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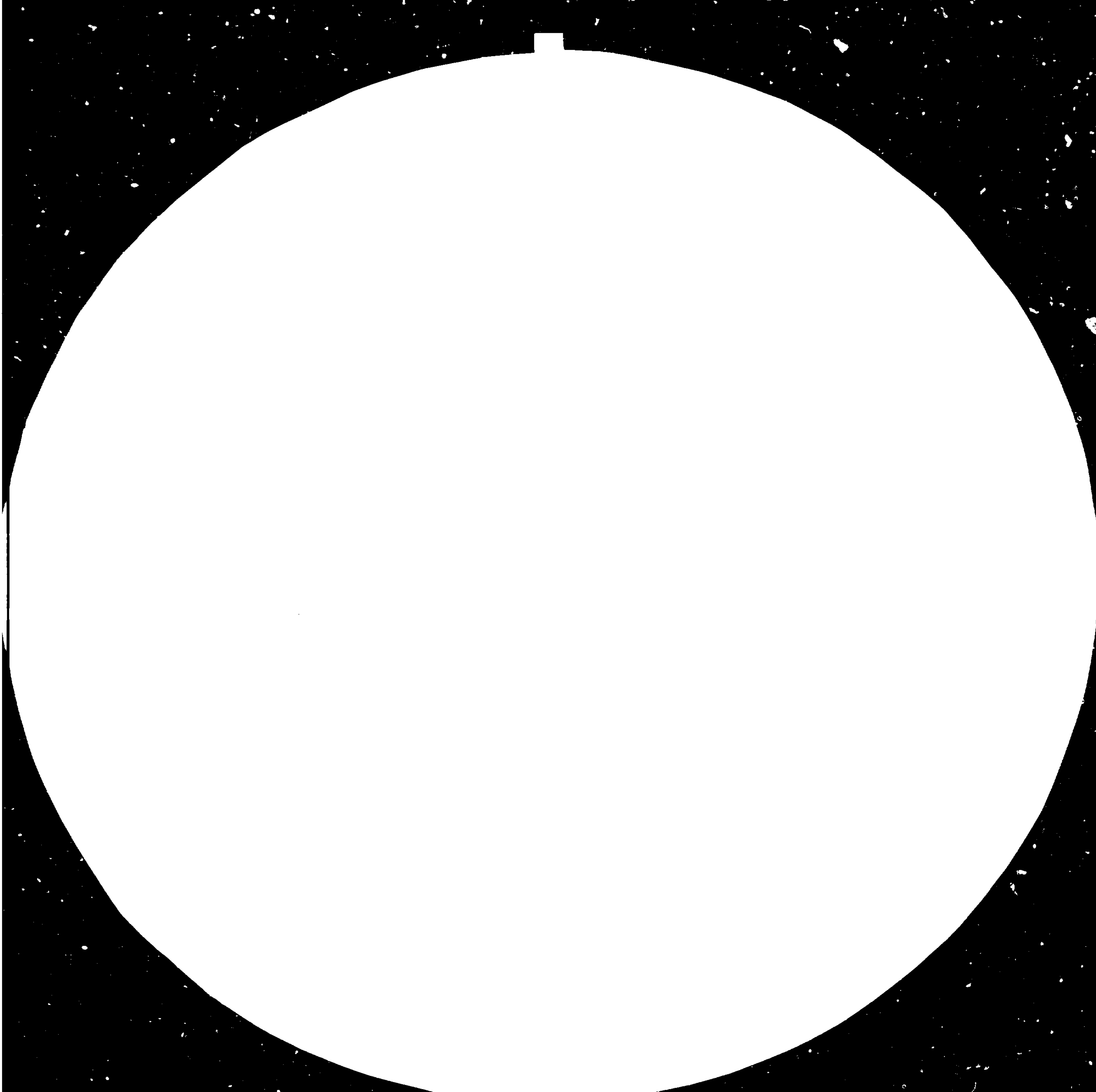

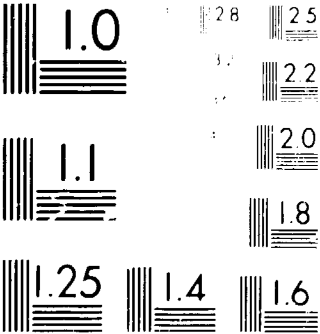
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by: J. Franče

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1. INTRODUCTION

Ceramic industry is one of the large energy consumers. Taking into account the ever-increasing energy prices, its development requires a very meticulous choice of suitable raw materials, the most appropriate processing technologies and the widest application of insulating materials. It is well known that the traditional ceramic and building materials and their processing technologies are very demanding as far as energy is concerned. Therefore, new raw material types and new technologies are being sought which would contribute to decreasing the firing temperatures, shortening of the firing process and its simplification /replacement of a two-stage firing process by a single-stage one/. In Czechoslovakia, these problems are given considerable attention.

The presented guide provides an outline of the important Czechoslovak raw material resources which have become the basis for the development of its ceramic industry, as well as of the orientation of the new research works in the field of fluxes, whose aim is a reduction of the energy consumption during the production process. In addition, plants and institutions are described the visits to which are a part of the in-plant training. Last but not least, places of interest which the visitors to the seminar will see en route are listed.

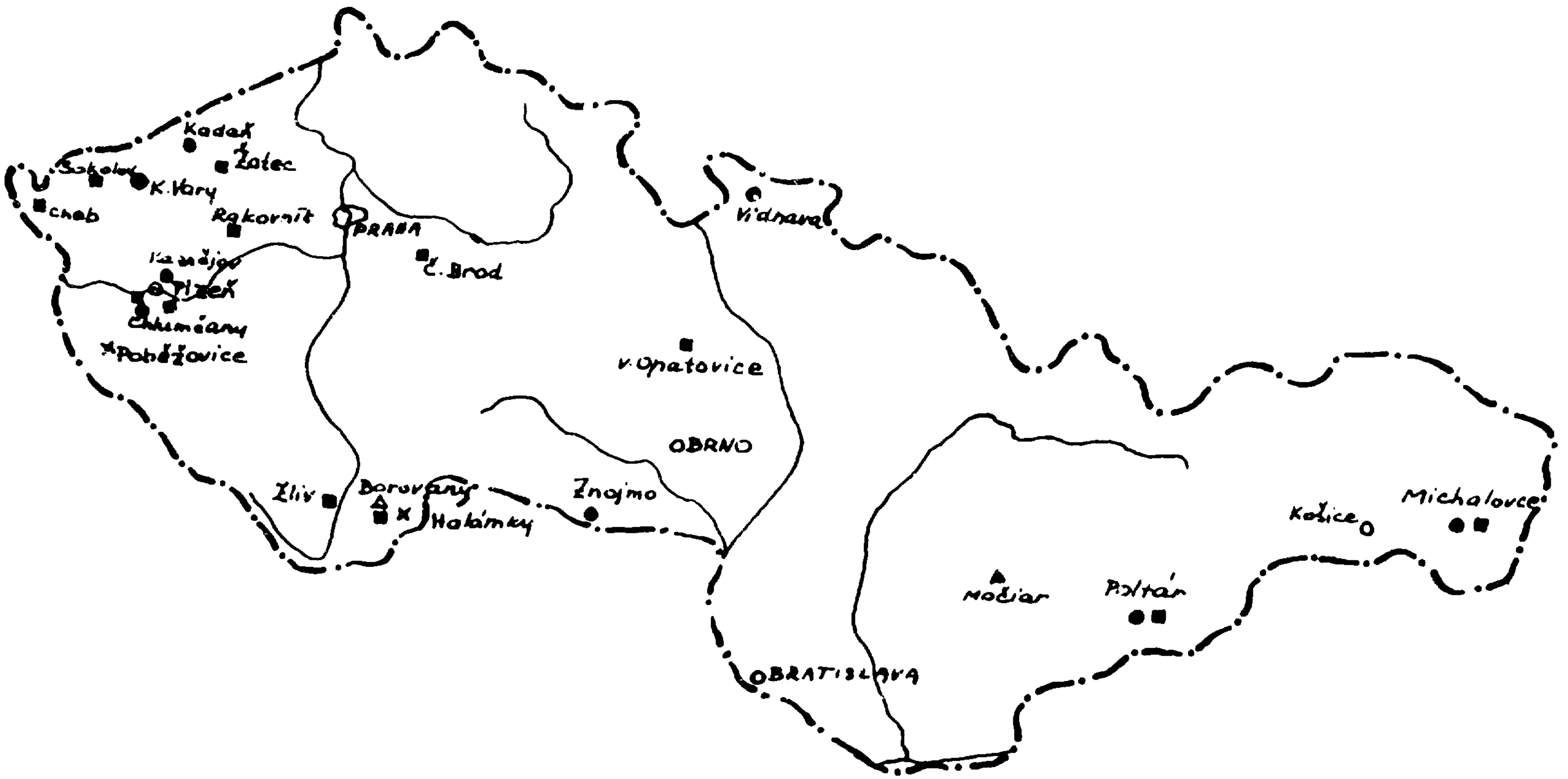

Fig. 1. The most important areas of kaolin, clay, feldspar and diatomite deposits in Czechoslovakia

● kaolin ■ clay or claystone ✖ feldspar △ diatomite

2. DEPOSITS AND DRESSING PLANTS

Kaolin deposits of the Karlovy Vary /Carlsbad/ area

The kaolin deposits of the Karlovy Vary area are situated in the south-western part of the Krušné hory Graben, which is called the Sokolov Basin. The basin filled with Tertiary sediments is limited by ENE-WSW trending faults against the Krušné hory crystalline complex to the NW /metamorphosed Proterozoic rocks with Variscan granits/ and the crystalline complex of the Karlovarská vysočina to the SE /predominantly granite/. The Tertiary Doupovské hory strato-volcano separates it from the North Bohemian Brown-coal Basin to the NE and a ridge built up of phyllites and mica-schist bounds it against the Tertiary Cheb Basin in the SW.

