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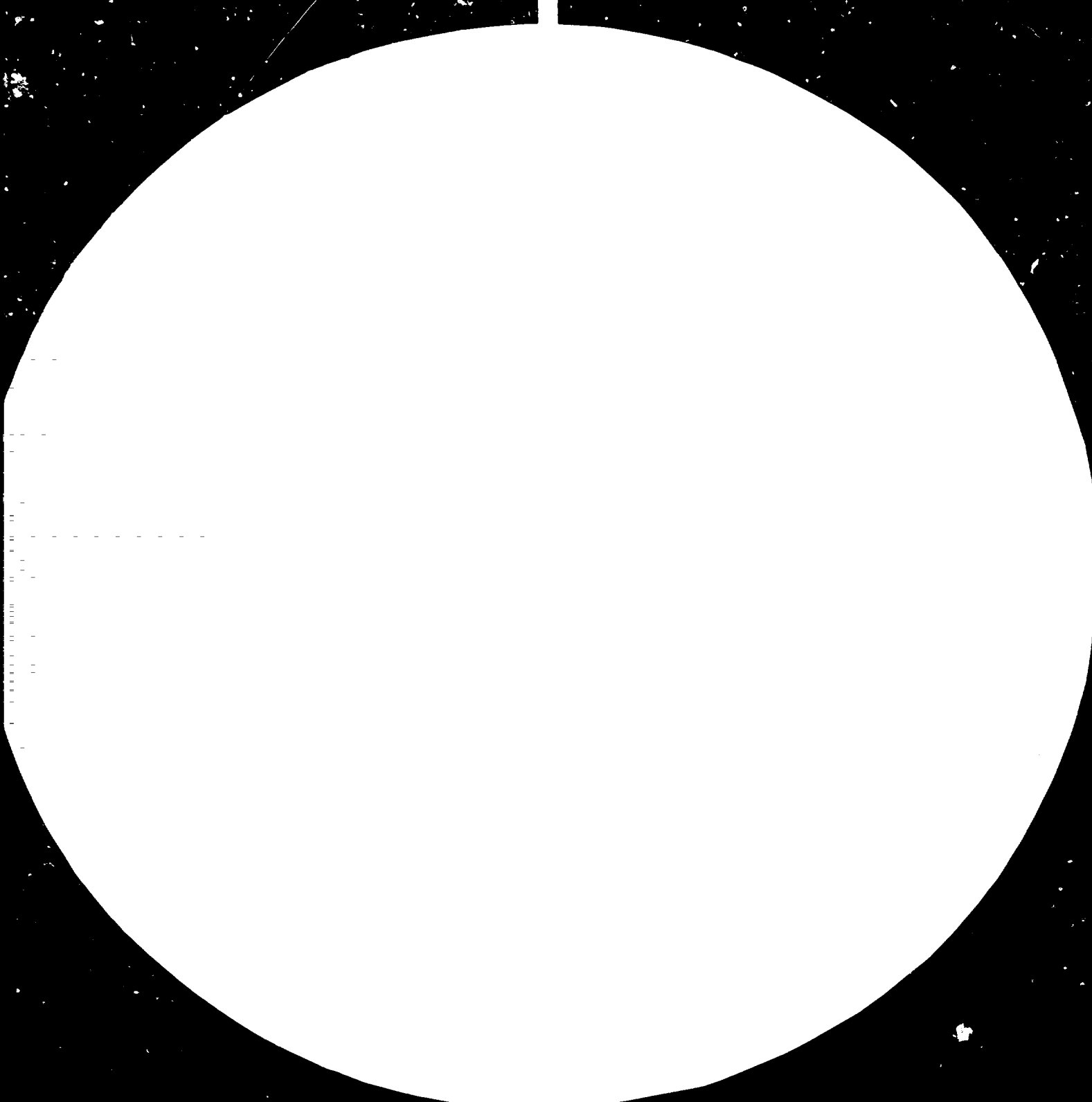
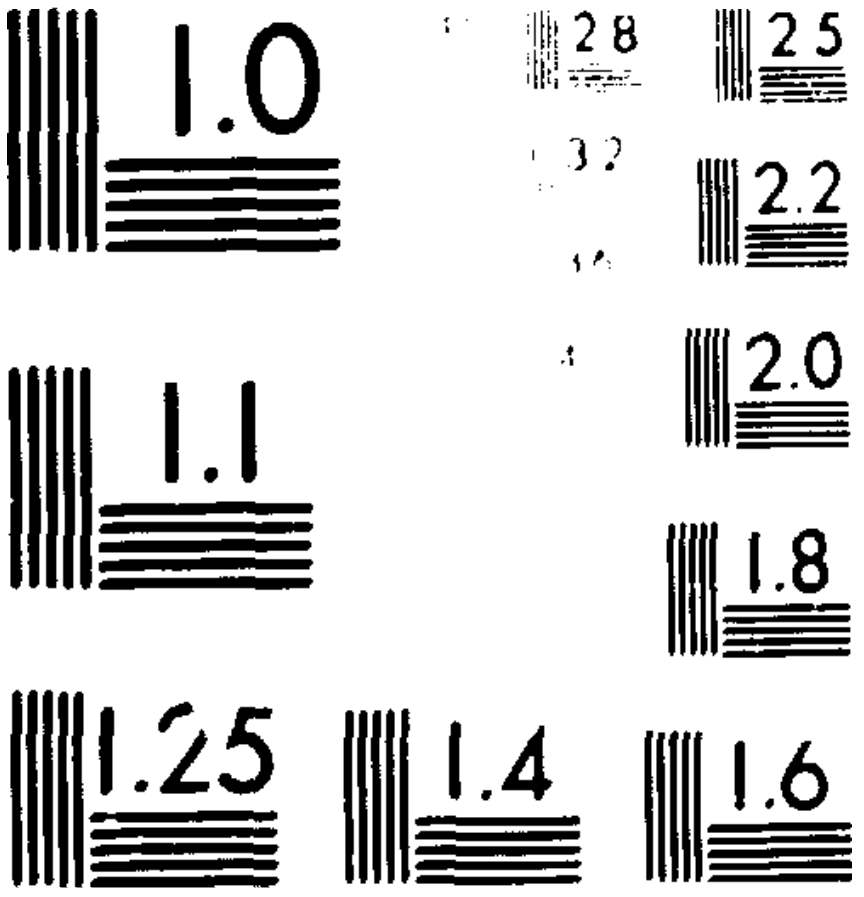
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org





