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PETROGRAPHY AND GEOCHEMISTRY OF PERMIAN QUARTZ PORPHYRIES IN RELATION TO U-Mo-Cu MINERALIZATION

(Fig. 1–13)

Abstract: In the paper individual varieties of quartz porphyries and porphyroids in the North Gemeride Permian are characterized. The layers of quartz porphyries underlying the mineralized tuffitic horizon as well as the pebbles found in this horizon show different representation of macroelements and microelements as compared to other varieties. An association of microelements analogous to that in the mineralized tuffitic horizon indicates U-Mo-Cu mineralization linked with volcanism of quartz porphyries.

In the Permian of the nothern margin of the Mountains of Spišsko-gemerské rudohorie on the basis of the works by M. Ivanov (1953, 1957), A. Biely (1958), F. J. Žukov (1963) and others we essentially can distinguish three main horizons: Lower Conglomerates, effusive-sedimentary complex and Upper Conglomerates. Different division is mentioned in the work by P. Adámek (1967), who ranges the Lower Conglomerates and the lower part of the effusive-sedimentary Complex to the so called Lower Complex with non-cyclic development while according to the author the Middle and Upper Complex are characterized by cyclic development with four mesocycles.

In the lower horizon besides conglomerates also intercalations of sandstones and quartz porphyries appear near Krompachy and Stratená (M. Ivanov 1953, M. Maheľ 1953, Š. Bajaník 1963).

In the lower part of the effusive-sedimentary complex besides sandstones and shales also quartz porphyries, tuffs and tuffites are present with U-Mo-Cu mineralization in the area of Novoveská Huta. The upper part of the effusive-sedimentary complex or possibly the cyclic development of the Permian according to P. Adámek is represented by conglomerates, sandstones, shales, with layers of evaporites, quartz porphyries and their tuffs.

The Permian volcanism and its petrography was the subject of the works by many authors, especially M. Ivanov (1935, 1957) presented a detailed characterization. In the area of Krompachy M. Ivanov distinguished the first and second volcanic period. The first volcanic period is only characterized by one eruption phase in the horizon of basal conglomerats and by petrography different from the upper volcanic period, with greater intesity of volcanism in the effusive-sedimentary complex.

In the paper presented these confirmed data will not be repeated any more. In connection with the investigation of U-Mo-Cu mineralization in the area of Novoveská Huta however some new data were obtained and besides known quartz porphyries of the second volcanic period, quartz porphyries were also found in the lower part of the effusive-sedimentary complex, i. e. within the range of the non-cyclic development according to P. Adámek, most probably belonging to the first volcanic period. The U-Mo-Cu mineralization in these quartz porphyries as well as their close relation to U-Mo-Cu mineralization in the overlying tuffitic horizon required more detailed characterization.

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PETROGRAPHY OF ROCKS

The quartz porphyries and porphyroids are essentially of the same mineralogical composition. While the texture of the rock is porphyritic, however the texture of he groundmass in quartz porphyries is felsitic more rarely micrographic (in quartz porphyries in layers in the Lower Conglomerate and in pebbles in tuffitic conglomerates), in porphyroids it is lepidoblastic conditioned by higher content of sericite, prevailingly of parallel orientation. The quartz porphyries are macroscopically prevailingly massive and the porphyroids cleaved.

Quartz porphyries and porphyroides show a variety of colours. Quartz porphyries present in layers in the Lower Conglomerates are violet and greyishblue. The colour of quartz porphyries underlying the ore bed near Novoveská Huta is light- and dark-green while in the overlying rocks it is violet and light-green. The porphyroids are exclusively of light-green colour.

The violete-grey colour of the rocks is caused by pigment of hematite-magnetite. The light-green colour is caused by sericitization, especially high in porphyroids, where sericite forms up to about 50 % of the groundmass. Sericite is especially concentrated on planes of schistosity. Present different colour of green quartz porphyries is conditioned by the absence, or sporadical occurrence of hematite. Metamorphosis caused carrying away of Fe-pigment but it is difficult to determine to what a degree primarily lowered content or its carrying away with metamorphosis is concerned.

