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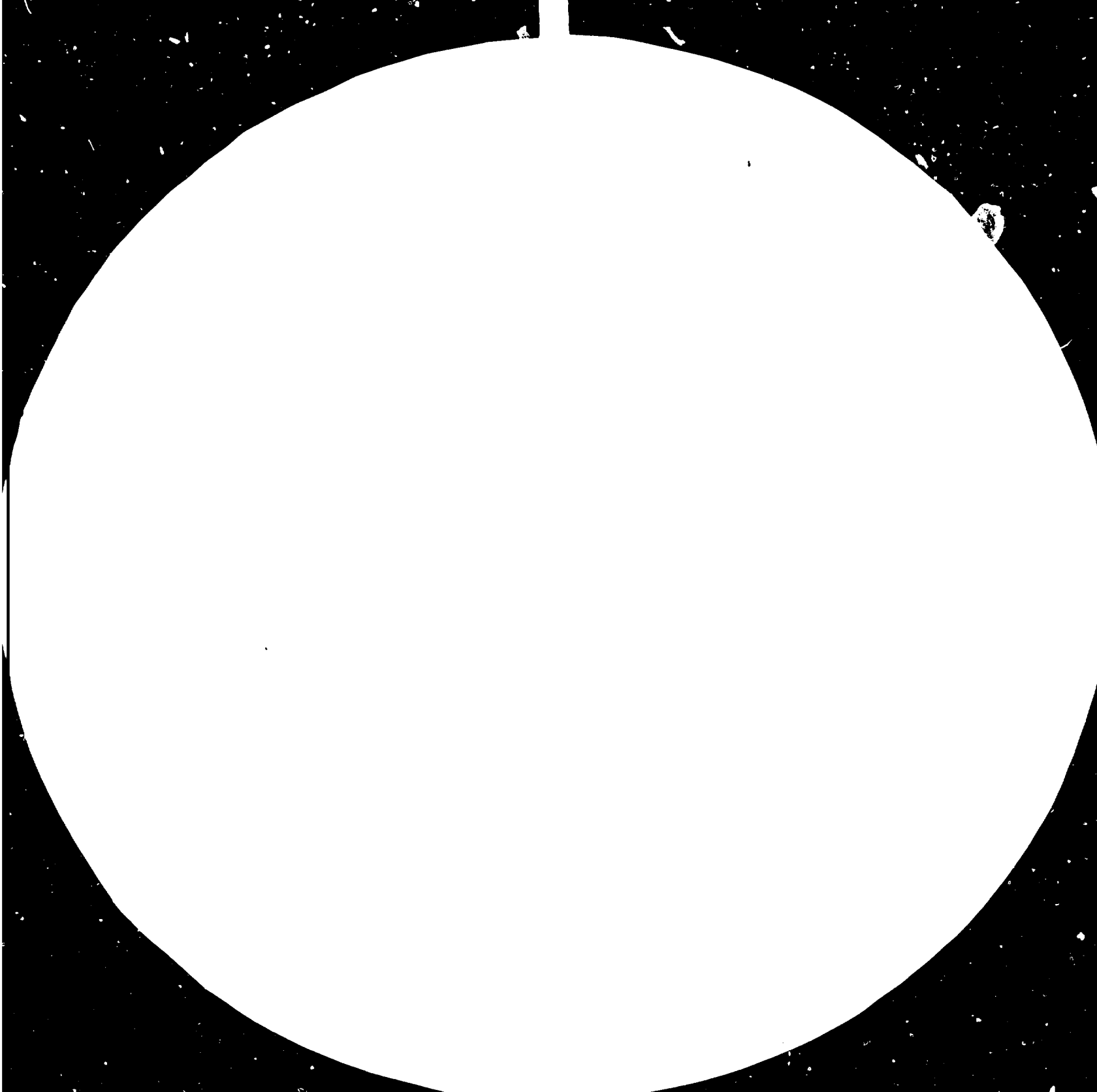