R. Miseck → Maria Dietrich

12025 1980

VOLCANIC ROCKS

APPLIED AS FLUXES IN CERAMIC MANUFACTURE:

TUFFS AND TUFFITES
NEPHELINES
PHONOLITES
PERLITE
ANDESITE

occurring in the group of carbonates: LIME MARLS

a/ Characteristics

b/ Occurrence in ČSSR

c/ Application

Volcanic building materials

The use of volcanic rocks in the manufacture of silicate products has become a frequently discussed topic in scientific conferences on raw materials as well as in literature. It is due to the fact that these rocks appear to be good fluxes and replace feldspars in many cases.

Volcanic rocks consist of many minerals crystallized primarily from the glowing magma or transformed from primary minerals by the action of steam, hot gases, high pressures and temperatures. The majority of these volcanic rocks is represented by silicates containing alkalis and calcium. The alkalis in the form of feldspars and feldspathoid foids participate in the creation of volcanic rocks by 60%, amphibole and pyroxenes by 17%, quartz by about 12% and biotite by 4%. Nearly all these rocks contain a certain percentage of chemically combined water.

/53/

In the petrographic classification of volcanic rocks carried out from the viewpoint of chemical composition the alumina is of a high importance. Its content fluctuates between 24 and 30% but seldom drops under 30%. Accordingly the volcanic rocks are classified in acidic, intermediate and alkaline ones, although these groups can hardly be precisely separated. The volcanic rocks often show a considerable alumina content attaining; especially in rocks rich in nepheline as much as 30%. The ferric and ferrous oxide content lies rarely under 1% but it may reach even 20%. The MgO percentage is between zero (traces) and 48% while the calcium oxide content can approach 20%. A similar range show alkalis where natrium oxide predominates.

/54/

Another classification of the volcanic rocks:

Rocks containing quartz - alkaline granites/feldspars, granites/potassium feldspars, granodiorite quartz, diorite and quartz gabbro;

Quartz-free and feldspar-free rocks - alkaline syenite, syenite, syenodiorite, syenogabbro, diorite;

Rocks containing feldspathoids - [illegible]: nepheline syenite, phonolite, melilitolite, leucitite with feldspathoids

/55/

For the [illegible] known [illegible] rocks follows:

A Tuffs and tuffites

B Nephelinites

C Phonolites

D Perlite

E Andesite

and besides from the group of [illegible]

F Lime marls.

Numbered references in the text refer to the list of applied literature.

Abbreviated on 13 July 1960
[illegible]

A/TUFFS, TUFFITES

Tuffs are [illegible] deposits of volcanic [illegible] of mostly [illegible] origin. Therefore they [illegible] solid pieces containing fragments of rocks and volcanic [illegible] usually had been transported and blended with [illegible] volcanic material. In this case they [illegible] tuffites.

Tuffs consist [illegible] of volcanic [illegible] ejecta and [illegible]. Tuffs usually [illegible], i.e. [illegible] vitrification or [illegible]. In tuffites [illegible] tuffs comprises also volcanic [illegible] and [illegible]. [illegible] to rock minerals with regard to [illegible]. /1, 2/

Occurrence of [illegible]

The deposits [illegible] in the Circum Pacific, especially [illegible] and North America. There are also extensive deposits of tuffs and tuffites [illegible]. The occurrence of tuffs is known [illegible] types of deposits bound to surface volcanic [illegible], shield volcanoes, [illegible] and especially [illegible] but also to subsurface formations, i.e. [illegible] volcanic chimneys, more or less denuded.

/3/

In České středohoří (a range of hills north of the river Ohře) the beds of basalts and phonolites are accompanied as a rule by thick deposits of tuffs. /4/

In North Moravia the beds of basalts and phonolites are concentrated around Bruntál. The known deposits are Uhlířský vrch 3 km south of Bruntál, Venuše Volcano and Velký Roudný situated in preserved territory. The deposit Uhlířský vrch is of a considerable size and has not yet been mined. /5/

In the deposit Uhlířský vrch volcanic rocks overlap subjacent beds Kulmské droby, often alternate lave flows, tuffs and agglomerates. The deposits of tuffs are 20 - 35 m thick. /6/

In Slovakia there are ample deposits of tuffs north of Polana and Detva where beds of andesite are separated by thick deposits of agglomerated tuffs. /7/

Further deposits of andesite tuffs in Slovakia are in known localities Sv. Benedik, Šemberovce, Čajkov and Veľká Tŕňa. Basalt tuffs occur at Hodejov. /8/

As well as the extensive localities of basalt tuffs in Doupov Mountains reaching as far as Podbořany and extending in northen direction to Kadaň in Bohemia should be mentioned. /9/

Use of tuffs

The bulk density of tuffs makes 1200 kp/cu.m and the compressive strength 50 kp/sq.cm. Therefore, tuffs are suitable for the manufacture of light-weight aggregates delivered in blocks or crushed as well as for the production of expanded perlite. Tuffs possessing hydraulic reactivity are applicable in the manufacture of cements and limes. Tuffs with decontaminating effects are considered to be suitable for rendering harmless the radioactive waste.