The conomic importance of the Sokolov Basin consists in its reserves of brown coal, kaolin and clay. The kaolin deposits occur in the north-eastern part, where the basement of the Tertiary is built up of Variscan granite of the Karlovy Vary massif.

The kaolinic crust of weathering in the environs of Karlovy Vary represents only a relic of the originally far more extensive Cretaceous and Palaeogene crust, which has been preserved on the downthrown granite blocks. Kaolin is often covered by a layer of kaolin washed from a short distance or redeposited by mud flow, and by basal beds of dated Tertiary complexes. In the kaolin the following three zones are distinguishable:

The upper zone of perfectly kaolinized granite /10-30 m thick/: feldspar phenocrysts and feldspars of the groundmass are fully kaolinized, quartz is strongly corroded and biotite decomposed. In clay fraction kaolinite is predominant. Technical properties of kaolin: 25-45 % clay substance, about 37 % Al_2O_3, refractoriness 34-35 SC, easy liquefaction, lower strength when untreated, firings at 14 SC porous.

The middle zone of partly kaolinized granite /5-15 m thick/: central parts of feldspar phenocrysts remain undecomposed, quartz is weakly corroded, biotite chloritized. The clay fraction contains kaolinite and illite. Siderite /locally also pyrite/ is the predominant Fe-mineral. Technological properties of kaolin: 15-25 % clay substance, about 35 % Al_2O_3, refractoriness about 33 SC, more than 1 % alkalis, difficult liquefaction, high strength when untreated, firings at 14 SC porous or dense, grey spots appear.

The lower zone of weakly kaolinized granite /2-10 m thick/: central parts of feldspar /orthoclase/ in the groundmass remain undecomposed. Quartz grains are not corroded, biotite is mostly undecomposed. Clay fraction consists of illite and kaolinite. Siderite, which is almost unoxidized is the predominant Fe-mineral. Technological properties of kaolin: less than 15 % clay substance, a low amount of Al_2O_3, refractoriness below 33 SC, low or non liquefaction capability, very high strength when untreated, firings at 14 SC sintered. Kaolin of this zone is not used.

Alkalis /in feldspar/ and iron /partly in illite/ increase with depth under a simultaneous decrease of kaolinite. Plagioclase alters into kaolinite sooner than potassium feldspar and, unlike the latter without illute interstage.

Along tectonically disturbed zones, CO_2-charged ground water percolated to a greater depth giving rise to kaolin deposits, frequently of elongated shape, with a greater thickness of kaolin.

The main minerals of Karlovy Vary kaolin are: in the clay fraction kaolinite /maximum 6-7 μ, motsly less than 1 μ large/ and illite /5-10 % in clay substance, 50 % in fraction below 0.03 μ; di-octahedral illite is the carrier of trivalent Fe/, and quartz, muscovite, accessory tourmaline, zircon, rutile, anatase, and pyrite in the coarse fraction. Petrographically, the Karlovy Vary kaolins may be defined as loose silty sandy-clayey granite residues. Their petrographical character is governed by the petrographical composition of the parent rock /especially by the biotite content, as it differs in the two main types of granite in the Karlovy Vary area/ by the depth under the surface at kaolinization time and by the nature of the overlying rocks /under the Lower Miocene Volcanogenic Complex the upper kaolin zone is depreciated owing to its permeation by Fe-minerals/.

In the chemism of kaolinization, the following well-known regularities are evident: SiO_2, Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O, Li_2O and P_2O_5 are removed during weathering, and the content of TiO_2, Al_2O_3 and the hydroxyl group is relatively increased.

According to the view accepted for the present, the kaolin deposits in the Karlovy Vary area originated by surface weathering under a warm, humid tropical or subtropical climate during the Cretaceous up to Paleogene, by the action of ground water charged with CO_2 and organic substances derived from a dense vegetation cover.

Božíčany Deposit and dressing plant

The deposit of kaoline originated through surface climatic weathering of medium- to coarse-grained, mostly biotitic mountain gneiss. Lower parts of the kaoline section contain mostly illitized feldspar phenocrysts. The biotite has been subject to metamorphic processes and is chloritized in the lower parts. Parts of the deposit which are of better quality originated through kaolinization of muscovito-biotitic, acidic granites.

The relief of the kaoline horizon is very complex in the vertical direction, occasionally reaching down to unweathered granite. The primary kaoline horizon is generally overlaid by a relatively thin layer of secondary kaoline, sand, and kaolinic clay. Farther upward, a layer of quartz or sandstone is occasionally developed, which is overlaid by the Josef bed, up to 15 m thick, locally with an interseam of ceramic clays that are, however, economically unexploitable. The last element of the overlayer sequence of the deposit is the basal part of the volcanodetritic strata. The deposit has not been tectonically affected; nevertheless, it has been pervaded by an extensive silicified zone which complicates the deposit exploitation. The thickness of the whole kaoline section is up to 60 m, the thickness of exploitable ceramic clays averages 28 m.

The deposit is worked out by the open-cut method, in mining faces which are established according to requirements of the selective mining. The mining process must be controlled in such a way so that high-grade /porcelain/ kaoline could be worked out in several places of the deposit simultaneously for the purpose of its proper homogenization. Especially, the mining process has to take care of avoiding green-coloured kaoline /containing much chlorite and illite/, rusty-coloured parts of the deposit, and sections with ample quartz and / or quartzite veins. The mining process control is based on a detailed network of boreholes and regular sampling. The samples are analyzed in the plant laboratory.

The principal minerals constituting the clay fraction are kaolinite, illite /5-10 %/ while muscovite and quartz are chief representatives of the coarse fraction. The following minerals are present as accessoric: tourmaline, zircon, rutile, anatase, hematite, magnetite.

The dressing process consists in homogenization, washing, and removal of the coarser, sandy fraction. Subsequently, the kaoline suspension passes via several hydrocyclones. The resulting kaoline suspension whose fineness is less than 20 μ proceeds via check screens, is thickened in tanks and dewatered in filter presses.

The principal advantageous features of the Carlsbad kaolines are their high green strength, good liquefaction ability, good casting capacity, white firing colour, and transparence of porcelains made from these raw materials.

The Božíčany kaoline dressing plant was put onstream in 1972. Its initial capacity was 60,000 tons of washed kaoline/year. The plant makes use of a traditional process technology; however, this has been expanded to encompass a number of new elements, and measures have been taken to make maximum use of mechanization and automatization. The plant maintains to produce the trademarked SEDLEC Ia kaoline which, in 1924, was declared to be the international standard. Approximately 70 % of the annual output of this type of kaoline is exported to almost all countries of the world.

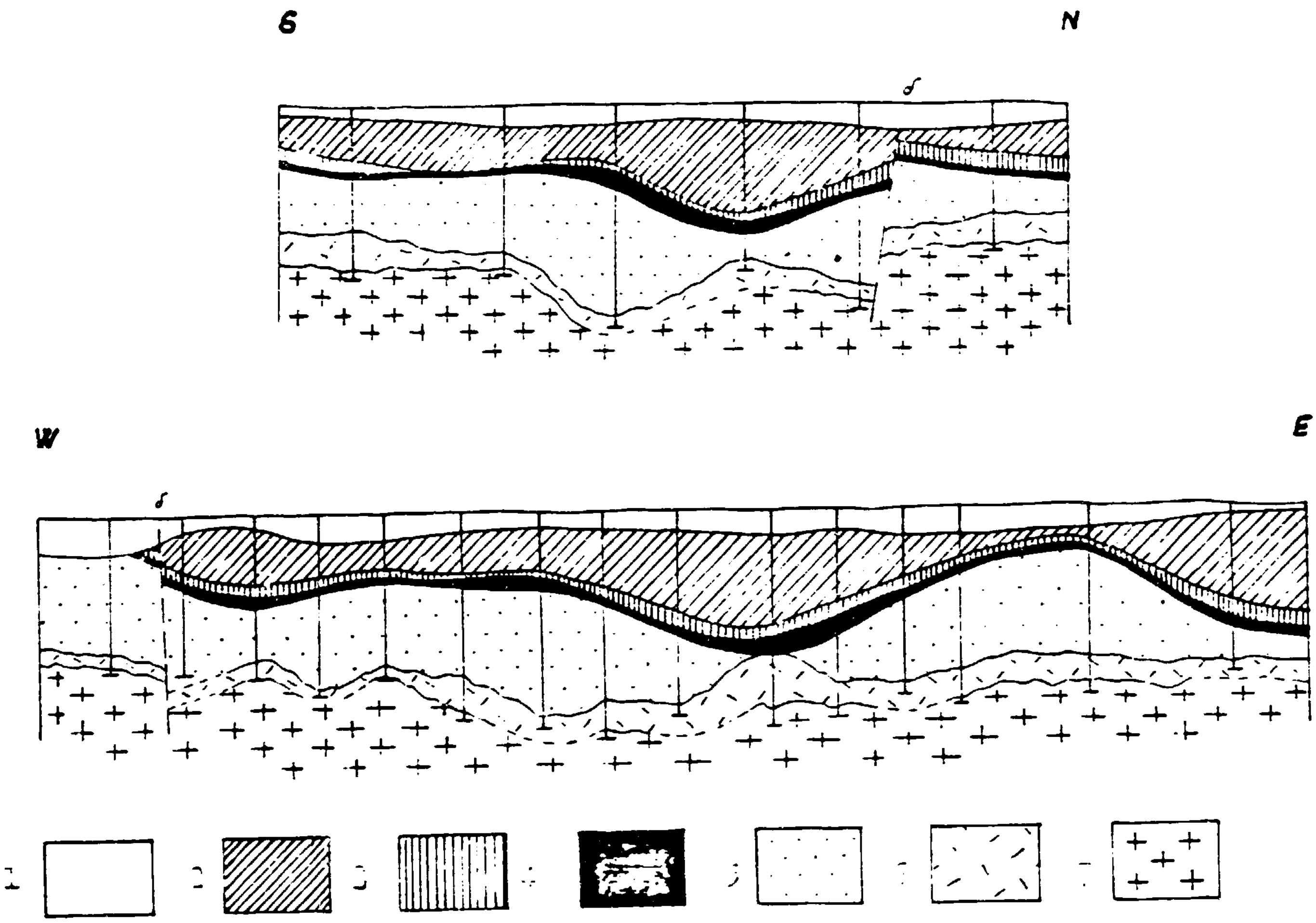

Fig. 2. Geological cross-section of the Božíčany-Osmosa deposit
1 - Quaternary loams, 2 - Volcanogenic Complex,
3 - coal seam with ceramic clays, 4 - sands, sandstones and quartzites, 5 - primary kaolin /upper and middle zone/, 6 - primary kaolin partly decomposed /lower zone/, 7 - slightly kaolinized granite