There is no hydrothermal alteration (by veins of the siderite formation) since some quartz veins penetrating reddish-violet quartz porphyry have not caused carrying away of hematite-magnetite substance and in the overlying rock they gradually pass into

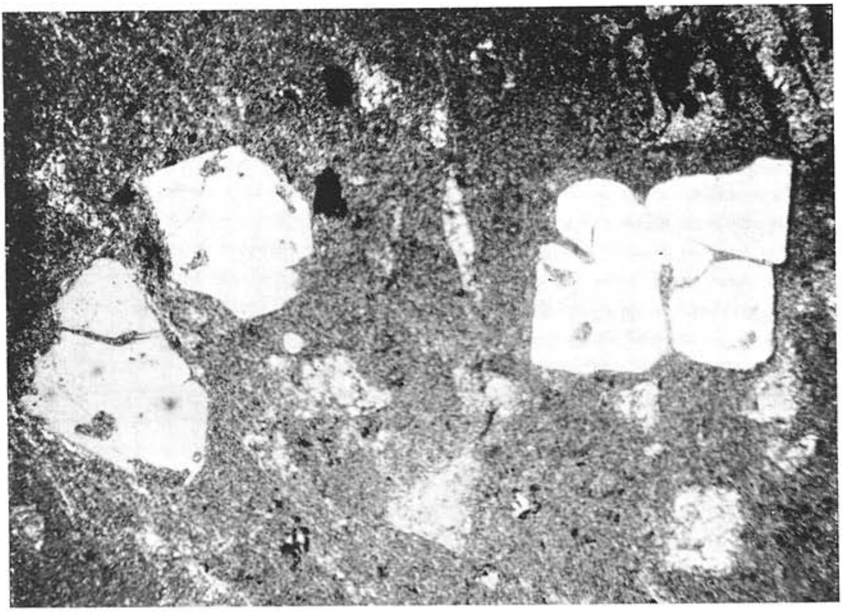

Fig. 1. Lower Quartz Porphyry with corroded phenocrysts of quartz and feldspars (Novoveská Huta, thin section, crossed nicols, magnif. 28 ×, photo Vrbovský).

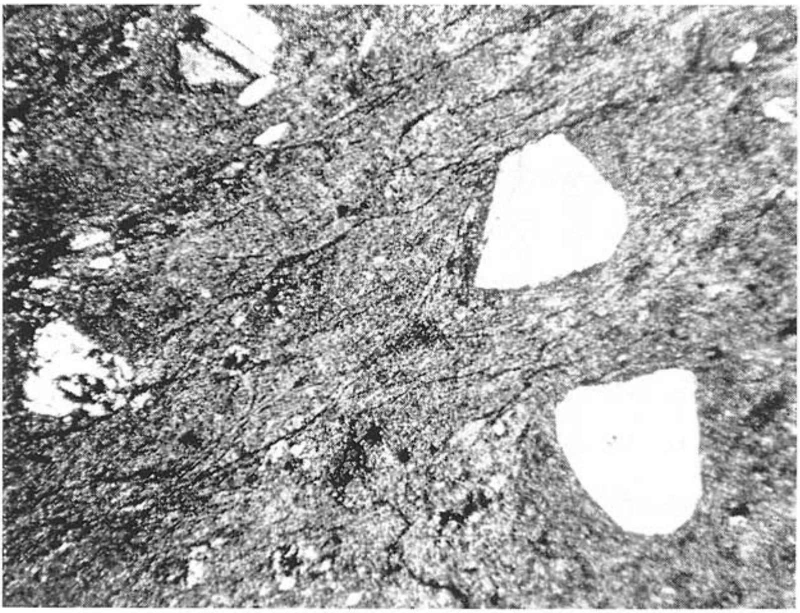

Fig. 2. Upper Quartz Porphyry with phenocrysts of quartz (right) and feldspars (left). (Novoveská Huta, thin section, magnif. 28 ×, photo Vrbovský).

green quartz porphyries. Sericitization cannot be exclusively considered as manifestation of wall rock alterations then. In the case of finely dispersed pyrite and increased content of chlorite as observed in the rock underlying U-Mo-Cu horizon and in pebbles in tuffitic conglomerates quartz porphyries are of dark-green to black colour (the colour of the rock is also influenced by U-Mo ore substance as comprehensible).