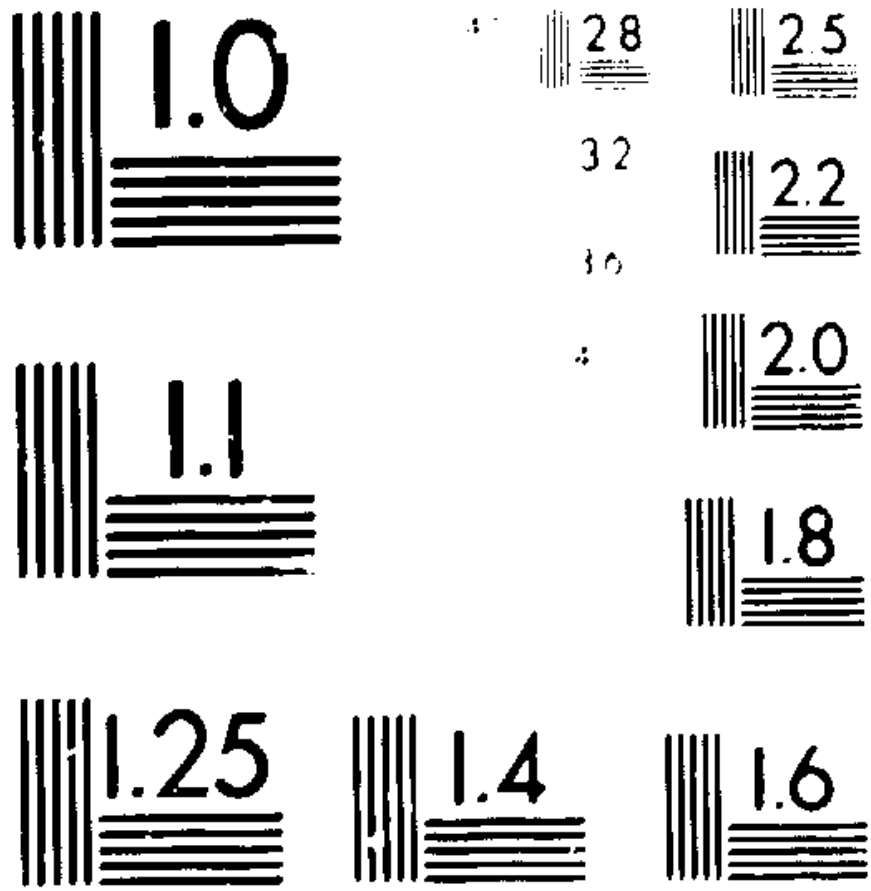

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PRODUCTION AND UTILIZATION OF QUARTZ, FELDSPAR, CLAYS AND KAOLIN

DP/YUG/82/004

YUGOSLAVIA

Technical report: Dressing of kaolin and other non-metallic minerals*

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

Based on the work of J. Baburek,
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United Nations Industrial Development Organization
Vienna

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Abstract.

The main purpose of Project is to increase the utilization of local resources of kaolins, quartz sand, feldspar and mica, Project number DP/YUG/82/004/11-03/32.1.B.
The objective was to:

Assist in the development of optimal technologies of delamination for selected kaolins.

Recommend industrial equipment / if possible continuously/ for delamination of local kaolins in order to decrease the content of kaolinite in the waste.

Evaluate from geological and mining points of view the deposits of local kaolins and formulate recommendations for their exploitation.

Duration of the mission was 25 days.

Laboratory and some pilot plant tests of kaoline dressing of local deposits had shown some possible methods of its beneficiation and utilization. We recommend to begin exploitation and dressing of kaolin and feldspar on Bare-Garaši deposit and erect a pilot plant on the same deposit. In the case of other local kaolin deposits we recommend to finish the geological prospection and to finish semi-industrial tests of dressing the raw kaolin. Besides, we suggest to continue the activation tests of kaolin and bentonite and start with the activation of special calcium carbonate fillers. We recommend to continue on the UNDP project and improve the laboratory results by pilot plant and semi-industrial tests. We recommend also to prepare a new project which will study dressing and utilization of local deposits of bentonites, zeolites and refractory raw materials - kyanite and sillimanite.

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INTRODUCTION

Yugoslavia is the country rich in the raw materials. Exploitation of non ferrous metals had excellent and very long tradition, and today the exploitation and dressing of them hat a great positive influence to national economy.

But, utilization of deposits of non-metallic raw materials had not a needed level, and many of them, such as kaolins for paper, rubber and ceramic industries have to import such kind of materials. Further, ones have to import refractory raw materials, filter aid diatomite, some special purposes glass sand, and many other non-metallic raw materials, also.

Geological prospections in last years, helps in finding many deposits of non-metallic raw materials including kaolin, white burning and refractory clays, feldspars, quartz sand for foundry, glass and other technical uses. Further, discovery of new deposits of bentonites, perlites, zeolites and many other.

Many of up mentioned raw materials must be dressed before the use in the industry processes.

Such a situation required to be solved and the Government of SR Serbia through the Institute for Technology of Nuclear and other mineral raw materials in Belgrade, asked for UNDP cooperation in order to shorten the lenght of time of the development of dressing and utilization of local non-metallic raw materials. In such a way the Project ''Utilization of local non-metallic minerals'' was established and during the implementation of its Phase I. covered

kaolins, refractory and white burned ceramic clays, mineral pigments, chalk, phosphates, magnesite, bentonite, bauxite, quartz, feldspar, alunite, limestone and other minerals so that it may be said that at the end of the Project's Phase I. it covered all of the non-metallic raw materials which were available not only in SR Serbia but in the country as a whole.

During the operation of Phase II. of the Project it was realized, that it is necessary to concentrate the capacity of the Project and also the capacity of the Institute /henceforth - referred to as ITNMS/ as its implementing agency to only few selected non-metallic minerals which are in the biggest demand and are also most important for the country and its industries. So it was decided to concentrate the effort on beneficiation and utilization of quartz sand, kaolins, feldspars and white burned ceramic clays.

In view of such a situation and promissing targets the Government of SR Serbia earmarked for the activities of Phase II. the sum of 37.096.000 dinars in kind and from IPF the amount of US $ 331.064. The implementation of Phase II. was programmed from 1. October 1978 to the end of December 1981.

The UNDP contribution was mainly utilized for procurement of some special equipment items, periodicals, recruitment of foreign experts and arrangement of training. The Government contribution was mainly used to support locally recruited personnel including the Project Director, maintenance of existing premises and equipment of the ITNMS as the counterpart organization.

The Project helped to work not only for the republic of Serbia but also for other republics and autonomous provinces of SFR Yugoslavia in dressing problems of non-metallic raw materials.

The ITNMS under the influence of the Project gradually increased the collaboration not only with other Institutes in SR Serbia, but also with the Insitutes in other republics and abroad.

During the life of the Project the non-metallic problems selected by scientific comunity came under a complex project where the ITNMS was selected as the team leader. Through all activities of the Project in the ITNMS the knowledge of local specialists increased so that they are able to support the local industries with the higher level of know-how namely in the field of dressing and beneficiation as well as in the field of utilization of non-metallic raw materials especially kaolins, clays, feldspars and quartz sand.