Kaolin deposits in the Plzeň /Pilsen/ Basin

The Plzeň Basin represents a relic of the tectonically predisposed intermontane depression of the Variscan mountain range. After the regression of the Devodinan sea and the folding of the Proterozoic - Paleozoic formations of the Barrandian, a folded mountain range came into being. Its destruction proceeded at a relatively rapid rate and the heigh defferences were levelled out by intensive erosion and continental sedimentation, persisting from Westphalian C - D to the Permian. The deposits filled the depressions of the relief and particularly the grabens, some of which were re-activated during younger geological periods, mainly by Saxonic tectonic movements. Subsequently to this refuvenation, the deposition of Tertiary sediments began in the Plzeň basin. Concomitantly, the Permo-Carboniferous sediments were desintegrated and their clastic material was redeposited in the form of lacustrine and fluviatile sediments. As a result, the Tertiary sediments do not differ substantially from these of Carboniferous age by their petrographical composition.

The Permo-Carboniferous of the Plzeň basin consists of four formations which differ in the mode of deposition, colour of sediments and the representation of fossil terrestrial flora. The following formations have been differentiated:

/1/ Lower Formation - Westphalian C - D
/2/ Lower Red Formation - Early Stephanian
/3/ Upper Grey Formation - latest Stephanian
/4/ Upper Red Formation - Permian.

All of them are built up of various kinds of arkose, sandstone, claystone, in places also conglomerate and breccia. Some sediments bear plant remains and workable coal seams. The basal beds are formed mostly of non-kaolinized arkoze overlying the unweathered Proterozoic basement. The kaolinized feldspars and kaolinitic claystone increase in amount upwards, particularly in sediments corresponding to a humid and warm climate. The uppermost parts of the Permo-Carboniferous profile were kaolinized in the younger geological periods, mainly in the Cretaceous and Early Tertiary.

The main kaolin deposits are situated in the northern part of the Plzeň Basin /Horní Bříza and Kaznějov deposits/. In the Chlumčany deposit, located in the southern part of the Plzeň basin, we can find also partly decomposed arkose, containing feldspathic kaolin, with relatively high content of feldspars. Arkoses forming and underlying kaolin deposits are kaolinized to a depth exceeding 200 m. Well kaolinized arkose, contains 20 - 25 per cent of kaolinite, poor parts contain 14 - 20 per cent of kaolinite.

The deposits of kaolin /kaolinized arkose/, kaolinitic clay or claystone in the Carboniferous of the Plzeň Basin gave rise to a comparatively extensive ceramic industry.

Kaznějov deposit and dressing plant

The deposit of Kaznějov is a part of the Týnec Sequence which constitutes the Lower Stephanian infill of the Permian-Carboniferous Plzeň Basin.

The kaoline deposit is composed of a sequence of kaolinitic arkoses, conglomerates, kaolinitic clays, and claystones whose thickness ranges between 20 and 120 m. The basin floor is composed of Proterozoic rocks. The deposit is dipping at 5^{o} to 10^{o} in the westward direction; its thickness increases in the same direction.

Genetic evidence suggests the major part of kaolinization processes to have taken place in the source area of the sediments; partial kaolinization processes having taken place during the Cretaceous and Tertiary periods cannot be disregarded, too. The causes of the kaolinitic sediments´ colouring are both primary and secondary /related to the Cretaceous-Tertiary deferization processes/.

The beginnings of the Kaznějov deposit exploitation are dated back to 1902 - 1904. At present, the deposit belongs to the ZKZ Works, Horní Bříza. In 1974, a new washing plant started to operate whose production capacity is the largest in Europe. It produces kaoline for paper, rubber, and glass-fiber industries.

The deposit is exploited using the open-pit method, by working slices, using excavators of the 2.5 cu.m scoop capacity. These are also employed in stripping operations. The worked-out kaoline is loaded into trucks and hauled to a crusher and a homogenization stockpile. The annual output is about 1.3 to 1.4 mil. tons, the average content of the washable kaoline equals 20 %.

The kaoline is wet-processed by washing. The raw material is transported by a belt conveyor to blungers where an approximate sorting and sand removal take place. The sand is subsequently sorted in a special line and supplied to customers. The kaoline mud passes via hydrocyclones /diam. 350 and 150 mm/ where the fine-sandy fraction is removed, and over check-screens serving for the removal of mica. The third stage of hydrocyclones /diam. 50 mm/ processes the special kaoline grades intended for the paper industry. The dewatering of the kaoline suspension is effected in three stages: thickening, effected in sedimentation tanks with flocculants added; filtration - the thickened mud passes via filter-presses; drying - in chamber-driers. The final product is stored in silos. It is transported by railway and trucks. The finest paper industry kaoline, the so-called "coating grade", is produced in a special line and transported in tank trucks in the form of a thick suspension.

The rubber industry and glass-fiber grades are further processed by grinding in an ATTRITOR drying mill where they attain the water content of less than 1 %. In 1978, a special, high-intensity electromagnetic separator was incorporated in the paper industry kaoline production line. It enables to remove dark-coloured minerals, thereby increasing the kaoline whiteness by 4 % to 6 %.

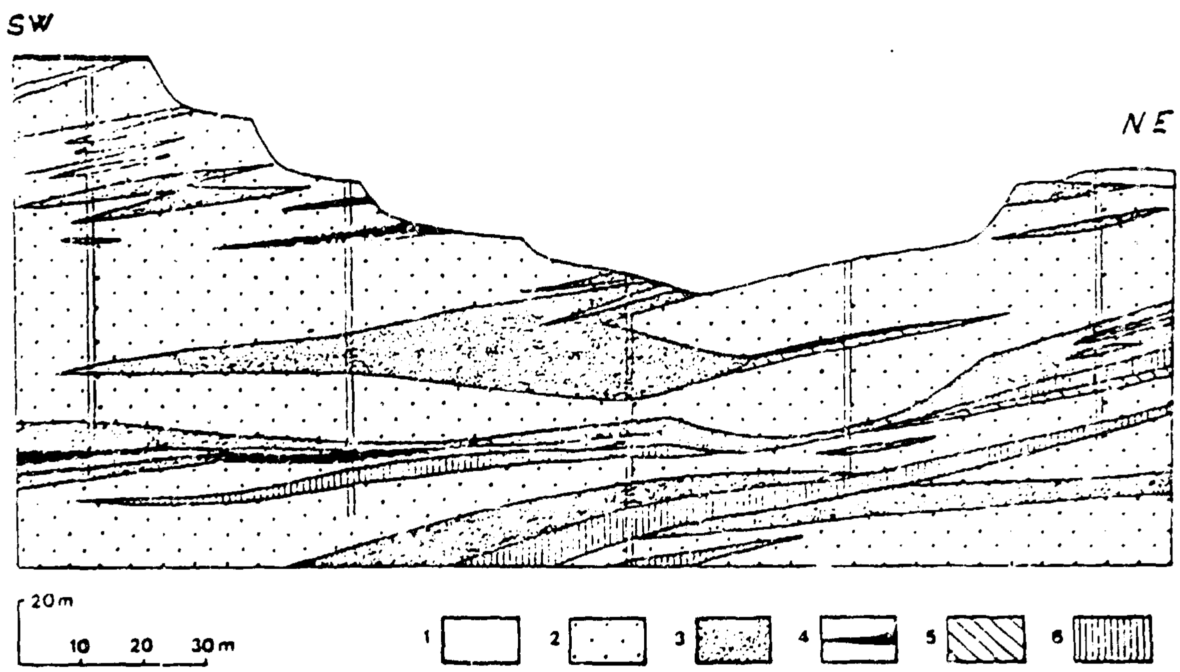

Fig 3. Geological section of the kaolin deposit Kaznějov /J.Wild/
1 - Quaternary loams, 2 - white kaolinized arkoze /kaolin/,
3 - coloured kaolinized arkoze, 4 - white and grey clays,
5 - yellow and light-brown clays, 6- red clays

Sokolov coal basin - the use of the overburden clays for the "Keramzite" production in Vintířov

Specific properties of the fired overburden clays of the Sokolov Basin, Western Bohemia, allow their use in the production of a very valuable, artificial expanded /cellular/ stone material, the so-called "keramzite".

Geological Setting and Characteristics of the Clays

The clays are a part of the Tertiary infill of the Sokolov Coal Basin and constitute the overburden of the main seam area. They fall within the Cypris Sequence whose name is derived from the occurrences of Ostracoda /Cypris Augusta Reuss/.

The thickness of the clay Tertiary sediments situated in the overburden of the main seam area is from 40 to 140 m. From the viewpoint of petrology, they are represented by clayey shales, and schistose, disintegrating claystones and clays, prevalently greenish-grey, ochrish-grey, and bluish-grey in colour. Their clayey component is composed exclusively of kaolinite and illite while clayey micas represent a frequent admixture. Locally, montmorillonite is also present. Carbonates, particularly siderite, and quartz represent a non-clayey component.