Porphyritic phenocrysts, mostly well observable also macroscopically, are representend by quartz, orthoclase and plagioklases. Quartz phenocrysts are most abundant. They attain the size of 1—2 mm on an average. The size of the phenocrysts inside one layer is relatively consistent. Certain differences in vertical direction are however to be observed. Greatest dimensions (2—4 mm on an average) are attained by phenocrysts of quartz in layers and pebbles of quartz porphyries in the Lower Conglomerates. In the lower part of the effusive-sedimentary complex (underlying the ore horizon) near Novoveská Huta and in the effusive-sedimentary complex in the area of Krompachy—Margecany and Košická Belá—Myslava quartz phenocrysts attain the average size of 1—2 mm (fig. 1). In quartz porphyries and porphyroids of the upper part of the effusive-sedimentary complex in the area of Novoveská Huta and Stratená the phenocrysts attain the greatest size up to 1 mm and in contrast to the foregoing ones, in which phenocrysts suffered from distinct magmatic corrosion, in these ones corrosion frequently manifested only slightly (fig. 2).

The quartz phenocrysts mostly show idiomorphic delimitation and distinct corrosion by the groundmass (in the above mentioned cases). The phenocrysts mostly show straight extinction, in some cases only undulatory extinction is to be observed. Pressure deformation manifested besides undulatory extinction also in cataclasis and rodlike stretching of phenocrysts in the place of disruption is to be observed.

Table 1. Planimetric Analysis

No	1	2	3	4	5	6	7	8	9	10	11	12	13
groundmass	°84,71	°87,97	°92,79	°83,90	•77,91	•87,67	•96,23	•92,78	•78,81	•84,51	•92,50	°84,52	•93,79
Quartz phenocryst	7,36	6,87	2,15	5,43	9,65	5,82	0,59	4,77	7,88	9,16	2,48	5,50	—
Orthoclase phenocryst	0,50	0,06	0,19	0,29	0,05	0,02	0,68	1,24	3,23	0,67	0,12	0,50	0,53
Plagioklase phenocryst	0,09	—	—	0,09	—	—	0,12	0,75	—	—	—	0,72	1,26
Sericite (pseudomorph)	—	—	—	—	—	—	—	—	1,85	1,58	1,42	6,51	0,06
Muscovite	—	0,14	—	—	—	—	—	0,07	—	—	—	—	—
Biotite (chloritiz.)	—	0,02	—	—	—	—	—	—	1,02	—	—	—	—
Carbonates	5,98	1,66	1,48	0,90	9,38	0,06	—	—	—	2,59	1,89	1,87	4,02
Chlorite	1,36	2,39	2,85	8,41	2,36	—	2,02	0,39	0,20	—	0,34	0,02	0,25
Felspar aggregate	—	0,31	0,29	—	—	—	—	—	—	0,15	—	—	—
Quartzite, phyllite	—	0,59	—	—	—	—	—	—	—	—	—	—	—
Opaque minerals	—	—	0,26	0,98	—	—	—	—	7,02	1,34	1,26	0,36	0,08
Quartz veinlets	—	—	—	—	—	—	0,36	—	—	—	—	—	—
Tourmaline	+	+	—	—	+	+	—	+	—	—	+	—	—
Zircon	+	+	+	+	+	—	—	+	+	+	—	+	+
Rutile	+	+	+	+	+	—	—	—	+	—	+	—	+
Apatite	—	—	—	—	—	—	+	—	—	—	—	+	—
Pyrite	+	—	—	+	—	+	—	—	—	—	—	—	—
Chalcopyrite	+	—	+	+	—	+	—	—	—	—	—	—	—
Magnetite, hematite, ilmen.	—	—	+	—	—	—	—	—	+	+	+	+	+
Leucoxene	—	—	—	—	+	—	+	—	—	—	—	+	+
Sum	100,00	100,00	100,01	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,01	100,00	99,99
Number of points	3 410	3 205	3 119	3 460	3 988	4 867	3 239	4 128	3 034	3 285	4 562	3 502	3 561
Variety	GQP, b	GQP, b	GQP, c	GQP, c	GQP, b	GQP, b	GQP	GQP	VQP	VQP	VQP	VQP, a	VQP, a