/10/11/

Tuffs can be applied in the manufacture of ceramics as well. Some pipes produced on the basis of tuffs need not be glazed. The drying and firing processes seem to be without problems.

/12/

[illegible] sodium potassium silicate, [illegible] albite (sodium [illegible] content of SiO_2. [illegible] developed hexagonal prisms [illegible] clear appearance.

/13/

[illegible] 44 – 45% of SiO_2 and 34 [illegible] 15% of Na_2O and [illegible].

/14/

[illegible] treatment for [illegible] substitute for [illegible] temperature [illegible] to a wide [illegible] and sintering; [illegible] the whole bulk [illegible] reaction [illegible] 1100°C.

/15/

[illegible] volcanic rocks [illegible] microscope. [illegible] it is usually white or clear, [illegible] crystal surfaces [illegible] and dyke

rocks are microscopically [illegible] mineral [illegible] more individuals [illegible] with [illegible] dimensions measured in [illegible].

/16/

In the [illegible] it is [illegible] forms:

a) Nepheline-[illegible] [illegible] silica. Nepheline-[illegible] [illegible], [illegible], amphibole and [illegible]. The proportion of [illegible] $Na_2O.Al_2O_3.2SiO_2$ and SiO_2 [illegible] $NaAlSiO_4$ represents [illegible]. [illegible] this [illegible] rock (up to [illegible]) [illegible] of biotite and normal, [illegible] [illegible] representation [illegible] [illegible] to the best [illegible].

[illegible] is composed of:

SiO_2	51.7%	[illegible] mineralogical composition:	
Al_2O_3	21.[illegible]		
Fe_2O_3	0.6[illegible]	[illegible]	53.4%
CaO	1.5%	[illegible]	9.6%
L.O	0.7%	[illegible]	6.2%
Na_2O	7.6%	[illegible]	30.4%
K_2O	[illegible]	[illegible]	

/17/

In [illegible] the [illegible] the Factory [illegible] of the [illegible]:

SiO_2	47.1 %
Al_2O_3	2.4 %
Fe_2O_3	0.2 %
FeO	0.1 %
CaO	1.7 %
Na_2O	12.7 %
K_2O	5.4 %

/18 /

b) Nephelinite occurs also in a pebble and clivia-nephelinite. These rocks are also a rule [illegible], distinguished in their typical [illegible] chiefly by the occurrence of the [illegible] + nepheline. [illegible] of ilvaite and [illegible], nephelinite [illegible].

[illegible] Kamenná vrch, [illegible] railway station Strážky and Čeľovce, [illegible].

Nephelinite [illegible] part of Kamenný vrch. [illegible], the other one at Bolfi [illegible]. [illegible] of the mountain to [illegible] nephelinite of Bolfi [illegible].

In Čeľovce [illegible] nephelinite [illegible] an isolated occurrence [illegible], 600 m east of [illegible], [illegible] and a further [illegible], about 600 m north of [illegible], [illegible]. Both occurrences of nephelinite [illegible] of the [illegible].

/20/

As for the olivine-nephelinites, they occur more frequently and they are also found as nephelinite basalts. The richest occurrences are in Český středohoří where they represent [illegible] lava-flows. They follow [illegible] for 62%.

/21/

Olivine-nephelinites are also known between Hladná Polomka and Jiřín. The [illegible] in Poland are in the surroundings of Lwówek, Bukowská hora and Kopalski vrch.

Olivine-nephelinites are [illegible]-ry to black, mostly porphyritic [illegible].

/ /

The most typical localities of olivine-nephelinites are Lovoš, [illegible], Ladiš[illegible] of Lovoše; Zbuzičany, [illegible]; [illegible], [illegible] No. 513, 4 km northwest of [illegible]; [illegible]; 6 km northwest of Lovoš; Vlkov [illegible].

/ 3/

The rocks of [illegible] rock no. Vlkov are in the Vlkov [illegible] both [illegible] porphyritic [illegible].

/24/

c) Nephelinite occurrences [illegible] in [illegible] localities Bořeň, [illegible], [illegible] Červený vrch [illegible].

/25/

Use of nepheline

A great attention is paid to the use of nepheline especially abroad where deposits; plants of nepheline rocks with magnetic separation of [illegible] li[illegible] concentrates with iron content under 1 [illegible] % to 1% of alkalis are prospective materials [illegible] possibly for feldspars as 78 portions of a ground [illegible] replace 100 portions of high quality feldspar. [illegible] firing; in such a way that also [illegible] low temperature body particles become sticky, the body is [illegible] without holes; compared by pressure [illegible] to the [illegible]; range The firing temperature [illegible] lies by and without [illegible] with bodies based on feldspar [illegible] reduction of firing temperature [illegible] nepheline concentrate with [illegible], e.g. [illegible] table. It may also easier the [illegible] by the recirculation of glazed ceramic [illegible].