A prerequisite limiting the use of the clays in the production of "keramzite" is their expanding ability on firing at the appropriate temperature /generally at 1,200° to 1,300°C/. During this process, a lightweight, porous, stone material of favourable physical properties is formed. Generally, well-expandable clays contain kaolinite of a worse-arrayed texture as the principal component, an admixture of montmorillonite and illite, and an important portion of finely dispersed siderite. Their Fe_2O_3 and Al_2O_3 contents are usually over 10 % and 37 % - 40 %, respectively.

Mining, Benefication, and Processing of the Raw Material

The Cypris Sequence clays represent the overburden material stripped during the coal mining. The clays stripped in the

George Mine are used in the production of "keramzite". They are stockpiled separately in the vicinity of the Vintířov Plant. The worked-out raw material is further homogenized in the supply store and processed by crushing and kneading to provide plastic clay of which small "noodles" are made. The firing of the "noodle" clays processed in the above-mentioned way takes place in a rotary kiln at temperatures over 1.000°C /generally 1.200°C to 1.300°C/. The firing implies the formation of a melt and various chemical reactions accompanied by the release of gaseous components. As the gases are relased from the "noodles" the enclosed molten surface of the noodles at the pyroplastic state temperature results in their expansion.

Properties of "Keramzite"

"Keramzite" is a valuable artificial stone material, characterized by its rounded shapes, sintered surface, and enclosed inner pores. "Keramzite" combines properties of traditional ceramic materials and the possibility of its use in large-dimension precasts. "Keramzite" is produced in different fractions, this fact enabling its use in any of the lightweight concretes, beginning with thermal insulating types and ending with light structural elements. One of the favourable properties of "keramzite" is its inherent combination of its low bulk weight and high strength. "Keramzite" produced by the Vintířov Plant is supplied under the KEVINT trademark in the four following fractions: 0 to 4 mm, 4 to 16 mm, 11 to 12 mm, and unsorted, up to 45 mm. It is delivered in the loose state and transported either in open carriages or trucks.

Potential Uses of "Keramzite"

The individual fractions differ in their looses state bulk weights which are as follows:

fraction 0 to 4 mm: 480 to 900 kg/cu.m, 715 kg/cu.m on average
fraction 4 to 16 mm: 360 to 540 kg/cu.m, 466 kg/cu.m on average
fraction 11 to 22 mm: 300 to 450 kg/cu.m, 402 kg/cu.m on average
unsorted : up to 600 kg/cu.m

For its properties, the KEVINT trademark material is preferably used as a filling material of concretes used in outer wall precasts of residential,industrial, civil, and agricultural structures. The use of KEVINT in insulating /structural "keramzite concretes" allows for the combination of very good insulating properties and favourable physico-mechanical properties. The high servicelife of these materials has been proved by laboratory tests and confirmed in practice.

Besides its use in building activities, KEVINT can also be successfully employed in agriculture for the hydroponic growing of plants in glasshouses, in public parks, garden architecture, and for growing of cactuses, flowers and other floral species.

Diatomaceous Earth in Southern Bohemian Basins

A typical component of diatomaceous earth, which plays the most important role in determining its properties, are microscopic siliceous tests of diatoms. These are remains of primitive plants - algae. The diatomaceous earth of Sourthern Bohemia originated during the Tertiary period, in a limnic environment. Monocellular algae, floating on the surface, were subsequently accumulating on the lake bottom so that a layer of approx. 10 m in thickness was formed. During younger geological epochs, the diatomaceous earth was hidden under a clay layer. The Borovany diatomaceous earth is characterized by prevalent tests of Melosira granulata.

The tests are approximately of the shape of a hollow cylinder whose surface is densely perforated. In the Borovany deposit, the raw material occasionally contains as much as 85 % of these tests, together with an admixture of clayey and sandy materials which must be separated from the tests in order to obtain pure diatomaceous material. The geological setting of the deposit is shown on Fig. 5.

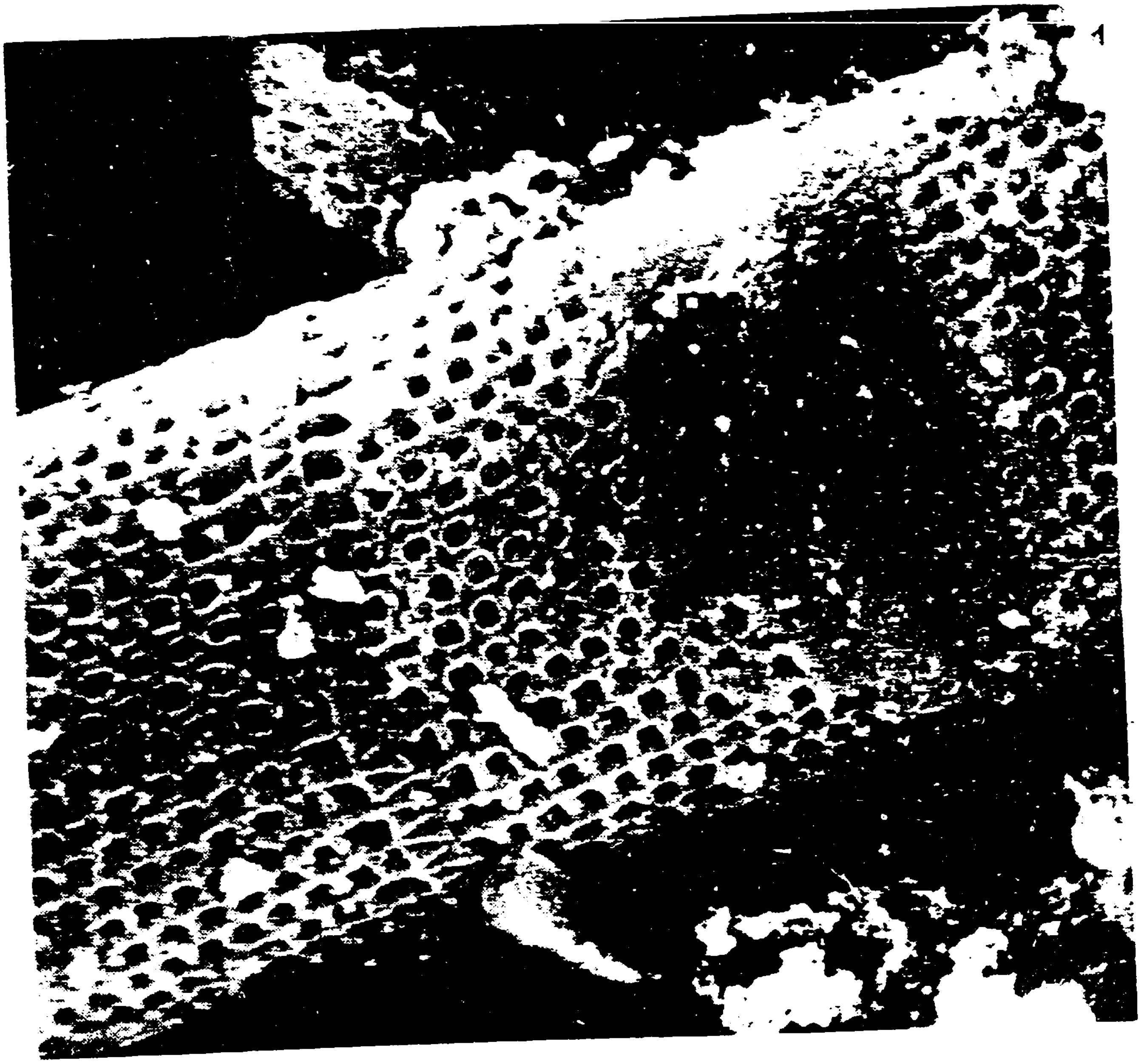

Fig. 4. Test of Mélosira Granulata; seen by electron microscope /magnified 8,500 times/. Diatomaceous earth, Borovany

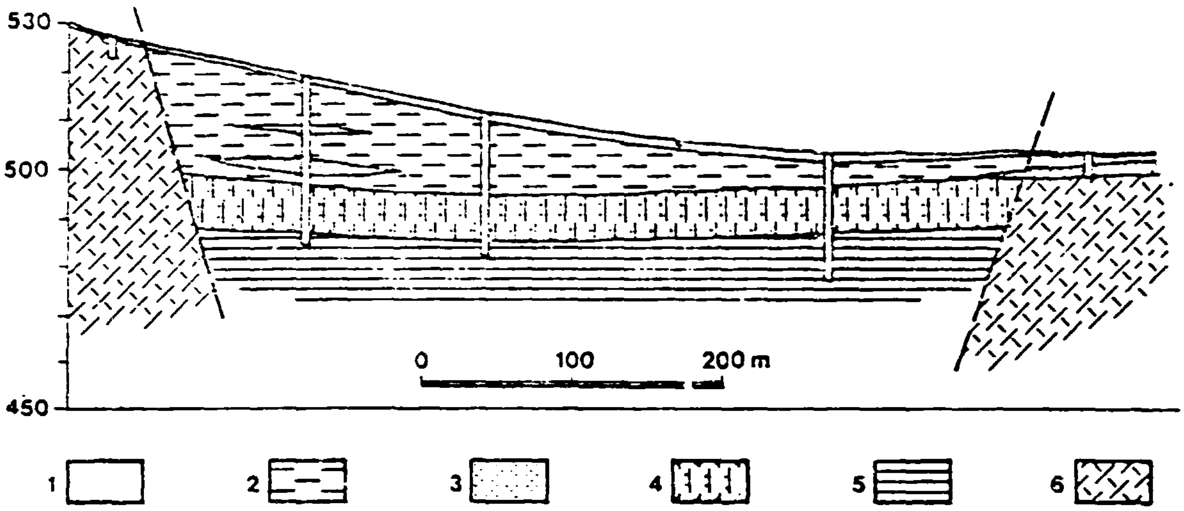

Fig. 5. Geological section of the deposit of Miocene Clays and diatomaceous earth in Borovany /A.Malecha/; 1 - Quaternary deposits, 2 - blue-grey, binding clay, 3 - sandy intercalations in clays, 4 - diatomaceous earth, 5 - green underlying clay, 6 - Moldanubic Crystalline Unit

Mining and Dressing of Feldspathic Sands in Halámky

Potassium feldspar for the production of porcelain has been mined since the end of the 19th century on deposits in Western Bohemia and the Bohemian-Moravian Uplands in Czechoslokia. The increasing consumption and rapid depletion of the deposits led to the search for a substitute in the sixties.