During the second step of the Project, it is found important to optimize before proposed methods of dressing, namely separation and delamination of kaolins and to determine the best methods of the activation of kaolins and calcite, in order to obtain high quality filler for plastics, paint and rubber. Therefore it was necessary to ask for the UNIDO expert help.

I. RECOMMENDATIONS

These recommendations outline the work programme for the solution of most urgent problems. To be in possibility fo give a real help in the development of optimal technologies of delamination for selected kaolins and evaluate the local kaolins and formulate recommendations for their exploitation, it was necessary to study attainable documents they was especially reports ITNMS, geological prospection reports, publications in periodicals, a technical and terminal reports for the Government of Yugoslavia by the United Nations Development Organization.

On the basis of hereto mentioned documents, and on the basis of the world levels of dressing and utilization nonmetallic raw materials it is possible to give next recommendations:

1. Exploitation and dressing of kaolin, Bare-Garaši deposit.

Kaolinized granite deposit Bare-Garaši is the greatest in all Yugoslavia, today. Reserves of raw kaolin, found by the geological prospection are very big.

The deposit is situated 7 km on the west from town Arandjelovac, on the western slopes of Bukulja Mt. It has an elongated lenticular shape and extends in the direction

NW - SE , with maximum lenght 3,5 km and maximum width 1,8 km. Thickness of kaolinized granite is 40 - 50 m, but along the faulted zones exceeds 80 m.

Overburden of the deposit is not to thick, and is composed of soft sediments as clay and soil with some pebbles. Desit is situated on the slope of the hill, what improve draining of the water during the exploitation of the kaolin.

Testing of the raw material which has been done by ITNMS and abroad, had shown that the kaolin contains iron compounds in a large quantities, most times, more than 2%. Tests on separation of iron compounds in kaolin were not successful because iron oxides there are very fine divided and buld a thin film on the kaolinite crystals and aggregates. From the stand point of high iron content those kaolins are not suitable for the use in porcelain production and as a filler in paper industry.

As nearby the kaolin deposit is located the big refractory plant, it seems a very best to use washed kaolin from this deposit instead refractory clays used up to day in the plant, from the old deposit which soon will have not a reserves of clay.

To improve economical parameters of kaoline production for refractory plant, it is usefull to separate the feldspars, which id a important raw material component.

Potassium feldspar and quartz sand are another two important products by complex utilization of crude material, from Bare-Garaši deposit. Dressed feldspar, according the results of ITNMS, corresponds to the I. quality according JU Standards except slightly higher content of CaO.

Utilization of quartz, which need the second flotation step to decrease content of feldspar, depends on economical balance. Any how, the quality of the quartz sand, and after the second step froth flotation is not suitable. For this reason it will be better to use it without any preparation, for example for civil engineering.

To accelerate the industrial utilization of this up to day biggest Yugoslav kaoline deposit we recommend the next:

1.1 According to the tests of geological prospection it is necessary to divide the exploitated field in blocks or balls with the same quality - with known iron oxide and alumina content. It make possible to exploit and produce in a future different types of washed kaoline, which possibly can be used in ceramic industry and as a filler in paper and rubber industries / see ANNEX 3/.

1.2 Total capacity of production plant should not be smaller than 100.000 tpa washed kaolin / in the first period it may be only 50.000 tpa/see ANNEX 2/.

1.3 To make a project of exploitation of the deposit and beneficiation of raw material so that it will be possible to excavate raw mineral material in different qualities.

1.4 Alternatively to solve the problem of utilization the sand fraction, waste product during the dressing process, mainly for civil engineering purposes.

2. Exploitation and dressing of Karačevo kaolin deposit.

The deposit is situated near the village Karačevo, 34 km NW from the town Bujanovac, in the western part of the great granite massif of Bujanovac. It has an elongated lenticular shape with variable thickness, from 0,5 m in the marginal part to 31 m in the central one. The kaolinized granodiorite passes gradually to the parent rock. In many cases there are in the kaolinized rock blocks of hard stone. The overburden consists of a granodiorite gruss.

Being geologically tested the deposit is opened and mined. The crude ore is presently used in small quantities as an addition to various ceramic bodies. The geological reserves there are not too large.

As the mineralogical and chemical composition and the technological properties of the mineral raw material are very variable, due to different stage of kaolinization

of parent rock, to clear, the possibilities of its utilization soon as possible, we recommend the next:

2.1 On certain place, near the deposit erect a pilot /or small production/ plant with the capacity of about 1 - 2 tph, to make a tests of different types of raw material from the deposit and to supply for a long period the perspective users.Later may be this plant completed with the necessary equipment and can produce up to 15.000 tpa washed kaolin.

Electromagnetically dressed kaolin fraction is actually a mixture of kaolinite /approximately 55 %/fine divided sodium feldspar and fine quartz sand and seems to be suitable not only for the production of porcelain a sanitary ware but also as a filler in paper and rubber industries.

2.2 To check possibility of production of ceramic semibodies and bodies with standard properties, for production of table ware, electrotechnical porcelain, sanitary ware and wall tiles.

2.3 Just after evaluation of articles 2.1 and 2.2, it can be possible to have a last decision about event. investment in the more large scale. However it depends on geological reserves of the raw kaolin in the deposit Karačevo.

3. Exploitation and dressing of raw kaolin from Motajica deposit.

The deposit is situated near the village Bosanski Kobaš, on the northern slopes of Motajica Mt.,Bosnia.