/25/

The [illegible] tested bodies [illegible] % nepheline concentrate of [illegible], [illegible] were fixed in a roller kiln at [illegible] cycles of 60 - 70 minutes. [illegible] were fixed at 1040°C for 60 - 70 [illegible] the addition of nepheline concentrate [illegible] to 4.5% and even under [illegible] can be applied.

/27/

Another example of [illegible] concentrate was based on the addition of [illegible] nepheline concentrate combined with glass c [illegible]. It [illegible] 1000°C and firing cycle [illegible] water absorption was achieved.

/28/

C/ PHONOLITES

Phonolite is a volcanic alkaline rock corresponding to nepheline syenite with trachy, belonging therefore to the group of phonolites, leucitite and sodalite trachytes and tephrite phonolites.

/29/

Phonolites are characterized by the presence of foids, i. e. mineral alumosilicates with lower SiO_2 content than feldspar possesses. Phonolites contain up to 66% of sanidite, 18% of nepheline, then acgirine alkaline amphibole and accessories as sodalite, leucite, apatite, etc.

/30/

According to the nepheline content, phonolites are divided as follows:

a) Phonolites of high nepheline content (nepheline phonolites),

b) phonolites with low nepheline content (trachyte phonolites,

c) leucitite phonolites (containing nepheline and leucite),

d) tephrite trachyben-phonolites (characterised by the presence of plagioclase, poor in Kfds).

/31/

Occurrence of phonolites

a) Nepheline phonolites. They contain 60 - 66% of sanidine (sodium feldspar), 11 - 18% of nepheline,

0 - 7% of haüyne, 8 - 15% of pyroxene and incidently minerals of the sodalite group. Phonolites in České středohoří represent 4% of all eruptive rocks. The localities are the mountains Bořeň, Zánecký vrch, Želenický vrch, Červený vrch, all of them near Bílina, Panenská Hora near Ústí n/L and Špičák near Most.

/32/

The following deposits of nepheline phonolite - Zlatník, elevation 521, Kymelský vrch, elevation 411 southwest of Zánecký vrch near Most. Isolated localities in České středohoří, 2 km north of Čeřenišťě and Rovný, elevation 529 between Teplov and Kýšov deserve to be mentioned.

/33/

Chemical composition of 3 main representatives of phonolites rich in nepheline is given below:

1) Želenický vrch
2) Špičák near Most
3) Červený vrch near Krušnými

	1	2	3
SiO_2	56,41	55,13	55,81
TiO_2	0,26	0.21	0.40
Al_2O_3	20.70	23.01	23.02
Fe_2O_3	0.95	0.10	1.04
FeO	1.80	0.16	0.32
MnO	0.23	0.13	0.18
MgO	0.57	1.[illegible]	0.13
CaO	2.30	1.23	2.73
Na_2O	7.47	8.07	10.02
K_2O	3.76	3.57	5.24
H_2O +	0.20	2.22	0.00
H_2O -	2.02		
P_2O_5	1.14	0.03	0.12

/34/

b) Phonolites with low nepheline content (trachyte phonolites)

These are mostly phonolites from České středohoří. Their denomination shows the similarity to trachytes by grey colour with greenish and rough surface and by lower content of nepheline so that the only foid in the rock is a mineral of the sodalite group. Their portion of nepheline fluctuates between 10% and zero, the portion of sodalite is mostly between 14 and 30%. An example of the trachyte phonolite is the rock from the mountain Kletečná.

/35/

Feldspars in trachyte phonolites are represented by sanidine or anorthoclase, sometimes even labradorite in the form of phenocrysts is present in the group of Milešovka.

/35/

By the preceding explanation the way of transition to tephrite phonolites is outlined.

Pyroxenes in trachyte phonolites are represented by aegirite/augite or even by diopside.

Trachyte phonolites form as a rule piles and laccoliths. In our country they are mostly represented in the group of Milešovka, elevation 835, Milešovský Kloc, elevation 733 and Kletečná, elevation 705.

Among other occurrences Doubrava, elevation 392, east of Teplice, should be mentioned. The second larger area of occurrences includes e. g. Klejn, elevation 755.

about 3 km from Bor, Jedlová hora, elevation 770, 7 km southwest of Varnsdorf, Vlhošť, elevation 610, 10 km southwest of Č. Lípa or Vrátenská hora, elevation 506, 4 km north of Děčno. The localities Velký Bezděz and Malý Bezděz belong to these deposits as well.

Also two occurrences of phonolites in Doupovské hory may be included in trachyte phonolites.

/36/

c) Leucite phonolites (containing nepheline and leucite)

These phonolites contain apart from nepheline also leucite and sometimes haüyne. Rocks of this type do not occur in ČSSR.

/37/

d) Tephrite phonolites

These rocks do not belong to the group of phonolites proper as they contain apart from alkaline feldspars and foids also a considerable portion of plagioclase. They occur in many places in České středohoří and contain a higher portion of pyroxenes, the portion of nepheline is low.

Occurrences: a part of the hill Klobouk west of Děčín, laccolith south of Chodovec and 5 km south of Podmokly Kozí vrch, elevation 379 southwest of Neštědice, Tachov, elevation 497 southeast of Boleň. /38/

This rock was thoroughly investigated in the Research Institute for Ceramics, Refractories and Raw Materials by Bořivoj Matějka in 1977 in the framework of the research assignment 0-0050-05 "Substitution for the phonolite Želenice".