An unusual raw material resource has been found and exploited in the upper Lužnice River in southern Bohemia. It consists of gravels and sands which have been found to contain feldspar present in the coarse fraction. Using a simple process, - sorting aimed at the removal of the fraction below 4 mm - feldspathic concentrate containing a certain amount of quartz can be obtained. However, it was necessary to solve the processing of the raw material as it contains biotite which is inacceptable for the porcelain production, due to its content of colouring /Fe/ oxides. The research has proved the contaminant can be eliminated using the high-intensity magnetic separation on the 0.1 - 1.0 mm fraction.

At present, the first stage of the plant has been finished. It includes the initial working-out of overlying sands suitable for building purposes, mining of the feldspathic raw material using a suction dredge /from the depth up to 25 m/, sorting and processing of the extracted raw material. The processing plant capacity is 85,000 tons of feldspar of various grades /from 45 % to 75 %/ per year. The processing is based on milling of the raw material to obtain the fraction below 1 mm /with simultaneous drying/ and on the removal of silty components and on using the three-stage electromagnetic separation. The final product is distributed either in rubber containers or in bags. The dressing results in the final product which has a very high purity and is usable with no subsequent grain size adjustment in the glass industry. However, its use in ceramics requires a subsequent milling to obtain the proper grain size.

The second stage of the plant will be represented by a milling line intended for the processing of ceramic feldspar to obtain the required fineness.

Thus, a new and large deposit of potassium feldspar /which, in many countries, is insufficient/ can be economically exploited.

New Mineral Raw Materials in Ceramic Industry

The research of new and non-traditional raw materials including new technologies of their processing has become the focus of interest of the Czechoslovak ceramic industry, too. Above all, those new raw materials and technologies are being sought which would enable savings either through a reduction of firing temperatures or by shortening of the firing cycle /rapid firing/ or by its simplification /replacement of a two-stage firing process by a single-stage one/.

Most of the research work in the field of new technologies and processing of new raw materials in Czechoslovakia during the 1970 - 1980 decade was carried out by the Ceramic Research Institute at Horní Bříza, in cooperation with ceramic producing plants. The research and geological investigation of the new raw materials in Czechoslovakia are handled by Geoindustria in cooperation with the Raw Materials Research Institute at Kutná Hora. In addition, the research of new and non-traditional raw materials is carried out by the Faculty of Science of the Charles University /in the department headed by Doc-Dr.Kužvart/, Prague, and by The Geological Survey, Prague. The latter organized an international symposium on the research of new mineral raw materials /NEMIRAM/ in 1981, which took place in Karlovy Vary.

An important potential source of energy savings in ceramic industry are fluxes introduced into production mixtures in the form of various minerals and rocks. Essentially, all these minerals and rocks consist primarily of oxides of alkaline metals /Na, K/, alkaline earths /Ca, Mg/ or other elements /Li, B, F/.

The best known fluxes used in ceramic industry are potash, sodium, sodium-calcium and mixed feldspars. While the production of utility- and electric-grade porcelain still requires potash feldspar, other fields of ceramic industry are rapidly switching over to mixed, sodium or sodium-calcium feldspars, or to brand new types of fluxes. Czechoslovakia has rich deposits of feldspar sands, which enable to obtain this porcelain raw material at low costs, in sufficient quantity and quality /see the description of the Halámky deposit/.

Another group of raw materials is represented by juvenile volcanic rocks /neovolcanites/ containing high-temperature feldspars and, occassionally, vitreous phase. As the examples we can name tuffs, tuffites /used in ceramic industry as an admixture in the production of earthenware/, perlite and related volcanic rocks, rhyolites and rhyodacites, etc.

Another group of raw materials consists of igneous rocks which fall within the groups of saturated and unsaturated rocks in the new petrological classification. The saturated rocks are important due to the fact that they do not contain any free quartz or any other SiO_2 modifications and, at the same time, any feldspar representatives /foids/. The unsaturated rocks do not contain SiO_2 modifications, too, and contain additional olivine or foids /nepheline, leucite, sodalite group minerals/. The absence of quartz and the high alkali content make these rocks excellent fluxes required as an admixture into present production mixes characterized by low firing temperatures and for rapid firing technologies. The rocks types can be divided into the following categories:

- rocks enriched by Na-metasomatism /the so-called feritization/ - albitites, alkaline syenites, alkaline syenites with foids /e.g. nephelinic syenite/,
- rocks enriched by K-metasomatism /e.g. calitrachytes/
- high-alkaline rocks formed by differentiation /e.g. trachyte, phonolite/

At present, the most widely used representative of the raw materials listed above is nephelinic syenite; in Czechoslovakia, the problem of using phonolite as a component of ceramic mixes has been solved, too.

Another group of fluxes is represented by Ca and Mg carbonates: limestone, dolomite, magnesite and mixed types of sedimentary rocks, such as marls or spongilites. These raw materials act very favourably in the production of porous tiles as the Ca and Mg oxides form low-melting eutectics in process mixtures, thus contributing to a reduction in firing temperatures.

A group of fluxing raw materials which is only little known in Europe consists of plastic raw materials on the basis of argillaceous micaix-illite and hydrated sericite. These raw material types are found mainly in some Asian countries /China, Japan, Korea/; however, recent investigations have confirmed occurrences of these raw materials in Czechoslovakia, too.

In order to be complete our survey we must mention the group of radical fluxing agents, represented particularly by minerals of lithium /e.g. petalite/, boron /collemanite/ or fluor /fluorite/. However, the use of fluorite is being abandoned in ceramic industry due to hygienic reasons. While petalite and collemanite are efficient fluxes, they are fairly rare raw materials which are internationally traded and whose prices have gone up considerably in recent years.

3. IN-PLANT TRAINING

Research Institute for Ceramics, Refractories and Non-Metallic Raw Materials in Plzeň

One of the industrial lines that have contributed towards the renown of Czechoslovakia abroad is the manufacture of ceramic products. It is backed up by the tradition of more than hundred years of its ceramic industry and by the unusually rich reserves of raw materials. The kaolin deposits in western Bohemia, particularly in the areas of Plzeň and Karlovy Vary, rank among the richest ones on European continent. In their immediate vicinity there have been built modern establishments for dressing and processing of kaolin and for production of ceramic articles used in the building industry; there has also been founded a research and scientific basis of the Czechoslovak Ceramic Works - the Research Institute for Ceramics, Refractories and Non-Metallic Raw Materials in Plzeň. The Institute's activities are carried out by specialized divisions.

Headquarters and Consulting Division Plzeň

- verification of eligibility of local raw material resources for production of ceramic articles, based on laboratory and pilot plant tests

- consulting engineering and technical assistance in commissioning of new industrial plants. Orientation tiwards production technology and mechanization of production of ceramic articles for the building industry, of refractory and insulating materials

- measurement of power consumption by heat consuming sets in the industry of ceramics and non-metallic materials conducted with the aid of a mobile diagnostic unit. Determination of potential adjustment of these sets aimed at a reduction of the demand for fuels, intensification and optimation of the process of production

Research Division at Horní Bříza

is engaged in research of:

- technology of manufacture of floor and wall tiles
- technology of manufacture of stoneware
- technology of manufacture of refractory and insulating materials
- technology of manufacture of art ceramics
- mechanization and automation equipment for ceramic industry

Research Division at Karlovy Vary

is engaged in research of:

- methods of extraction of non-metallic raw materials
- methods of dressing and refining of non-metallic raw materials for the ceramic and glass industry /production technology and the corresponding mechanical equipment/

Research Division at Rájec-Jestřebí

is engaged in research of:

- special refractory materials for metallurgical applications /sinks made of fused quartz, lubricating and separating materials for die casting of metals/
- applications of liquefiers and SiO_2 gel in ceramic industry

Technical Assistance

The Research Institute for Ceramics, Refractories and Non-Metallic Raw Materials in Plzeň offers the following services to its trade and technical partners - central organs, specialized institutions and production establishments in both industrially advanced and developing countries:

in the sphere of extraction and processing of raw materials:

- complex evaluation of raw materials for ceramic and glass industry obtained through geological survey and prospection, assessment and determination of their potential applications in production of articles for building industry and of refractory products
- investigation of new methods of extraction, dressing and refining of raw materials for the ceramic and glass industry
- dressing tests of all types of non-metallic raw materials with projects of lines and plants for their treatment

in the sphere of technological processes of production:

- research into and development of working masses, with elaboration of technological processes of manufacture of ceramic articles for the building industry, such as facing tiles, floor tiles, sewerage and industrial stoneware
- research and development of working masses with elaboration of technological processes of manufacture of refractory materials, such as fireclays or high-alumina products, dinas of high density on the basis of crystalline quartzites and others

in the sphere of mechanical and technological equipment:

- development and design of machines and equipment for mechanization and automation of technological processes in production of ceramic articles

- development and technical conception of instruments and apparatuses, e.g. automatic control of temperature in laboratory furnaces and in industrial heat consuming sets

in the sphere of thermal power engineering

- setting, optimation and intensification of operation of furnaces and kilns in ceramic industry
- application of refractory solid and light-weight insulating materials in industrial furnaces

in the sphere of engineering activities and technical assistance:

- prognostic studies in the line of ceramic and glassmaking raw materials, of ceramic articles for building industry and of the refractories
- technical and economic study for capital investment projects involved in modernization of old and construction of new plants of ceramic industry abroad
- assessment of projects of ceramic plants
- all kinds of consulting activities, training-in of experts and other kinds of technical assistance in the line of ceramics
- assistance afforded to developing countries during introduction of ceramic industries within the scope of activities of the Research Institute for Ceramics, Refractories and Non-Metallic Raw Materials in Plzeň and of the UNIDO-Czechoslovakia Joint Programme for International Cooperation in the Field of Ceramics, Building Materials and Non-Metallic Minerals Based Industries.

in the sphere of active licenses:

- affording of production licenses concerned with various ceramic and technological production processes, mechanical and technological equipment, checking and control instruments.