The parent rock of the kaolin is a granite of Late Hercynian age, with a following modal composition: quartz - 32,5%, K-feldspar - 35 %, plagioclase - 25,5%, muscovite - 5% and biotite . 1,5%. The deposit was geologically tested geological reserves of many milion tons in A, B, and C_1 categories are ensured.

The wet dressed kaolin is in its granulometry slighly coarser than e.g. kaolin Karačevo or Djevdjelija. On the other hand this kaolin is as far as content of mineral kaolinite concerned one of the best kaolins in SFR Yugoslavia. It can be therefore used in combination withy any other more plastic kaolins for the production of fine ceramic, electroceramic, and sanitary ware. However, it is to be stressed that large Pilot plant or semi-industrial tests should certify first laboratory results obtained.

The kaolin was delaminated /fraction 10 - 63 um/ to find the possibility to separate quartz, kaolin and feldspar within aggregates. It is shown, that delamination of kaolinite crystal aggregates take place, but simultaneously occurs very intensive desintegration of iron bearing minerals.

We recommend :

3.1 To done pilot plant and semi-industrial tests to prepare big amount of washed kaolin which may be industrially tested by users.

3.2 On the basis of semi-industrial tests carry out technical and economical evaluation of deposit Motajica and its industrial utilization.

3.3 As the laboratory tests which we have up to day shown that the raw material contents only 10 % of washed kaolin, it seems not to be industrially explored in a near future.

4. Dressing of kaolin from Bela reka deposit.

The deposit of sand stones "Bela reka" is located in the eastern part of SR Serbia, in the region of Bor. The geological prospection has established and confirmed the reserves of sand stones in categories $A+B+C_1$ are large enough.

The laboratory and semi-industrial tests have shown that quartz sand from the deposit Bela reka in respect to its granulation and chemical composition. Sand stone contains few percen of kaoline, which must be washed to obtain requested quality of the glass sand. Washed kaolin - actually a mixture of kaolinite, very fine quartz particles and potassium feldspar is principially possible to use in local industries.

Kaolin fraction is - as said above - according the laboratory tests a mixture of approximately 40 % kaolinite, 15 % feldspars and 45 % fine divided quartz. However, the

content of iron and titania oxides is low.

Quartz sand, which was tested not only in Yugoslavia, but also by the British Glass Industry Research Association is of good quality.

For the deposit Bela reka a study for capital construction has been prepared by the ITNMS and it is expected that a plant producing high quality quartz sand is going to be built very soon.

We recommned:

4.1 As, in this days, Yugoslavia imports considerable quantities of high quality glass sand it is necessary to accelerate construction of the plant on the deposit Bela reka, and to make a good marketing in domestic and foreign glass sand market, in order to provide selling of the goods from the plant.

4.2 As it is known, the content and mineralogical composition of clay fraction in such a kind of sand stones may vary in a very wide range. From this reason we recommned to build up a settling basin in which will be this fraction concentrated so, that it will be possible to use it for industrial purposes in the future.

5. Exploitation and dressing of raw kaolin from Mesići deposit.

Mesići is a new deposit tested geologically in last few years and occurs near the town Vršac. According the results of geological prospection it is a secondary deposit, kaolin and clay fraction is of a low quality because of high content of iron compounds, which cannot be removed nor by high gradient magnetic separation.

A pilot plant production line was erected at Vršac - Mesiči with a capacity of one ton per hour, producing feldspar and quartz sand as well as mica by froth flotation.

In this case we recommend:

5.1 Nevermind the content of clay fraction reach 17% in the raw material, its quality is so low, that is possible to use it only for stone ware respectively for wall and floor tiles production. The stone ware plant /Bela Crkva/ can use this clay, but its price will be so high, that the final production will be no rentabile. Eventually separation of feldspar and qurtz sand and mica will not improve the rentability of the plant. From this reasons we do not recommend the erection of the plant.

5.2 Technological and chemical characteristics of the raw material recommends its good homogenization and utilization for the stone ware production after milling in a raw stage.

6. Exploitation and dressing of the kaolin on a Djevdjelija deposit.

Deposit of kaolinized gabbro is actually a part of a large Vardar gabbro massif. A relatively broad zone hydrothermally decomposed gabbro extending itself from North to South is well kaolinized. The best kaolinized gabbro, white in colour, occur near the village Dono Konsko. However, the geological survey is not yet completely finished.

Washed kaolin has after magnetic separation a good quality, low content of iron and titania compounds, but a little higher content of calcium and magnesium. However, for the paper fillin purposes such a content of calcium and magnesium is not dangerous as well as for some ceramic productions.

Deposit has a linear schape, it lies in a narrow valley and the overburden is vulcanoklastic sediments. From this reason, the opening and exploitation will be very complicated and costly.

We recommend :

6.1 Accelerate the evaluation of the geological prospection and calculate exploitable reserves of kaolin on the deposit Dono Konsko. Accelerate the new geological

prospection in surrounding of the deposit.

6.2 On the base of geological prospections chose a typical sample for semiindustrial tests. The washed kaolin from these tests, to be tested in paper, rubber and ceramic industries.

6.3 On the base of technical-economical study prepared on the results of geological prospection and technological tests, make a last decision to start or not the erection of the plant.

7. The activation of the ceramic kaolin.

It is very good known, that correctly conducted and suitable applied mineralogical studies alone can provide explanations for different technological properties of various mineral raw materials and allow to determine the optimal dressing method at minimum costs.