By comparison of chemical composition as tested on samples delivered to the Institute and the average composition given by K. H. Scheumann in 1913 it is confirmed that the composition of this raw material fluctuates considerably with regard to iron oxides and alkalis. Besides, it is difficult in crushing and grinding.

/39/

Use of phonolites

Phonolite is used as a flux owing to a high content of alkalis. It has proved to be an efficient substitutent for feldspar. Phonolite replaces also imported soda for glass industry. The application of phonolite in ceramic industry is hindered by a high content of iron oxides. In cases where the colouring of final product is not concerned, this raw material is prospective. In any case it should be emphasised that it is the phonolite from the still unopened deposit Červený vrch near Bramny which shows the best properties.

D/ PERLITE

Perlite is an acidic effusive rock of granodiorite or diorite magma containing volcanic glass. In the technical sense it is a product of expansion of acidic effusive rocks containing volcanic glass with chemically bound water. In rapid heating to a suitable temperature (1100 - 1200°C) these rocks enlarge their volume 8 to 14 times reducing in this way substantially their bulk density. The sorts of perlite are classified according to the extent of expansivity:

1) Raw material of bulk density up to 80 kg/cu.m after expansion

2) Raw material of bulk density 80 to 150 kg/cu.m after expansion

3) Raw material of bulk density 150 - 200 kg/cu.m after expansion

4) Raw material of bulk density 200 - 250 kg/cu.m after expansion

Chemical composition (approximative):

SiO_2: 65 - 78 %, Al_2O_3: 12 - 16 %, Fe_2O_3: 0.5 - 2.8 %, CaO+MgO: 5 %, alkalis: max. 6 %

Coefficient of thermal dilatation not tested, thermal conductivity 0.04 kcal/m °C.

Occurrences in ČSSR:

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Alkalis
Lehotka pod Brehy, %	69.70	0.33	13.38	2.28	0.86	1.61	6.34
Byšta, %	71.02	0.09	12.68	1.62	0.35	1121	5.81

Use of perlite

Perlite is used in loose condition for insulating fills. It is applied for perlite plasters and mortars, perlite concrete, gypsum perlite, bitumen perlite, ceramic perlite thermal insulations and lighted perlite fireclay shapes for temperatures up to 1400°C (KIRKO).

Expanded perlite is used in the USSR as substituent for nepheline concentrate in combination with glass cullet in the manufacture of façade tiles on conveyor lines, e. g. in Dědovskij keramičeskij zavod.

/41/

MARL, LIME MARL, SINTERED LIMESTONE

Limestone contains often contaminations of which especially magnesium carbonate and clay admixtures are important. The mixtures of calcium carbonate and magnesium carbonate occur in a continuous series transiting to dolomite. Limestone contains in the nature very often also clayey earths, according to the content of which it is classified in technical practice.

	Percentage content	
	$CaCO_3$	Clay
High percentage limestone	100 - 98	0 - 2
Chemically pure limestone	98 - 95	2 - 5
Limestone	95 - 90	5 - 10
Marly limestone	90 - 75	10 - 25
Calcareous marl	75 - 40	25 - 60
Marl	40 - 15	60 - 75
Calcareous clay	15 - 5	75 - 95
Clay	5 - 0	95 - 100

This classification does not fully comply with the Czechoslovak standard (ČSN 721 330) according to which marls are clayey earths containing 25 to 75 % of calcium carbonate. Sometimes the general designation "marlite" is used in cases where the above standard applies "marl".

(Note of the author)

/42/

According to genesis calcareous marls are sediments of Secondary formations with predominant shells of microfauna. The lower limit of their utilization in the manufacture

of cements and mortars is about 60% of $CaCO_3$. The grainage of the rock is indicated in thousandths of milimeters, calcite attains the grain size up to 0.1 mm. Clayey minerals constituting cement matrix are represented mainly by illite, less by kaolinite and exceptionally by montmorillonite. Accessories are formed by quartz.

/43/

Occurrences

The most important area is the North Bohemian Cretaceous System. The main deposits lie between Lovosice and Louny, in the surroundings of Litoměřice, in the western part of České středohoří and around Teplice. Marly sediments in South Moravia represented by the sediment Tlumačov - Kurovice and Neogene sediments of flysch in Ostrava region and in Southeast Moravia are of minor importance.

/43/

Characteristics of some individual deposits

North Bohemian Cretaceous marlites and marly limestones - Čížkovice - Úpohlavy

The deposit Čížkovice lies in a slope northwest of the street between Úpohlavy, Želenovice and Vrbičany. It is the most prospective locality of this area. It reaches the thickness of 15 to 20 m. There are marlites in the underburden with about 40% of $CaCO_3$. The lower part of the deposit is formed by a bank of light-grey marly limestones with 70 - 82% of $CaCO_3$. The bank is 6 to 10 m thick.

In the upper part softer marlites (50 to 70% of $CaCO_3$) and calcareous banks alternate. The overburden consists of marlites with only 30 - 60% of $CaCO_3$. The raw material is characterized by a high content of hydraulic oxides, high reactivity in the firing process owing to the fine grainage and by homogenity of natural mineral mix.

/44/

Vast deposits of calcareous marls are located in the area Řetenice near Teplice, Hudcov, Lahošť, Zahrušany, Straka, nowadays mostly out of operation. Their composition is given below:

Loss on ignition	30 - 35%
SiO_2	23 - 14%
Al_2O_3	8.4 - 5.3%
Fe_2O_3	2.1 - 1.2%
CaO	35 - 43%
MgO	0.50 - 0.75%
Alkalis	0.78 - 0.74%

The first column indicates the data referring to the upper part and the second to the lower part of the deposit Lahošť.