Diagnostic Mobile Unit

Diagnostic mobile unit of the Research Institute of Ceramics, Refractories and Raw Materials, the research base of the Czechoslovak Ceramic Works, Prague, can be used. It is equipped with suitable measuring instruments, a computer and specialized evaluation centre. By positioning the unit immediately at the heat consuming unit to be diagnosed and by direct connecting the measuring instruments with sensors placed on the respective spcts and spaces of it, it is possible to control and evaluate the measured values in a single centre.

These diagnostic measurements executed by a team of Czechoslovak specialists may be focussed to minimize the energy consumption on the one hand and to optimize the thermal technological process on the other.

Energy Balance

All qualitative as well as quantitative values of applied energies and all kinds of thermal losses in the whole heating system of the respective equipment are measured to find out the energy balance of a heat consuming unit. At the same time conditions of the heating system, level of combustion processes and of the heat transfer in the unit are being ascertained and possibilities of an improvement of hitherto operating conditions tending to achieve required energy savings are verified.

Thermal Technological Process

To verify the correctness of the thermal technological process conditions of the respective unit values relating to the quality of the final product are measured to find out the possibility to decrease the heat consumption, e.g. by means of more sophisticated exploitation of the applied energy, by shortening of thermal technological cycles, by the intensification of the technological process etc.

Statements

All technical values gathered by the measurings mentioned above are processed in a computer. Due to a close continuity between the thermal technological process and the energy balance of the respective heat consuming unit there is recommended to make both energy and technological measurements and surveys coincidentally to be able to prepare to the user an objective and complex statement and to draft all suitable and recommendable adjustments and changes which are to be realized for its perfect and effective service.

Carlsbad Glass - Moser

The glass of kings, the king of glass: this is the name of the glass produced since 1857 in the Moser Glassworks, Carlsbad. The epithet has been acquired owing to the fact that many coronated and non-coronated heads of states, governments, diplomats, and leading representatives of political, cultural and economic scenes of the world have taken a liking in it.

It is the glass which by far outranks the standard production. It is the result of the 700 years´ lasting development of the Czech glass manufacture, during which tradition and quality have earmarked the way.

The origin of the Moser glass manufactory is closely related to the development of the world-renowned spa of Carlsbad. In the 18th century, Carlsbad became an important place of the world, not only curative, but also cultural, political, and social. Hence, there were favourable conditions for activities of artists, particularly of those who dealt in the manufacture of tailored-to-order, engraved glass. The founder of the present glass manufactory, Ludvík Moser /1833-1916/, passed his engraver´s apprenticeship with famous O.J.Mattoni, and established his own workshop in 1857. Gradually, he expanded the production of engraved glass by adding of cutting and edging and, in 1892, he built even his own glass smelter. Unlike most of glassworks of the time which concentrated upon a mass production, his was the only one which had specialized in the manufacture of artistic glass of the highest quality achievable. The plant has maintained this goal until now, since 1945 operating as a national enterprise.

The basic prerequisite of the production is the so-called Bohemian crystal - a hard, sodium-potassium glass made from purest raw materials: glass sand whose maximum allowable Fe_2O_3 content is 0.015 %, glass limestone, potash, and soda. The pure and hard glass, whose parameters are very similar to those of rock crystal, is best in view of its suitability for engraving, decoration with gold and paint, and cutting performed on large areas. The production process in the existing manufactory makes use of the best available equipment; however, the initial stage, i.e. blowing, as well as other operations, such as engraving, cutting and other artistic works, are manual.

The carriers of the production programme are table sets, richly decorated by engraving, cutting, possibly gilding. The best-known sets are: Splendid, Maria Theresia, Maharani, Mozart, Royal and Pope´s. These are shown in the manufactory exhibition hall, together with a number of medals and awards acquired since the date of the Moser Glassworks establishment in 1857.

Another important part of the assortment are so-called Moser´s phantasies. The name encompasses various decorative articles - vases, bowls, ashtrays, jardinières etc., which are either cut or shaped directly at the furnace. A speciality of the plant are the so-called Moser´s colours, inimitable colour shades obtained with various oxides of rare earths. These are designated as follows:

BERYL - fine-green colour with a transition into blue under artificial light

TOPAS - occurs in a number of shades, from gildish to smoky

ALEXANDRITE - belongs to the rarest shades; it is characterized by a light-violet-pink colouring in which the two shades entwin

ROSALIN - a typical pink colouring which essentially differs from the so-called golden and copper rubies

ELDOR - warm yellow colour

Articles of these colours remind rather of synthetic semiprecious stones than of glass.

A special remark should be devoted to Moser´s engraved glass. In this area, articles produced by the Moser Glassworks are based on the tradition of hunting and/or heraldic motifs, classist sceneries and, at present, even modern works of art.

Another group of the Moser Glassworks programme are the socalled "Romans". These are wine-glasses made of six-coloured, cased glass. A very popular article are the so-called giant tumblers. This is a set of six constituting a complete. The tumblers represent six statures each having its specific features and name.

The Moser Glassworks does not remain confined to their traditional production. In cooperation with outstanding artists, the assortment is continuously supplemented by new decorative topics. The raw material and glass quality is given the utmost care. The glassworks maintains the high quality production and, since its foundation, it has been visited by a number of VIPs, lately particularly on the occasion of the International Film Festivals, hels annually in Carlsbad.

Wall-Tile Ceramic Plant, Horní Bříza

The development of the ceramic production in Horní Bříza is closely related to kaoline mining and washing in the Plzeň /Pilsen/ region. Between 1858 and 1896, many washing plants were built in this area. After the erection of the Horní Bříza kaoline plant in 1883, the local kaoline and clays were used in the ceramic production. In 1886, a separate plant for the production of wall-tiles was built. The local washed kaoline, supplemented by local clays, later by the Vildštejn clays and other raw materials, represented the main bulk of the plant raw material consumption until 1974. The wall-tile production based on these raw materials represents a traditional technology together with subsequent calibration. The HOB trademarked articles have gained acknowledgment throughout the world. In the sixties, the plant was rebuilt and its annual output presently equals 2.5 mill. sq.m of wall-tiles.

A principal change in the production technology occurred in 1974 when the plant introduced a new technology of the production of porous, shrinkage-free wall-tiles from the so-called calcareous-siliceous body, which enables a higher effectiveness and productivity. The new technology employs cheap raw materials, such as the Kaznějov deposit kaoline, the Kyšice deposit light-coloured /after burning/ clay, and limestone. The process consists in a two-stage firing which ensures a high quality of the glaze and perfect appearance.

Another updating, which has been taking place recently, is aimed at the production increase, decrease of labour, increase in quality and expansion of the assortment programme in terms of the products' finish and decoration. The plant keeps abreast with competing factories from abroad, this being confirmed by the fact that well over 50 % of the annual output is exported.

Production of Floor-Tiles in the Chlumčany Ceramic Works

The history of the Chlumčany Ceramic Works is closely related to the discovery and exploitation of kaoline in the vicinity of Chlumčany. Kaoline was discovered during coal mining, in the second half of the 19th century. First experiments concerning mining and washing of the kaoline date back to 1873-1875, having continued, after a short break, until 1890. Another mining plant was established in 1888-1889. Initially, owners and leasers of the plant exchanged many times, the plant producing only washed kaoline which was distributed to other manufacturers. It was not sooner than in 1912 that the kaoline was used for the first time in the production of ceramic articles. In 1912, the Dobřany Kaoline and Fireclay Works Co. was establieshed that built a washing plant, introduced the production of lime-sand bricks, fireclay and dinas, and, in 1913-1914, built also a plant for the floor-tile production. The present production programme, which developed particularly after the nationalization of the plant in 1945 and its expansion, is fully based upon the utilization of the kaoline deposit.

The annual output of undressed kaoline is 200,000 t from which approximately 40,000 tons of washed kaoline is obtained. This amount is partly distributed as paper kaoline, partly used in the tile production. The sand which is a by-product of the kaoline washing is used in the neighbouring plant which produces porous concrete materials.

The annual output of the tile production equals approximately 4 mill. sq.m. At present, its main bulk is still represented by unglazed tiles /about 2/3/ while the production of glazed tiles has been introduced only recently. The assortment programme includes mosaics /square and rectangular tiles, Florence tiling/, unglazed tiles 10 x 10 and 10 x 20 cm, tiling strips, 6.5 x 25 cm, glazed tiles 10 x 10, 10 x 20 and 20 x 20 cm, clinker bricks, acid-resistant earthenware and industrial tiling.

The basic principle of the production technology is the use of the feldspar content which is present in imperfectly kaolinized parts of the deposit and occurs in the fine fraction of 0.02 - 0.3 mm. This material can be advantageously made use of in the ceramic production, particularly as grog and flux. The tile mixture is composed of 25 % of washed kaoline, 50 % of feldspar-quartz material /by-product of the kaoline washing/ and 25 % of clays /Pilsen region/ which are added in order to increase the plasticity and strength of the mixture. The process mixture is white; if combined with various colouring oxides it can provide a rich variety of unglazed coloured tiles, which is typical for the Chlumčany production. The mechanization and automatization of the process have been playing an ever-increasing role. The plant provides examples of several development stages under a single roof. As far as the preparation of mixtures is concerned, automatic batching according to the selected formula is being introduced. The raw material grinding takes place in drum-mills /wet-grinding/ and its duration is 14 to 16 hours. The traditional filter-press dewatering is being replaced by spray-drying. As far as moulding is concerned, new high-capacity automatic presses are increasingly used which possess of an automatic stacking feature. The old tunnel kilns fired by generator gas /firing time 42 to 48 hours/ are replaced by electric ones which considerably cut the duration of firing /to 3.20 hours/. The production assortment is expanded by adding of new types of glazed tiles.