A suitable example of applied mineralogical research is the process for increasing the green strenght of clays and kaolins by extensive mechanical stressing of plastic raw material pastes and by adding a suitable electrolyte. Clays and washed kaolins contain as main component clay minerals, as kaolinite, montmorillonite, illite, chlorite etc. These minerals are mostly in the form of microscopic and ultramicroscopic particles which, however, do not arise separately, but are agglomerated in various compact blocks

similar to packs of cards. Although these blocks are partially disintegrated during the wet dressing of kaolin, there still remains a large number of crystal clusters, which markedly affect the properties of kaolin and those of the final products.

There is a number of reasons why the individual clay minerals crystals should be bound together in crystal aggregates. Apart from the diagenetic changes in sediments these are in particular the following:

The forces due to attraction by neighbouring particles.

Overlapping of ranges, in which molecular forces exhibit mutual effects, as a result of the considerable mutual area size of two neighbouring crystals.

Electrostatic forces affected by changes in the lattice of clay minerals as a result of electrically unbalanced changes in structure, as well as a result of attraction between the ions adsorbed on the surface of clay mineral particles.

The joining effect of absorbed molecules; these are in particular the oriented water molecules and the polar molecules of some organic compounds.

The presence of silicic acid in various forms and that of iron hydroxides which may act as cement in crystal aggregates of clay minerals.

All of these causes / and probably certain others/ are probably mutually combined in various ways so that it is difficult to assess which type of aggregation prevails with some raw material.

The extensive experiments which have been carried out in recent years have shown, that mixing of suspensions has in many cases a comparatively small effect on the disintegration of the crystal aggregates of kaolinite. Dry grinding of kaolin brings about disintegration of crystal aggregates however, even the individual crystals of kaolinite are broken and the non-clay substances present are likewise ground.

Optimal solution is a very extensive kneading of ceramic paste with addition of suitable electrolyte / the best are Na_2CO_3 and NaOH/ and huminic acids. Exchange positions or "acid centres", which are exposed during during the delamination process, are occupied by Na^+ ions. The molecules of huminic acids are adsorbed on the surface of the clay mineral crystals and had a function as a protection colloid.

Therefore we recommand:

7.1 Construct a laboratory continuous delamination equipment.

7.2 To do a test on delamination of different Yugoslav kaolins and ceramic clays, and results to be used as a base for industrial line project.

8. Activation of kaolin for a plastics and rubber uses.

Kaolins have been used for a long time as a fillers in rubber and plastics industries. It has be prepared, up to day in two main ways: washed kaolin have been dried to

the humidity up to 1% and milled, and second, calcinated on the temperature about 800°C, and very fine milled. In the last years, rubber industry have need for the activated kaolins, in which, the exchangeable kations have been replaced by some heavy metals, for example Cu or Zn. In the case of calcined kaolins the consumers needs a benefication of their surface with silanes.

We recommend:

8.1 Continue the tests on activation of selected kaolins by the compounds of Zn , and will be find the optimal reaction conditions, to build up laboratory test line, from which the product will be tested in industry. On the basis of industrial laboratory tests to project the semi-industrial and industrial line.

8.2 To test the possibility of production of calcium carbonate filler, coated by fatty acids and the product obtained test in rubber, plastics and cable industries. In positive answer, start with the semi-industrial production.

9. Accelerate of utilization of pyrophillite deposit Konjic.

Because, in a near future it will be not possible to replace imported kaolins for paper and rubber industries by local ones, we recommend acceleration of erection the plant for dressing of pyrophillite Konjic. The scheme

of dressing, suggested by IMMS is in principal good. Some changes will be necessary to make in near future. Further we recommend a testing of pyrophillite from Konjic deposit by manufactoring some refractory materials and electroporcelain.

10 . Activation of calcite.

The major consumers of white carbonate are the polymer / plastics and rubber/, paint and paper industries. The actual proportion consumed by each varies from one country to another and depends on a number of factors such as the relative size of each industry and the availability of carbonates compared to other fillers/extender products.

Of the major three end-users - paint,polymers and paper- major growth in consumption is likely to be in plastics, particularly if European automotive industry follows the US example by employing more and more plastic units in car manufacture, and paper, if the trend towards neutral/alkaline sizing gathers pace.

Although chalk, limestone and marble are all varieties of the mineral calcite, there are distinct physical differences between them. Chalk is a soft product made up of the shells of millions tinny organisms. The individual particles are rounded and the bounding between particles is weak and easily broken. Limestone, marble and dolomite are generally crystalline rocks, whose particles and grinding display the characteristic rhombohedral structure of

of compact but pointed particles.

The key functional properties of carbonate filler/extender are as follows:. particles size and shape, brightness, absorption characteristics / of oil and polymer/, dispersion characteristics, refractive index, and specific gravity. For most applications the higher fineness and higher brightness comands a price premium.

The Yugoslavia is rich in high purity calcium carbonates and dolomites. It is necessary to know a very pure calcit deposit Gadžin Han near Niš, Venčac near Arandjelovac and many other deposits in SR Macedonia,SR Slovenia and SR Bosnia.

Considering deficit of white kaolins and other white mineral fillers and pigments in Yugoslavia it is necessary to accelerate the production of white carbonate pigments and activated fillers. This problem of preparing of white pigments and fillers was discussed and laboratory tests starts during the mission of UNDP expert.

We recommend :

10.1 To do laboratory tests of milling, activation and sizing of calcium carbonate fillers and pigments in IMMS, product this beneficiation to be rest in rubber, plastics and paints industries.