/45/

Calcareous marls in the Cretaceous system of the Moravian flysch are Těšín limestones in the area between Třinec - Frýdek Místek, Frenštát at the northen foot of Moravskoslezské Beskydy. The deposits inbedded in Těšín schists are 50 - 100 m thick. Calcium carbonate content is rather variable.

/46/

An independent type of calcareous marls not yet proved in practice is a layer outcroping from deposits of cretaceous marly limestones in surroundings of Litoměřice and near Ronatec. The rocks are here 30 m thick with 60 to 75% of

$CaCO_3$. They are whitegrey, strong and cleavable.

/47/

The deposit of marlites Tlumačov - Kurovice in South Moravia delivers raw material to the lime plant at Tlumačov. The marlite with 65 to 75% of $CaCO_3$ has suitable hydraulic properties. The contents of other main components of the raw material are as follows:

SiO_2	18.2 - 27%
Alumina	1.7 - 2.7%
Fe_2O_3	0.8 - 1.4%
MgO	under 1%

Potential application in ceramic industry

The Research Institute for Ceramics, Refractories and Raw Materials investigated thoroughly in the years 1969-1971 and again in 1971 the possibilities of utilizing calcareous marls in ceramic manufacture. The conclusion recommended these marls as a suitable basic material for the manufacture of ceramic tiles with limequartz body as being capable of substituting for both the plastic components and the components delivering the required calcium oxide. The only obstacle was a higher iron content of ferric oxide of the tested calcareous marls. A marl from the area Rohatec-Býchory, in total 18 samples, were tested. The best results gave calcareous marl VP 80 of the following chemical composition:

SiO_2	41.05%
Al_2O_3	6.04%
TiO_2	0.32%
Fe_2O_3	1.93%
CaO	46.31%
MgO	1.13%
Alkalis	1.87%

The CaO, SiO_2 and Al_2O_3 contents were rather variable so that stored raw materials had to be homogenized. It was found that the addition of calcareous marls to wall tile body is in principle feasible. Their main advantage consists in fine dispersion of calcium carbonate which makes possible also partial replacement of plastic components. An addition of 30 - 50% proved to be adequate. The verified samples were from the prospective but not yet exploited deposit.

/48/

Heinz Schmidt in FRG was engaged in thorough research of utilization of marls and calcareous marls oriented to heavy ceramics. In his study there are interesting passages dealing with the favourable influence of added calcareous marls on strength of the body, dry and firing shrinkage, bending and compressive strength, sensitivity to drying, maximum of temperature limit, colour, porosity, etc. The author also stressed the importance of microfine calcium oxide in raw material.

/49/

ANDESITES

Andesites (also designated as porphyrites) are effusive rocks of light-grey to dark-grey colour with 52 - 6[illegible] of SiO_2 content, their mineralogical composition being pla[illegible]ase 58%, enstatite 16%, orthoclase 15%, augite-biotite [illegible], quartz and volcanic glass 6%. They are spread all over the world and in our country they form in Slovakia the predominant part of the Kremnicko-štiavnické rudohoří and the prevailing part of Prešovské vrchy and Vihorlat. Andesites were found also in the surroundings of Handlová in form of rolled pebbles and conglomerates of overburden layers. The occurrence of andesite in 15 beds on the northen side of Poľana north of Detva is of importance. These beds are mutually separated by streams of tuffs.

/50/

A deposit of pyroxene andesite was verified near Obyce where a large shelf quarry at the foot of the elevation 359 close to the street Topoľčany - Obyce had been opened. Tuff agglomerates are deposited in the overburden.

/51/

Andesites are classified according to the predominating character of minerals:

a) Andesites with predominating biotite (surroundings of Handlová, northwest of Banka, ground mass volcanic glass)

b) Andesites with prevailing amphibole (a quarry near Dolné Strháry, southwest of Zvolen)

c) Andesites with predominant portion of hypersthene (peak of Vepor, Ficbork near Krupina south of Zvolen)

d) Andesite with prevalent part of augite (Prešovské vrchy, Czesárské vrchy)

An average biotite andesite shows the following chemical composition:

SiO_2	62.25%
TiO_2	1.65%
Al_2O_3	16.10%
Fe_2O_3	3.62%
FeO	2.20%
MnO	0.21%
MgO	2.03%
CaO	4.50%
Na_2O	3.55%
K_2O	2.44%
P_2O_5	0.40%

According to literature andesite is supposed to be even in the environs of Hanétín.

Use of andesite

The application of andesite as basic raw material for the manufacture of glaze fritt containing 53% of SiO_2, 17% of Al_2O_3, 3.9% of MgO, 5.5% of CaO, 7.6% of Fe_2O_3, 0.4% of MnO, 1.2% of TiO_2, 6.6% of alkalis. This fritt with addition of 1.8 to 3.3% of boric acid and 6% of ZnO gives a yellow-red colour in the phase 600 - 750 nm of spectrum. The glaze is opacified, very stable, well covering and is applied in fast firing of wall tiles and floor tiles with firing temperatures 900, 950 and 1000°C and firing cycle of 25 minutes.