The Chlumčany Ceramic Works plant is an example of a complex utilization of a kaoline deposit in the production of a rich variety of tiling materials and porous construction concrete.

History of the Carlsbad Porcelain, china ware factory Nová Role

The history of porcelain began in China, approximately in 6th or 7th centuries. Europe became acquainted with porcelain in 1295 when first samples were brought from China by Marco Polo, a citizen of Venice. He found his successors in Portuguese and Dutch merchants who also brought porcelain from China and Japan to Europe. Naturally, the import of porcelain induced efforts of discovering the secret of its manufacture, The first European substitute of porcelain was the Italian faience; however, its quality was rather far from that of porcelain as its body did not have the hardness which is so characteristic of porcelain.

Nowadays we know that the manufacture of porcelain in Europe was a genuine new production technology. The raw materials from which porcelain has been made in some Asian countries until now /such as China, Japan, Korea etc./ are very different from the European ones, both in their composition and genesis. The Asian raw materials are partly hydrothermally decomposed effusive rocks which contain all the three components necessary for the manufacture of porcelain, namely kaolinitic-clayey component, feldspar, and quartz. Moreover, the components are finely dispersed in the rocks. In Europe, the manufacture of porcelain demanded to find the mix formula based on three different raw materials: plastic kaoline and non-plastic feldspar and quartz. That was why attempts to manufacture porcelain succeeded no sooner than in the beginning of the 18th century in Europe. On March 20th, 1709, the alchymist and pharmacist Johann Fridrich Böttger announced to Fridrich August, the King of Poland, that he was able to manufacture both white and painted porcelain. On June 6th, 1710, the first porcelain manufactory in Europe was established in Meissen. The second porcelain manufactory was established some 10 years later in Vienna.

In Bohemia, the first attempts of introducing the manufacture of porcelain are dated back to 1789 when František Haberditzl of the village of Rabensgrün near Slavkov tried to manufacture fine ceramics from local raw materials and applied for the permission to establish an earthenware manufactory which he obtained in 1791. In 1792, Jan Jiří Paulus and J.J. Raumann applied for granting the state privilege for the porcelain manufacture. One year later, in 1793, Jan Mikuláš Weber established another porcelain manufactory in Klášterec in Thun´s estate. Other manufactories followed: in 1803 in Březová and Kysibl, in 1811 in Loket. By 1815, there were already 8 poercelain manufacturies in the Carlsbad region.

Since its very beginning, the porcelain manufacture in Bohemia and Austria has been closely connected with the exploitation of the kaolines of the Carlsbad area. Exceptional properties of the kaoline were particularly recognizable after its washing. First washing plants were established there where water mills had already existed. The first one was built by Václav Lorenz in Sedlec in 1805. By 1810, there were 21 known kaoline deposits in the Carlsbad area; since 1819, the Carlsbad kaoline has been used not only by all porcelain manufactories in the Carlsbad district but also by the Vienna manufactory and porcelain manufactories in Germany. In 1914, the production of washed kaoline attained 30,000 tons with more than 2/3 intended for export.

In 1924, through the effort of the Czech Ceramic Society, the Congress of the Union of Pure and Applied Chemistry, held in Copenhagen, proclaimed the Sedlec kaoline to be the international standard. Since the beginning of the Sedlec kaoline exploitation attempts have been made to discover the extraordinary suitability of this raw material for the porcelain manufacture. Prof. Kallauner /who also proposed the adoption of the Sedles kaoline as the international standard/ inferred that these favourable properties are due to a virtually 100 % purity of the Sedlec kaoline. Research works performed in last decades have proved that the Sedlec kaoline contains a small admixture of illite which considerably influences one of the most important properties of kaoline, namely its green strength. The Sedlec kaoline is appraised mainly for its high green strength, good liquefaction ability /for the production of poured articles/, white colour after firing, and transparence of the produced porcelain. Another important feature is its homogeneity, i.e. repeatability and consistency of the above-mentioned properties, which is controlled by mixing of raw material types of different parts of the deposit and perfect dressing in the modern processing plant in Božíčany.

The manufacture of porcelain basically maintains the following formula: 50 % of washed kaoline, 25 % of feldspar, 25 % of quartz. The Carlsbad porcelain belongs among hard ones which make use of potash feldspar. At present, the Carlsbad porcelain manufacture uses the Halámky deposit feldspar /see the separate article on the deposit/. The formerly used vein quartz has been due to economic reasons, replaced by the quartz sand of the Velký Luh deposit /Cheb Basin/.

The Nová Role plant, which will be visited in the framework of the training workshop, was /in its present appearance/ built in 1963. It consists of four parts:
- newly built plant producing utility porcelain
- renewed plant
- central production of firing aids
- rich decoration

The Nová Role plant is, under Czechoslovak conditions, a large factory /the size determined by the maximum possible concentration of labour force - approx. 1,200 employees 70 % of which are women/. The factory produces a wide assortment of utility porcelain which is prevalently exported.

The plant is equipped by a tradition mix-preparation stage /wet grinding in drum-mills, filter-presses/ which was supplied by the Přerov Machinery Works. The most interesting parts of the factory are probably the machine forming and pouring lines whose design is the work of the employees of the plant. In some cases, the machinery which can be seen in either of the lines is quite unique, such as the automatic plate-forming machine. Licenses pertaining to these pieces of equipment have already been sold to a number of countries.

The firing takes place in modern tunnel kilns made by Riedhammer /Nürnberg/; these kilns are considered very well designed for firing of hard porcelain by long-distance gas.

According to the plant´s representatives, further development should concentrate mainly upon the decoration. The hard porcelain which is typical of the Nová Role factory production is, unlike many types of porcelain produced abroad, extremely suitable for applying rich decoration, thereby enabling to maintain a highly automatized production and, at the same time, to satisfy special requirements of individual customers.

Bechyně Ceramic School

In 1984 the Secondary Technical School of Ceramics in Bechyně will celebtrate its hundredth anniversary. The history of this school founded 100 years ago is closely related to the development of ceramic industry in Bohemia and Moravia. The choice of the school seat was influenced by the rich raw material deposits in the vicinity and the advanced pottery and fireclay manufacture around Bechyně. Even as early as in the 16th century there were 10 pottery and fireclay workshops in Bechyně. At first, only tile stovemaking was taught, the curricula later amended by art pottery and in 1890 by decoration /painting/ of ceramic products.

Since 1961 the school has been housed in a new building with spacious laboratories and workshops and modern equipment. It has a well-maintained centre of scientific, technical and economic information, a language laboratory, depositories, a drawing room and studies. Attention is paid to the accomodation of the pupils and their cultural satisfaction. The pupils live in a newly built, beautiful dormitory.

Since the time of its foundation the school has trained more than 2,000 graduates. Some of them went on with their studies either at technical universities or at art academies; however, most of them found their occupation in ceramic industry where they command many important posts.

At present, the school takes four years to complete, the studies being closed by a school-leaving examination. The curricula are divided into two principal study subjects:

1. Ceramic Technology

The pupils majoring in this subject are acquainted with ceramic raw materials, their properties and processing, they perform their analyses, they acquire the knowledge on forming, drying, glazing and firing of ceramic products. They attend workshops where they make themselves familiar with the manufacture of plaster moulds, decoration of ceramic products and production of building ceramics. The curricula of this subject contain the following lessons: technology, technological laboratory exercises, thermal technology, economics, machines and equipment, in-plant training practice, technological calculations, physical chemistry. The theoretical lessons are combined with practical checking of basic knowledge throughout the time of the study, the pupils gaining necessary working skills at the same time. In the first two terms the practical angle comprises workshop exercises in the ceramic painting workshop, the plaster room, the building ceramics workshop and the workshop of utility ceramics. Laboratory exercises also supplement theory in subjects such as analytical chemistry, physical chemistry, electrotechnology, automatization and technology. The curricula of the first three terms contain a fortnight in-plant training, those of the fourth term a longer, in-plant practical training directly in producing factories. Graduates majoring in ceramic technology find jobs as test and laboratory technicians, masters of technical control, foremen of workshops, technologists, and in a number of other technical/organizational posts.

2. Decorative Ceramics

The subject is subdivided into two specializations: /a/ modelling of utility and decorative ceramics and /b/ decoration of ceramics. The pupils majoring in this subject gain the same technological knowledge as those studying ceramic technology. However, more attention is paid to practical angles, that is to exercises in the ceramic workshop, painting and plaster rooms. The pupils are provided with the necessary creative education through being taught the subjects such as drawing, modelling and history of art.

The graduates can find their occupation as highly qualified art craftsmen in the fields of decorative ceramics, design of ceramic products, as modellers and employees of desing workshops or creative studios. In addition, they are employed as technicians in factories producing decorative, utility or figure ceramics. The gifted ones may continue their studies at art academies.

Bechyně Sanitary Ceramics Plant

The beginning of the production of sanitary ceramics in Bohemia and Moravia is marked by the foundation of the Ditmar - Urbach factory in 1884 in Znojmo. The production of sanitary ceramics gradually expanded to South Bohemia with its long tradition of pottery and stovefitting dating back to the 16th century. In 1949, smaller plants in Jarošov, Příbram, Brunšov and Bechyně merged into a single enterprise which concentrated the production of sanitary ceramics into a new plant built in Bechyně in 1962.