10.2 Continue in wet milling and sizing of calcium carbonate fillers and coatings for paper industry.

10.3 Prepare technical-economical study of development of production of the calcium carbonate fillers and pigments in Yugoslavia, from the point of view of European market. In the content of the study, it is necessary to take in mind decreasing of consumption of crude oil and energy by application of activated calcium carbonate fillers in plastics.

11. Research and utilization of bentonite and zeolite in agriculture.

Yugoslavia has many of deposits with high quality bentonite, Some of them are in exploitation. Some of them, mainly with a lower quality will be possible to use in agriculture for benefit the soil properties, specially in the areas with low humidity in the soil. Other types of bentonite it is possible to use for preparing the cattle, pigs and chicken dietary.

The same case is with utilization of zeolite and zeolite tuffs which deposits have been last years discovered in Yugoslavia, but besides zeolites have more possibility of utilizations : dietary for pigs and chicken, for reducing the ammonia in the field of aquaculture, in deodourising animal waste products and many others.

We recommend :

11.1 To start with mineralogical research of the composition and possible utilization of bentonites and zeolites for agricultural uses.

11.2 To prepare technical-economical study of utilization of the domestic bentonites and zeolites in connection with needs of different climatic areas in the country and start with practical industrial tests.

12. Investigation of organobentonites and zeolite.

In this period of time there are increasing interests in organomineral materials, such as organophilic bentonites. The needs come from paint industry, lubricants and so on. In similar way, the increasing interest is also in use of zeolites, in recovery of sun energy, to effluent clean up, as a paper fillers etc.

From the point of view of the large geological reserves, both raw materials, we recommend:

12.1 Evaluate geological reserves of high quality bentonites usable for organobentonite production, and geological reserves of zeolites. To do laboratory research of mineralogical and chemical composition and technical properties of bentonites and zeolites.

12.2 Continue in laboratory research in possibilities of getting the organophillic bentonites and beneficiation of zeolites.

12.3 Prepare technical-economical evaluation of the method of preparing organophillic bentonites and make a project studies.

13. Pilot plant for kaolin and clay dressing.

As it is written in Terminal report /Project findings and recommendations/ from 2.9.81, all the laboratory results should be verified by semi-industrial and Pilot Plant tests, which can produce enough dressed products for technological testing of their utilization. These Pilot Plant tests will also give necessary datas for elaboration of realistic feasibility studies and investment projects, which are necessary before erection of any factory can be done. And Yougoslav economy is waiting for factories producing basic raw materials from local sources.

Therefore it was prepared Project Proposal "Promotion of the Benefication and Use of Domestic Kaolin". With this project of erection Pilot Plant it is necessary to agree but with this exception, that the location of Pilot Plant seems from today's point of view not the best. Also, the scope of suggested equipment in details have to be revised. In previous text it was explained in details, why we do not recommend the Pilot Plant erection in Bela Reka. In contrary to, the location of Pilot Plant near Bare-Garaši deposit will have the next positive sides:

a/ Bare-Garaši deposit is up to day the largest deposit in Yugoslavia. The raw kaolin have very variable properties.

b/ On the deposit soon will be erected the biggest plant for kaolin dressing in Yugoslavia which will need very close technical background and good training of personel for the new technological equipment.

c/ On the deposit there are a parts of raw material with a lower iron compound content and hogher content of alumina. With separate exploitation and dressing of this type of raw material will be possible to obtain a good quality kaolin which will be usefull in paper, rubber and ceramic industries.
d/ In this case the Pilot Plant will be located in central part of a country, not far from ITNMS and it will be possible to improve all the laboratory results of benefication of all kaolins, ceramic clays and other raw materials. In the case, that Pilot Plant capacity will be " tph of washed kaolin , yearly production in one shift will reach about 3,5 - 4.000 tons per year.

We recommend :

13.1 To locate the Pilot Plant in suitable place near the deposit Bare-Garaši.

13.2 To prepare the project of the Pilot Plant in that manner, that it will be possible to beneficiate here different types of raw kaolin from Bare-Garaši deposit and produce washed kaolin for a long period, and also, to beneficiate here all possible kaolins a other raw materials from other lowalities. It is necessary to provide classification stage of dressing in wide range having in mind installation of high gradient magnetic separator.

13.3 The capacity of Pilot plant have to be of 2tph of washed kaolin.

13.4 It seems, therefore, to be establish a new UNDP Project which can help also in this final step and in such a way to help to bring this Project to a practical end.

14. Supplement of laboratory equipment of ITNMS

ITNMS is considerably good equiped with laboratory instruments for the dressing of mineral raw materials except some types of mills, and equipment for exact dry classification of very fine particles. It is necessary to complete laboratory equipment for exact dry classification of small samples in a range between 2 - 25 um, for X-ray diffraction analysis with heating chamber to 1500°C, X-ray fluorescence analysis, infrared analyser, optical microscope with a heating chamber,directthermom, different types od turbomixers etc.

15. New UNDP Project for utilization of local deposits of bentonite,zeolite and some special refractory raw materials /sillimanite group/.

In addition to new UNDP project for erection of Pilot Plant on Bare-Garaši deposit, and semi-industrial evaluation of laboratory tests obtained in the phase 1-3 existing Project we recommend:

15.1 To prepare a necessary documentation for the establishing the new project which will cover a laboratory research, semi-industrial tests and industrial utilization of:

a/ Local deposits of bentonites for organophillic bentonite preparation.
b/ Local deposits of bentonite for agriculture.
c/ Local deposits of zeolite for agriculture and other utilizations.
d/ Local deposits of kyanite /disthene/, sillimanite and andalusite for production of special high quality refractory materials and for export.