/52/

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Glossary of some less frequently used mineralogical expressions

Microcline	Feldspar of the same composition as orthoclase crystallizing, however, triclinically. It occurs in rocks concurrently with orthoclase.
Albite	Sodium feldspar
Anorthite	Calcium-sodium silicate containing in pure condition 43.28% of silica and 36.62% of Al_2O_3
Oligoclase	Sodium-calcium feldspar containing about 60% of SiO_2, approximately 24% of Al_2O_3, 8 - 10% of Na_2O and 3 - 7% of CaO
Labradorite	Like oligoclase and andesine with a little lower SiO_2 content (49 - 55%) containing, however, more CaO (10 - 15%) and less Na_2O (3 - 5%)
Leucite	Potassium-aluminium silicate with 55% of SiO_2, 21.6% of K_2O and 23.4% of Al_2O_3
Haüyne	Mixture of aluminium potassium silicate and sodium sulphate containing 31.6 % of SiO_2, 27.3% of Na_2O, 27% of Al_2O_3 and 14.1% of anhydrite It forms usually a part of quartz-free rock rich in late effusive rocks.
Biotite	Magnesium silicate and aqueous aluminium -potassium silicate, MgO content 11 to 20%, K_2O_5 content 11%

Olivine	Ferrous magnesium silicate with 5 - 23% of iron in form of oxides and 37 - 52% MgO
Augite	Pyroxene called ferric magnesium calcium silicate, 4 - 9% of Al_2O_3
Diopside	Variety of augite with poorer FeO content (up to 5%). It contains 26% of CaO, 19% of MgO and a low percentage of Al_2O_3
Amphibolite	Mixture of calcium-magnesium and ferric silicates with 8 to 15% of Al_2O_3
Enstatite	Magnesium silicate $MgSiO_3$
Hypersthene	15 - 34% of FeO, 11 - 22% of MgO
Apatite	Mixture of chlorine and fluorine calcium phosphate
Ilmenite	Mixture of Fe_2O_3 and TiO_2

A P P E N D I X

Deposits and localities of tuffs and tuffites abroad

Known localities:

FRG	Neuwieder basin, sediments of the volcano Laach, Eifel
Greece	Islands in Aegian Sea: Santorin, Aegina, Lesbos, Kos, Nyali, Nisyros, Milos, Amorgopulos
	Peninsulae: Methana, Erythräa, Halikarnassos
Italy	Lipari Islands, Pozzuoli
France	Auvergne
Japan	Kiushiu, Waidara
USA	Arizona, California, Oregon, Hawai, New Mexico
New Zeeland	Arapuni, Northern Island
USSR	Kamrajen, Mastara, Armenia

further countries: Kenya, Honduras, Chile, Kapverd Islands, Spain

A P P E N D I X

Nephelines and nephelinites

There are different varieties of nephelinite raw materials abroad denominated mostly according to their localities characterizing particular groups of species, too. They are listed below:

Chibinite	Lardalite	Maligite
Shonkinite	Lujavrite	Ditroite
Urtite	Loparite	Rissčorite
Ijolite	Lichtfieldite	Foyaite
Melteigite	Mariupolite	Theralite
Särnaite	Miaskite	Tinguaite
Aplite	Essexite	Foidolite

Important world localities

FRG	Katzenbuckel, Odenwald	shonkinite
Hungary	Range of hills Mecsek	foyaite, foidolite
Romania	Ditro /Ditrau/	ditroite
Italy	The Dolomites, Predazzo	foyaite
Portugal	Serra Monchique, Foya	foyaite
England	Berolan, North Scotland	foyaite
Norway	Telemark	lardalite
	Fen	melteigite
		ijolite, urtite
	Oslo, Longenthal	lardalite, essexite
Swedon	Almunge/Upsala	ijolite
Finland	Jivaara, Kuusamo	ijolite

USSR	Kola, Umptek	theralite
	Kamasurt	lujavrite
	Chibinsk tundras	chibinite
	Mariupol, Azov Sea	mariupolite
	Miask, Ural	miaskite
India	Coimbatore and others	species not indicated
Namibia	Granitberg	species not indicated
Canada	Renfree, Bancroft, Hephton	foyaite
	Maligna, Ontario	maligmite
France	Auvergne (Puy de Sandoux)	nephelinite
USA	Lichtfield, Maine	lichtfieldite
	Blue Mountains	lichtfieldite
	Cripple Creek /Colorado/	foyaite
	Rock, Arkansas	shonkinite
	Shinkin Sa.;	shonkinite
Brasil	Cabo Frio	aplite, foyaite
	Serra de Tinguá	tinguaite
Madagascar	Bezavona Masif	aplite, foyaite
South Africa	Leuvkraal	foyaite
Kenya	locality not indicated	
Greenland	Julienhaab	lujavrite

Phonolites

In the world it has not yet been clearly decided when the denominations phonolite and trachyte should be used. Both of them are effusive equivalents of syenites with foids, likely as alkaline trachytes. On one side it is believed that phonolite must contain nepheline, on the other the denomination phonolite should refer also to the rocks where foids are represented by leucite.

The following classification has partly been accepted:

a) Nepheline phonolites

b) Trachyte phonolites (with small nepheline content)

c) Tefrite phonolites, characteristic by presence of more basic plagioclases.