No	14	15	16	17	18	19	20	21	22	23	24	25	26
groundmass	°67,50	•87,84	•82,89	°83,21	•82,45	•89,28	•73,95	°85,44	°86,15	*97,83	•89,03	•85,86	*84,23
Quartz phenocryst	9.21	2,70	4,95	7,20	9,03	6,89	6,00	4,81	0,19	0,38	5,23	8,91	6,99
Orthoclase phenocryst	0,37	1,18	0,10	2,40	0,05	1,82	—	0,10	0,71	0,19	5,15	3,68	0,05
Plagioklase phenocryst	1,12	3,24	—	3,86	—	0,20	—	—	1,33	0,25	0,38	0,61	0,01
Sericite (pseudomorph)	0,16	—	10,84	—	6,67	—	8,64	0,68	—	—	—	—	0,11
Muscovite	—	—	—	—	—	0,50	—	—	—	—	0,17	0,29	0,12
Biotite (chloritiz.)	—	—	—	—	0,07	—	—	—	—	—	—	—	—
Carbonates	21,46	4,41	—	—	—	—	—	8,78	6,41	—	0,04	0,61	3,59
Chlorite	0,19	0,10	—	1,14	—	0,96	—	0,06	—	1,30	—	0,04	4,53
Felspar aggregate	—	—	—	—	0,20	—	0,37	—	—	—	—	—	0,39
Quartzite, phyllite	—	—	—	—	0,03	—	—	—	—	0,02	—	—	—
Opaque minerals	—	0,54	1,22	0,17	1,49	0,36	6,03	0,13	—	—	—	—	—
Quartz veinlets	—	—	—	—	—	—	—	—	5,21	—	—	—	—
Tourmaline	—	—	—	2,03	+	+	—	—	+	0,03	—	+	—
Zircon	—	—	+	+	+	+	+	+	+	—	+	+	+
Rutile	+	+	+	—	—	—	+	+	—	—	+	—	—
Apatite	—	—	—	+	—	—	—	+	—	—	—	—	—
Pyrite	—	—	—	—	—	—	—	—	—	—	—	—	—
Chalcopyrite	+	—	—	—	—	—	—	—	—	—	—	—	—
Magnetite, hematite, ilmen.	+	+	+	+	+	—	+	—	—	—	—	—	—
Leucoxene	—	—	+	—	+	+	—	—	+	—	—	—	+
Sum	100,01	100,01	100,00	100,01	100,02	100,01	99,99	100,00	100,00	100,00	100,00	100,00	100,02
Number of points	3 215	3 060	2 869	3 501	4 093	3 021	3 216	3 098	3 091	3 159	3 168	3 492	4 905
Variety	VQP, a	VQP, a	VQP	VQP	VQP	VQP	VQP	pQP, c	wQP, a	P	P	P	P

Explanation:
+ present; — absent; Groundmass (estimated): o Quartz, felspar more than 80 %, sericite less than 20 %, • Quartz, felspar 60—80 %, sericite 20—40 %, * Quartz, felspar less than 60 %, sericite more than 40 %.
QP — quartz porphyry, GQP — green, VQP — violet, P — porphyroid, wQP — white, pQP — pink.
a — quartz porphyry overlying the mineralized tuffite horizon near Novoveská Huta, b — underlying, c — QP pebbles in tuffite conglomerates.
Locality: Explanation in table 3.

Feldspar phenocrysts are generally less represented than those of quartz. More frequent representation of feldspars in contrast to quartz is to be observed in quartz porphyries near Košická Belá and in some layers of quartz porphyries near Novoveská Huta in the upper part of the effusive-sedimentary complex. Volume representation of feldspars is however considerably misrepresented by their high sericitization. In many cases alteration of feldspars was so high that pseudomorphs of sericitic aggregates after feldspars formed, which in the case of action of greater pressure on the rock acquired more oval shape. In mutual ratio of orthoclase and plagioklases certain dependences are observable. In the area of Novoveská Huta orthoclase is prevailing over plagioklases in quartz porphyries underlying the ore horizon while in layers in the rock overlying it the ratio is reverse (tab. 1).

Feldspar phenocrysts, crystallographically well-delimited in some cases, attain the size of 1 mm on an average, more rarely up to 2 mm and are more rarely corroded by the groundmass as quartz. Orthoclase uses to be highly sericitized. Frequently only relics or sericitic pseudomorphs of it are observable. To a lesser degree although quite frequently its albitisation („chess-board albite") is observable. Plagioklases of albite-oligoclase composition (as a consequence of their sericitization the method of Fedorov could not have been employed and the basicity of plagioklases was determined on the basis of extinction of lamellae in the symmetrical zone) are also sericitized and to a lesser degree replacement by carbonate and chlorite from the rim is to be observed, which also form up to pseudomorphs. Carbonates and chlorites are however also present in the rock scattered and in the form of veinlets especially near hydrothermal veins.