II. BODY OF THE REPORT

UNIDO expert work in the Institute For Technology of Nuclear and other Mineral Raw Materials under the guidence of the Project Director.

He studied the reports of geological prospection different kaolin, quartz sand, feldspar, bentonite, zeolite, pyrophillite and calcite deposits, reports of laboratory tests of this raw materials done in ITNMS and Technical and Terminal Reports prepared for the Yugoslav Government by the UNIDO. During his stay in ITNMS expert utilize all knowledges which he got during his previous visities of non-metallic raw material deposits in Yugoslavia.

He recommend to complete some previous laboratory and pilot plant tests and in some cases a industrial utilization of them. He suggest priorities in the works combine with utilization of local raw-material deposits, to reduce dependance of Yugoslavia in import of some mineral raw materials and to have possibility to export in the future.

He give recommendations and specify some methods of geological survey so, that the plant for kaolin dressing which are in projecting or erection, will have a raw material sources for a long period of run.

He trained the personel in a new methods of research, evaluation and dressing of non-metallic mineral raw materials.

His activity was further orientated to activation and delamination of kaolin and on activation of calcium carbonate as a filler for plastics, rubber and paints. There was done some initial practical experiments of preparation of this products.

It was discussed the problems concerned the pilot and semi-industrial tests of raw kaolin and ceramic clays and erection of pilot plant for the kaolin and clay dressing, on the suitable place.

It was recommended some improvements in the high gradient magnetic separation of the different raw materials, mainly of kaolin.

The discussions take place with the personnel from raw material industry about possibilities of finalizing the results of previous laboratory and semiindustrial tests in ITRMS. Those personnel demand for additional testing and utilization of local mineral raw materials. They have been informed about a new possibilities of optimal industrial application of local raw materials after dressing and about its export possibilities in the future.

People from Geological survey /namely of Geozavod Belgrade/ have been informed about new methods of evaluation of kaolin and clay deposits including utilization of computer.

Together with Project Director and other workers of ITNMS was recommend the continuation and enlargement of the Project and erection of Pilot Plant for the semiindustrial tests of raw kaolin and clay dressing.

All the programme of "Job Description" was in a shorten number of days fulfill. The results of practical tests, start during the expert mission in December 83 will be discussed during next visit, which is agreed between ITNMS and expert and planed in February 1984.

Recommanded suggestions /see Chapter I./ we consider realistic, corresponding with results of geological survey, laboratory and semi-industrial tests of mineral material benefication. Its effective utilization might be affect by expanding of Project and accelerating erection of Pilot Plant for the kaolin a ceramic clay dressing tests.

It is agreed tha UNIDO expert Mr.Jiri Babůrek will stay in continuous contact with Project Director and other personel of ITNMS to help in the laboratory and semiindustrial tests, their evaluation and realisation obtained results.

Findings.

1. Geological prospection up to day have proven large reserves of kaolin on Bare-Garaši deposit. Large parts of this reserves of kaolin contains more then 2% of iron oxide in the washed kaolin. From this reason the kaolin is suitable mainly for refractory production. On this deposit, there were discovered some types of raw material with lower content of iron bearing minerals and with higher content of alumina/ see ANNEX 4/. In the case of selective exploitation of this type of raw material, it seems possibly of its utilization in ceramic industry and as a filler in paper and rubber industries. A high content of mica is possible to substantially reduce by special type of hydrocyclones / see ANNEX 2 / and when it will be necessary, by high gradient magnetic separation. For this reason it seems very usefull to open Bare-Garaši deposit in ones on more places and a raw material with lower content of iron compounds and higher content of alumina beneficiate in a Pilot Plant of 2tph capacity. The erection of the big plant in etappes / at first approx.50.000tpa/ and later increasing up to 120.000 tpa will make possoble of optimal utilization of all the deposit.

Lets us consider that geological survey on this deposit will continue in the future and give more exact results for the exploitation.

2. Geological survey and results of industrial exploitation of raw kaolin of Karačevo deposit had shown that previous datas according geological reserves on this deposit was too optimistic. A methodics of geological survey up to day used do not allow discover not fully kaolinized parts of parent rock. From this reason will be not in the near future erected large capacity beneficiation plant and on the basis of our recomendations / see ANNEX 3/is in preparation investment study for erection of semi-industrial line with a lower capacity. In the same time, will be find a possibility of production of raw material for ceramic semibodies and bodies. We consider, that geological prospection will continue in this area.

3. The geological and technological investigations of deposit and raw material Bela Reka, Bujanovac, Djevdjelija, Mesići and Motajica are not yet finished. In many cases is necessary to finish a geological prospection of deposits, to recognize geological reserves of mineral raw material. In all this cases it is necessary to do semi-industrial dressing tests. In the case of deposit Mesići it seems tobe much more better to utilize its raw material in a raw stage.

The sand stone Bela Reka deposit can give, after its beneficiation, good quality glass and technical sands. Content of fraction below 10um in this raw material is low and its composition will be from the mineralogical and chemical composition view point very variable. New plant for beneficiation of glass sand is not yet finished. In

In a future it will be better, the fine fraction concentrate in settling basin for its possible utilization in future.