Known world localities of phonolites

GDR	Hammeruntervviesenthal	a,
	Kottmar,	a,
	Rhön (Dietrichsberg)	c/
FRG	Eifel (Selberg, Brenk, Main)	a,
	Hegau (Staufen, Hilzingen)	a,
	Vogelsberg (Lollar)	c/
Yugoslavia	Surroundings of Beograd	a,
Italy	Roccamonfina, Viterbo,	
	Sardinia	a,
	Monte Somma	c/
	Capo di Bove	c/
France	Auvergne (Puy de Sandoux)	a,
Libya	Msid Charian	a,

USA	Cripple Creek (Dolorado)	a,
	Apache Mountains (Texas)	a, apachite
	Black Hill (Dakota)	a,
Austria	Burgenland/Oberpullendorf, Weitendorf, Kobendorf	c/
USSR	Kola (Rasvumchor)	c/

Further countries: Spain, Japan, Syria, Kenya, Tanzania, Malawi, Madagascar, Indonesia, Lebanon, Brasil

Kenya (kenyite- volcano Kenya)
Canary Islands, Archipelago de Cabo Verde, Island St. Helene

Andesites

Abroad denominated also as porphyrites.

Important localities

GDR	Haldensleben, Bebertal, Süplingen Harz: Ilfeld Hirschbach /Th.W./
FRG	Kusel, St. Wendel, Kirn, Pfaffelbach, Odernheim, Wolkenburg, Stemmelberg, (Siebengebirge) Selters (Westerwald)
Hungary	Csálhegy, Csódihegy, Erdobénye, Tállya, Tikaj, Recsnek
Romania	Thick effusions in Carpathians
Bulgaria	Karaburun, Demi dere, Šiflik, Vitoša
Yugoslavia	Ljubnica
Greece	Marathonisi, Santorin (= Porfido verde antico)
Italy	Fassa, South Tyrol, Sardinia
Switzerland	Lugano
France	Corsica (Ajaccio), Giromagny, Belfahy (Haute Saone)
Belgium	Quenast, Ardennes
USSR	Sverdlovsk (Malaja Blagodat) Čeljabinsk (Beljakovka) Altai, Kamčatka, Zagaĭan, Sachalin Akča (Usbekistan)
USA	Rocky Mountains (Nevada, Colorado)
Brasil	Rio Grande do Sul

Further countries: Columbia, Equador, Bolivia, Chile, Argentine, New Zeeland, Iran, Turkey, China, Japan, Filippines, Indonesia, Honduras, Nicaragua, Peru, Mexico, Martinique

Perlites

Perlites are acidic volcanic glasses of the species obsidian, pitchstone and pumice. According to the petrographical classification they belong to effusive acidic rocks of the group of granodiorite to diorite, primarily rhyodacite, rhyolite, dillenite and liparite. Abroad they are summarilly denominated as hyalins or hyalomelanes. Perlites are these breaking down in spheres, pearls.

World localities

GDR	Flechtingen, Halle-Löbejrün, Schwerz
FRG	Schiesheim, Dossenheim-Odenwald Nohfelden - Saar
Poland	Krzeszowice
England	Glencoe, Canisp-Scotland
Hungary	Tokaj - Zemplin Mountains
Greece	Aegina, Hyali
Romania	Siebenbürgen
Spain	Canary Islands
Yugoslavia	Mirnine-Čuke
France	Auvergne, Lessines
Bulgaria	Slakonica
Italy	Colli Euganei
Switzerland	Avdalen
USSR	Muchortalin Altai, Caucasus

USA New Mexico, Arizona, California, Colorado

Turkey Cumaovasi

Other countries:

Iran, Ethiopia, Somalia, Kenya, Uganda, Tanzania, Columbia, Equador, Mexico, Finland, Vietnam, Australia

Marls, calcareous marls, marly limestones

Occurrences abroad

Marlites (vague designation of lim stones contaminated with clay) occur as accompanying layers of pure limestones. They contain 10 to 25% of clay.

Localities

GDR	Kamsdorf, Könitz - Düringen Rübeland, Elbingerode, -[illegible] Germrode-Ballenstedt, Hienburg, Walbeck
FRG	Wetzlar, Vilmar, Dietkirchen, Paffrath, Bubenheim, Höpfingen, Niderholmringen and others
Austria	Gosau, Afram, Wollersdorf, Hallstät
Hungary	Siklós, Tardos, Sopron, Soskut
Poland	Bolechowice, Dombrowa, Slask Gorny, Zalesiaki
Romania	Monasa
Bulgaria	Carevec, Russe, Čepelare, Jablanica
Yugoslavia	Bale, Lipica, Dolac, Sibenik, Maskara
Greece	Euböa, Damaristikas
Italy	Lucca, Siena, Trani, Savone, Nava
Switzerland	Laufen, Tessin
France	Caen, Herault, Corsica, Euville
Spain	Alicante, Cortes, Estremadura, Bilbao
Portugal	Alcobaca, Sintra
Belgium	Liege, Goudnies
England	Devonshire, Oxfordshire, Portlandstone
Finland	Lohja

USSR	Tula, Rostov, Donbas and others
Burma	Mandalay
India	Jodhpur, Bikanir, Baroda, Abur, Haydarabad, Coimbatore
Turkey	Ezine, Gebze, Sapanca
Syria, Lebanon, Baalbek, Aleppo	
Egypt	Djebel Ataga
Tunis	Aziz, Djebel Rouas
Algeria	Oran, Constantine
Maroco	Sefrou
Sudan	Summit Hill
Benin	Cotonou
Upper Volta	Tin Hassan
Kenya	Kunkur
Canada	Quebec , Ontario
USA	in all states
Republica Dominicana	Cabo Rojo

Further countries: Sri Lanka, Afghanistan, Iran, Ghana, Nigeria, Malawi, Zambia, Nicaragua, Venezuella, Uruguay

Note: Marly limestones are not specified anywhere.