The Bechyně plant produces a wide variety of sanitary ceramic items. It operates on rich resources of domestic raw materials. The principal components of the Diturvite trade-marked material are ground feldspar, ceramic clays and washed kaolin. The products are made by casting into plaster moulds, by glazing and firing at 1280°C. In order to keep pace with the world progress, new technologies and product mixes are continuously introduced. Individual plants of the entire ceramic trust are specialized as far as their production is concerned. At present, attention is paid to the improvement of thw working environment. The whole Bechyně plant will be modernized and renovated during the 6th Five Year Plant.

The sanitary ceramics of Bechyně has a good reputation abroad and is widely exported. There are several tens of types of washbasins, water closets, bidettes and other ceramic products, both in plain and coloured versions. The good name of the Diturvite-trademarked sanitary ceramics is thoroughly justified.

Borovany Mining and Processing Plant

The occurrence of diatomaceous earth and its excellent properties became known already in the beginning of the 20th century. In 1920, the CALOFRIG corporation was established which dealt in mining and processing of the Borovany deposit diatomaceous earth. After its nationalization in 1945, the CALOFRIG national enterprise has been rapidly developing. A new plant has been built, the old one renewed, and a number of new assortment elements introduced.

The industrial processing of diatomaceous earth has so far consisted in the manufacture of fired insulants and insulating building materials. The fired articles are used for insulating of thermal equipment up to 900°C.

Apart from its insulating qualities, diatomaceous earth possesses of a number of other excellent properties which are apt to be made a much wider use of in future. It can find application in food, chemical and pharmaceutical industries /filtering processes/. Also, it can be used as a catalyst. Another possibility of its use is in the field of fillers of paints, epoxide resins, rubber, and various plastic materials, abrasive mixtures and polishers.

Diatomaceous earth is used as an adsorber in fills of fire extinguishers and pressure gas bottles. It finds a wide application in the field of chromatography as well.

The following paragraphs present a survey of products made of diamtomaceous earth, appropriate technological processes, and properties of the products:

Cured diatomaceous products

These are made of diatomaceous earth, sawdust, lime and cement and are steam-cured in autoclaves at 175°C and 8 atmospheres. The "Isostone" shaped bricks´ specific weight is 600 kg/cu.m. Due their excellent insulating properties, they are used in bricking of perimeter walls 25 cm thick.

Diatomaceous panels

These are building materials used in residential, civil, and industrial structures. If used in a single-storey buildings, they can perform the function of a load-bearing element; if the number of storeys is higher they can be used in filling perimeter walls.

Fired diatomaceous products

These are either standardized or tailored shaped products /pieces/ used in thermal insulation linings up to 900°C. They are made of diatomaceous earth and combustibles by pressing, drying and firing. Their application is found particularly in various steam-, hot-water-, furnace- and reactor- thermal insulation linings. The specific weight of these materials is between 610 and 960 kg/cu.m, their specific thermal conductivity 0.10 - 0.20 kcal/mh°C.

Filtering materials and fillers

These are manufactured by calcination, grinding and air separation. The trademarks of the filtering diatomaceous materials are F2 and LAS while that of the filler is FJ. Their bulk weight ranges between 200 and 300 g/l. The properties of the materials are determined by a number of standardized criteria.

"Cromaton" diatomaceous material

It is prepared from physically and chemically preprocessed diatomaceous earth by shaping, thermal dressing and sorting. It is used as an indert carrier in separation of organic compounds in analytical and/or preparatory processes.

Loose diatomaceous materials

These are made from raw diatomaceous earth by drying, grinding, sorting, and possible adding of other admixtures. They are used as loose insulants, in insulating mortars, and in various other applications, such as in the production of catalysts.

Fired diatomaceous chippings

This is a thermal insulating material which is made either of fired diatomaceous shaped bricks by crushing or from raw diatomaceous earth by firing in the presence of porousness-increasing additives. It is used as a loose insulant up to 900°C.

4. SIGHTSEEING

Prague

Prague lies on 50° of northern latitude and 14° of eastern longitude at a height of 177 to 383 metres above sea level on the hills and terraces surrounding a meander of the river Vltava. It has more than 1 million inhabitants and covers an area of 290 sq. kilometres.

The history of the town begins in the 5th century. In this century Slavonic tribes made their way to the Prague valley. The size of the later town was demarcated by fortified princely seats on rocky cliffs above the Vltava: Prague /now Prague Castle/ in the north and Vyšehrad in the south. There are three main historical cores of the town:

Prague Castle, the most important Czech national cultural monument is a work of eleven centuries. Its site was originally occupied by a Slavonic community. From the 9th century it was the seat of princes and later of kings and emperors. It stands on a narrow headland above the river Vltava and is rich in architectural monuments from the Romanesque period up to the present. It is now the seat of the President of Czechoslovakia.

In the 11th century Vyšehrad was for a certain period the main Přemyslid residence. However, it was destroyed in 1420 and later rebuilt as the souther Baroque fortress of the town.

The third main core of the town was the Old Town market near the old princely customs house /the Ungelt/. The first stone bridge named after Judith, wife of King Vladislav I, was built in 1158-72 on the site of the present Charles Bridge. About 1235 the town of Prague /now the Old Town/ reached its present size. In 1257 King Přemysl Otakar II founded the present Little Quartier on the opposite bank of the river and at the beginning of the 14th century the townlet of Hradčany originated in the west along paths from the Castle.

Political and building activities were developed by Charles IV, King of Bohemia and the Roman Emperor. In 1344 he established the archbishopric of Prague and in 1348 he founded the first university in Central Europe. He founded the New Town of Prague stretching along the river as far as Vyšehrad and surrounding the Old Town. A new stone bridge was built /Charles Bridge, from 1357/ and the reconstruction of the royal palace, St. Vitu´s Cathedral and the Old Town Hall was commenced. In that time, Prague became the largest town in Europe.

With the arrival of the Renaissance, Prague was enriched with the magnificent Vladislav Throne Hall, Queen Anne´s Summer Palace and the present Schwarzenberg Palace. The Baroque period gave rise to works of a new, robust scale and plasticity.

In the 19th century, industrial suburbs sprang up around Prague. In 1845 the first railway track to Prague was laid. From the second half of the 19th century Prague underwent rapid growth, being enriched with a large number of monumental buildings. They are represented by three main buildings: National Theatre /1868-83/, the House of Artists /the Rudolfinum - 1876-84/ and the National Museum /1885-90/.

In 1918 Prague once again assumed the role of the metropolis and the seat of the head of state. Now Prague is capital of the Czech Socialist Republic and capital of Czechoslovak Federal Socialist Republic. Prague is center of administratif institutions, as well as large industrial town /machinary, etc./, center of cultural life and many kinds of schools. Last years, big housing estates are being built, an underground railway and a network of effective road communications are under construction.

Plzeň

Plzeň is an old royal town, founded by Přemysl Otakar IInd, at the strategically important site near the confluence of the Mže, Úhlava, Úslava and Radbuza rivers. At that time, the old part of Plzeň, Starý Plzenec, had already existed. The importance of the town of Plzeň was stressed by Karel IVth in the middle of the 14th by founding of the Radyně Castle whose ruins now overlook the whole Plzeň area.

Of the important buildings of interest in Plzeň, at least two must be mentioned. The first is the Renascence town-hall dated back to 1554 to 1559, the work of Giovanni de Statio, the second is the famous Church of St. Bartholomew, dated back to about 1320, whose spire is 102 m high, being thus the highest eccesiastical structure in Czechoslovakia.

The modern Plzeň is known mainly due to its two industrial plants: the Škoda Works, the largest machinery enterprise in Chechoslovakia which produces engines, boat engines, energetic equipment, and nuclear reactors, and the famous Plzeň Breweries whose products will not sure remain unknown to you. The most popular of them is the Pilsner Urquell of which there exist many copies in the world but which is, for its taste and effects, quite inimitable. Apart from its traditional production technology, its qualities are due to specific local conditions, such as water, climatic conditions, and maturing in cellars whose corridors´ length is well over 9 km. Therefore, it is no wonder that, of the 2,000,000 hectolitres of the annual output /i.e. more than half a billion glasses/, the major part is exported to 80 countries of the whole world.

Spas in Western Bohemia

One of the natural features of Western Bohemia is the ample occurrence of thermal springs whose origin dates back to the period of the Tertiary volcanic activity. These gave rise to a number of spas the most important of which are Karlovy Vary, Mariánské Lázně and Františkovy Lázně. Last but not least, the Jáchymov radioactive spa makes use of the radioactive water occurring in the area.

Karlovy Vary

The largest and most important spa in Czechoslovakia. It was founded by Charles IVth who had a small castle built at the curative thermal springs then known already for a long time. Also, he declared the then existing settlement a royal town.

Only the tower of the original building has been preserved; however, even now fanfares can be heard from its gallery which announce the beginning of the spa seson. Most of the remaining architectonic buildings of interest date back to the 18th and 19th centuries when the spa was a European dating place, hosting the most important persons of those times. Among the most valued monuments, the baroque church above the Spring, the Neo-Renascence collonade, the pseudo-baroque theatre, the Jugendstil spa building, the Moskva-Pupp and Imperial hotels, must be named. Of the new buildings, particularly the new spring collonade and the 20-storey Thermal hotel whose rooms and halls serve also for the International Film Festivals and other important social events are worth mentioning.

Jáchymov

The Jáchymov spa, the first radioactive spain the world, was founded in 1906. In the 16th century, the town was the most important centre of silver mining in Europe. A number of historic monuments have been preserved from those times, such as Šlik´s Tower /the remainder of the original castle, under construction since 1515/, the Late Gothic town-hall with a Renascence, Saxon-type front part, the Renascence building of the former mint, many burgher houses dating back to the Renascence and Late Gothic ages, the church, and the Chapel. Recently, the spa has been reconstructed so that the great number of radioactive springs could be effectively used. Particularly, illnesses of motion and blood circulation are cured here. The highest elevation of the Krušné Hory Mts., Klínovec /1,244 m a.s.l./ is nearby, as well as the winter recreational area of Boží Dar.