4. Intention to increase utulization of raw kaolin from the deposits in Yugoslavia, by delamination of aggregates of kaolinite and other clay minerals, in fractions 10 - 63um od 10 - 100 um is practically possible. But this fractions contains large quantities of not fully weathered feldspar, biotite and muscovite mica and other iron and titania bearing minerals. During the process of delamination it comes clearly to the disintegration of this minerals in very fine fractions. For this reason it is not possible to recommend application of this method in industrial scale. Only in the case, when we have mineral waw material which will not content in the fraction 10-100 um of iron and titania bearing minerals, will be possible to use this method of delamination.

5. As Yugoslavia have large geological reserves of high quality calcite, it is possible to immediately begin with research and erection plant for preparation of special fillers and pigments for plastics,rubber,paint and paper industries. Never mind we have a high quality raw material with low content of iron compounds and silicate, it must be extremely fine milled and exact classified. For the milling is suitable ball mill /for example - Harding type/. For classifying we need a air separator with possibility to clasify very exactly lower 2, or 10 or 5 micrometers.

Interests on the world market for this type of fillers is increasing day by day. Addition of fillers to the plastics increase the quality of filled plastics and in the same time decrease the energy and crude oil consumption. The greatest consumer of calcium carbonate fillers are plastics, rubber, paint and paper industries.

Calcium carbonate constitutes the most widely used mineral filler in the plastics industry, where it is added in the form of chalk whiting, ground limestone, crystalline calcite/dolomite or precipitated calcium carbonate. The principle functional properties of the various types of calcium carbonate are - particle size and shape, brightness, absorption characteristics, dispersion characteristics, refrective index and specific gravity. A group the calcium carbonate fillers have the lowest dil absorption of all the major bulk mineral fillers. Within the group the compact crystalline calcite derived from marble tend to have lower oil absorption than the more porous chalk whitings.

A variety of carbonate grades are available with surface coatings, not only to lower oil absorption values but also to improve dispersion characteristics, so the particles do not "clog" when added to the polymer but disperse easily into the mix. Most commonly the surface coatings are fatty acids such steric acid or one of its derivative salts added to the filler in sufficient quantity to ensure that all the mineral surfaces are covered. Usually 0,5 % to 2% coating is used.

A N N E X 1

Training of ITNMS personel

/5-12-1983 and 9-12-1983 /

The expert was requested to extend a training geared for new methods of laboratory examinations of kaolins, bentonites, zeolites and other non-metallic raw materials. During the discussion were tached the problems of dressing and possibilities of use the non-metallic raw materials in a different industries.

Also, it have been explained methods of activation of kaolin and calcite for use as fillers in plastics, rubber and paints.

Attendance :

Mr. Jiri Babůrek, UNIDO Expert

The trainees :

Ms. Dr. Magdalena Tomaševič-Čanović
Mr. Milutin Dumić, dipl.ing.

The following publications were handed over this ocassion for training purposes:

Konta J. : Keramické a sklárské suroviny, 364 pp., Praha 1982.

Babůrek J. : A new dressing process aimed at changing the physical properties of kaolins and clays.- Silikáty, v.3, p.183-193, Praha 1973.

A N N E X 2

Training of ITNMS technicians

/ 8-12-1983 /

The expert was requested to extend a training in the use of new type of hydrocycloning for more effective classification of kaolin suspensions in order to increase utilisation of local kaolin deposits to produce a good quality final product.

In the same time, the expert take a look to give own opinion about proposed technological production diagramme of the dressing kaolin, feldspar and quartz sand plant.

Attendance :

Mr. Jiri Babůrek, UNIDO Expert

The trainees :

Mr. Miroljub Marinko, dipl.ing.
Mr. Nenad Djaković, dipl. ing.

A N N E X 3

Appointment with the representative RIK Karačevo

/ 9 - 1_ - 1983 /

To clear up the situation in geological prospection and exploitation of kaolin from Karačevo deposit, it was arranged the appointment in IMNMS with Mr.Obrad Nikolić, Investment Director, RIK Karačevo.

The representative of RIK Karačevo have informed about the fact, that in near future will be not on Karačevo deposit built up a large capacity plant for kaolin dressing. In preparing stage is feasibility study for beneficiation line of capacity of approx. 10.000 tpa washed kaolin.

The feldspar and quartz mixture - the by product of this plant will be probably separated by froth flotation in plant Bujanovac, 15 km far from Karačevo.

Further it was discussed about possible industrial utilization of high quality bentonite from deposit, located near Karačevo. Preliminary tests shown that this bentonite after dressing can be used in chemical and pharmaceutical industries, in paint and food industries. Also, it was discussed about the next steps in investigation and industrial utilization.

A N N E X 4

Visiting of Bare-Garaši kaolin deposit.

/ 11 - 12 - 1983 /

To inform himself about the situation of geological prospection and possibilities of opening and exploitation Bare-Garaši deposit, UNIDO expert have visited with chief geologist Mr.R. Atanasković from Geozavod Belgrade, this deposit.

Deposit is divided in two parts, by a small river. The boundary of the deposit is relatively good determined. The stage of geological survey of deposit is on a good level, and it is necessary on a future to determine the areas of low iron content and high alumina content.

To-days shortage of water for the kaolin dressing, will be solved by erection of two small dams not far from deposit. One of them is in period of preparation works.

As a conclusion, from the geological point of view there is no reasons against the erection of large capacity benefitiation plant on Bare-Garaši deposit.

It seem as a reasonable to erect here a Pilot Plant for kaolin and ceramic clay dressing. It was recommended to evaluate the results of geological prospection of Bare-Garaši deposit by computer.