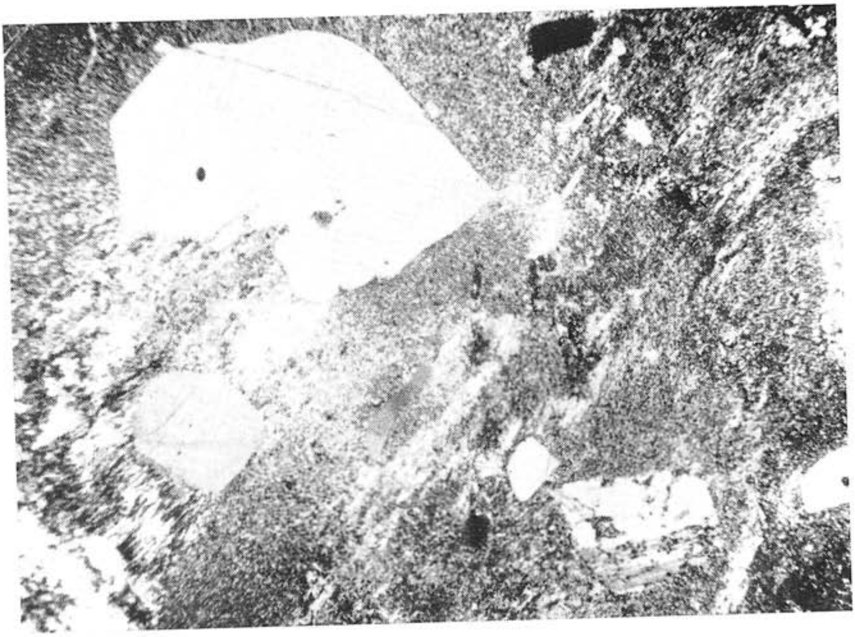

Fig. 3. Porphyroid with phenocrysts of quartz and feldspars with oriented sericite in the groundmass (Štefanská Huta, thin section, crossed nicols, magnif. 25 ×, photo Vrbovský).

To a lesser degree biotite and muscovite are represented, forming scales up to 0.5 mm large. Biotite is mostly baueritized and chloritized. Replacement of biotite by hematite is also frequent, hematite is mostly present at the circumference of biotite grains and fissility planes. The hematitized biotites were especially found in violet quartz porphyries present in the Lower Conglomerates near the community of Krompachy. A similar case of hematitization of biotite is described by J. Šalát (1954) from the Permian of the Mountains of Čierna hora.

In some quartz porhyries lenticle-shaped aggregates of quartz and feldspars are observable, in some cases only of feldspars, attaining the size of 1—5 mm. In the Gelnica Group similar formations were described by M. Kuthan (1950) as relics of amygdaloidal texture and by J. Kamenický (1954) as manifestation of albitization. C. Vareček (1965) admits beside autometamorphic albitisation origin of these formations (J. Kamenický 1954) the possibility of vesicles filled up in the post-magmatic stage or amygdaloidal formations to be concerned and in the case of undisturbed feldspars in these formations in more highly dynamometamorphosed porphyroids they could have been formed with termination of metamorphic processes. In Permian quartz porphyries the first two possibilities may be rather considered (autometamorphosis, amygdaloidal texture) since we cannot speak about fresher character of feldspars in the formations.

