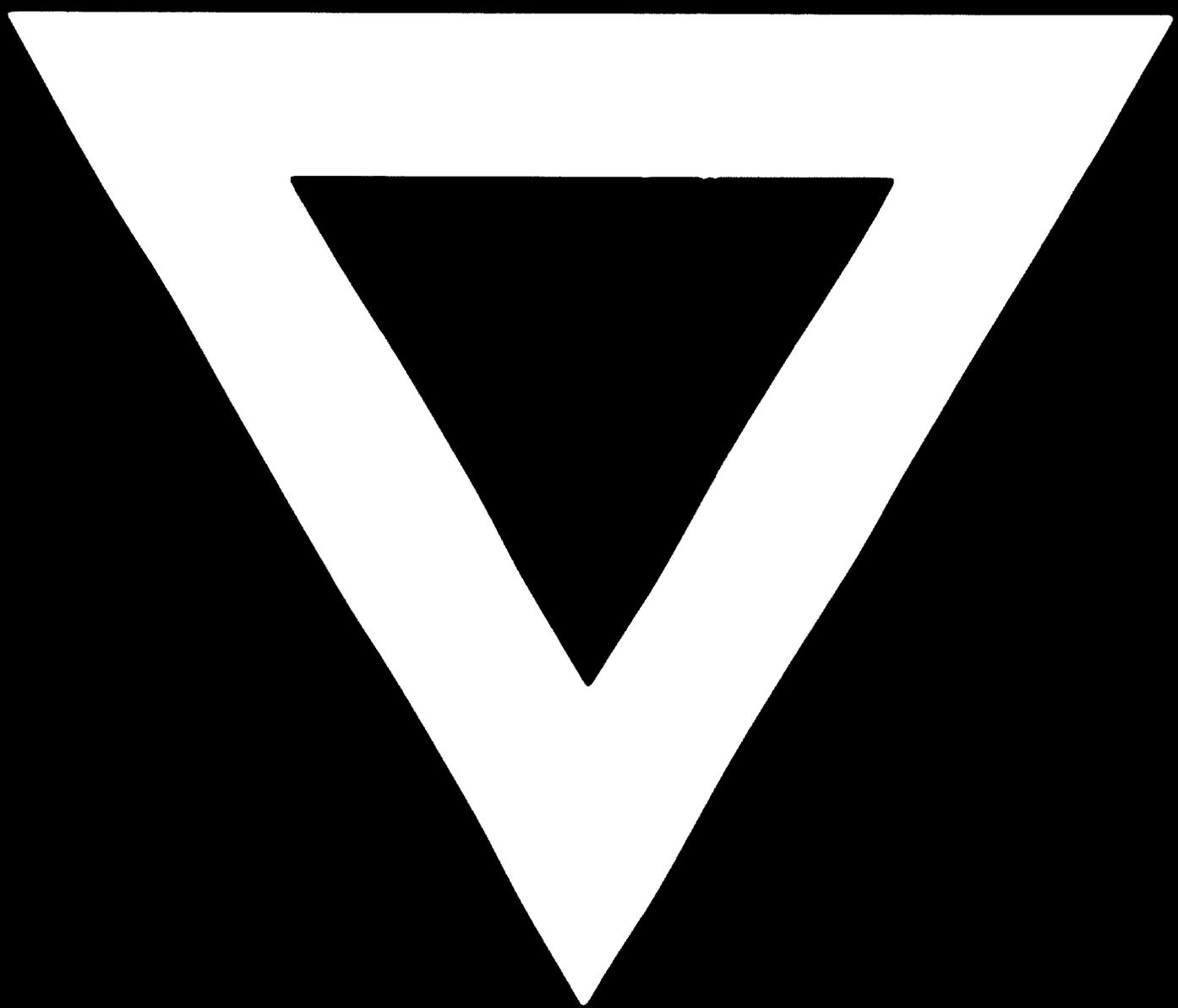
1. Berthelotmahler colorimeter
2. Dust collector based on gravimetric sedimentation
3. Digital ion meter, type PW-9417
4. Core drilling machine for sample preparation, type T.SB-23
5. Electric centrifugal pump - 2 pcs.
6. Grinding machine for preparing laboratory samples
7. Screen vibrating machine for screening samples, type MLW
8. Kiln for firing to 1,200°C, type LP-08
9. Filtration equipment for dewatering samples

Annex III

LIST OF TECHNICAL REPORTS PREPARED DURING THE PROJECT

	Title	Author	Date
1.	Comment on discussions and suggestions about problem of investigating the possibility of thermal treatment of feldspar to obtain concentrated potassium salts	S. Sen	December 1976
2.	Pre-fsasibility study on kaolin dressing at Rgotina	K. Engelthaler	January 1977
3.	Technical note on fused quartz, its properties, uses, and production	S. Sen	February 1977
4.	Technical note on electrofused corundum, its production, properties, and use in refractoriss	S. Sen	February 1977
5.	Technical note on and suggested work-plan for industrial utilization of alunits ore from Macedonia	S. Sen	March 1977
6.	Technical note on bentonite, its properties, uses, and production	S. Sen	June 1977
7.	Determining $CaCO_3$ and $MgCO_3$ in bentonites	S. Sen	August 1977
8.	Possible production of pyrometric cones	K. Engelthaler	November 1977
9.	Production of alumina ceramics	S. Sen	November 1977
10.	Some aspects of dressing quartz sand and feldspar from the deposit Vlaški Poljs "Stale".	K. Engelthaler	December 1977
11.	Dressing quartz sand from Valjevo-Ćucugs	K. Engelthaler	January 1978
12.	Pre-feasibility study of dressing kaolin and feldspar from granite at ths Bars deposit, Arandjslovac basin	K. Engelthaler	February 1978
13.	Dressing refractory clay from Rudovci	K. Engelthaler	March 1978

I-499



81.05.27