The groundmass is very fine-grained and frequently it is not possible to find out single individuals and only anisotropy shows the crystalline character. In the groundmass quartz, feldspars and sericite are present, sericite in higher metamorphosed porphyroids is of distinct parallel orientation and forms lepidoblastic texture of the

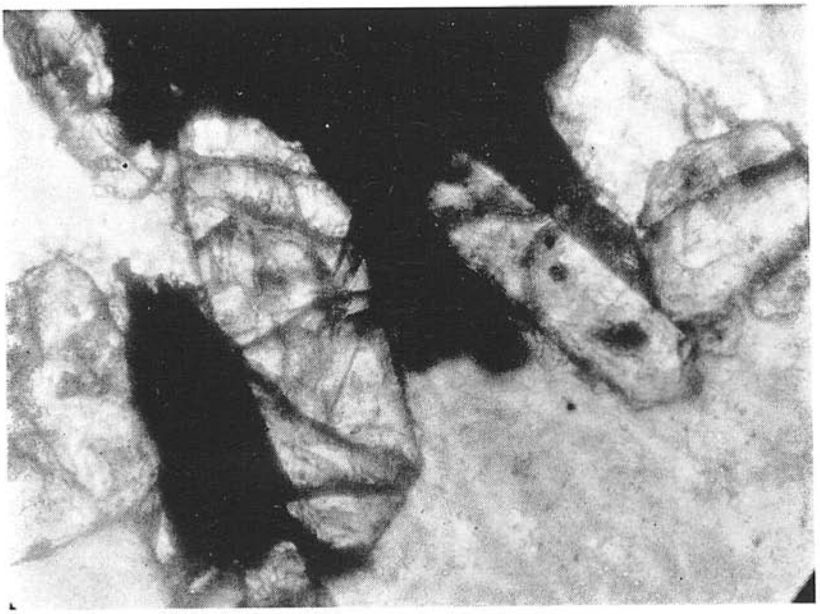

Fig. 4. Columns of zircon in quartz porphyry (Novoveská Huta, thin section, 1 nicol, magnif. 150 ×, photo Vrbovský).

groundmass (fig. 3). The scales of sericite frequently grow round porphyritic phenocrysts. In higher metamorphosed quartz porphyries and porphyroids oriented growing round of quartz phenocrysts by sericite is to be observed (M. Ivanov 1953. I. Rojkovič 1964). Flowing round of phenocrysts by sericite also uses to be frequent.

Accessory minerals. The most common accessory mineral probably of metamorphic origin is rutile. It forms rods and needles and typical knee-like intergrowth is frequent.

From other titanium minerals leucoxene is frequent. usually associated with rutile, anatase and titanite are rare.

Zircon is a current accessory, even when in very small amounts. It forms transparent idiomorphic crystals, up to 0,2 mm long. of elongated. columnar habit and high relief, sometimes with slight brown and light-green shading (fig. 4).

Tourmaline forms small columns and clumps (consisting of fine columns) with distinct pleochroism. It may be observed almost in all thin sections. Its contents were found to be more abundant only near hydrothermal vein mineralization.

Apatite is present only sporadically. It forms small columnar crystals.

From ore accessories magnetite, hematite, ilmenite and limonite are represented in violet varieties. In green varieties, especially higher metamorphosed, ore minerals are mostly not present or represented by pyrite, chalcopyrite (ore minerals in mineralized quartz porphyries were described in the foregoing work — I. Rojkovič 1968) and only scarcely by small amounts of magnetite.

GEOCHEMISTRY OF ROCKS

Macroconstituents

According to the classification of Niggli the studied quartz porphyries and porphyroids belong to the II. and III. group of alkaline-calcareous magma. i. e. to the group of granite and granodiorite. Most frequently they belong to the mojite (7) and normal granodiorite subgroup (10). Further ones belong to the tasnagranite (6) subgroup of granite magma and leucotonalite (11) subgroup of granodiorite magma. Nearly one third of the samples (8) could not be classified correctly since as a consequence of the decrease in alkalii due to sericitization and increased content of younger minerals (chlorite, ore minerals etc.) the rocks studied would belong to VI. and VII. group. what is in contradiction with the mineralogical composition and especially with the high content of quartz (fig. 5. tab. 2. 3).

The Na-K-Ca diagram (fig. 6) shows predominance of K-constituent over Na, the coefficient k being more than 0,5 (an exceptionally higher share of Na-constituent show some samples from the rock overlying the horizont of mineralized tuffites).

According to the ratio c/fm quartz porphyries and pophyroids belong to sections I to V. the greater part falls into the field of sedimentary rocks (fig. 7). Similar cases are described by C. Varček (1965) at porphyroids of the Mountains of Spišsko-gemerské rudohorie. explaining the change of chemism manifesting in carrying away of alkalii and increased share of al. especially caused by sericitization. later metamorphic and hydrothermal processes. For Permian quartz porphyries and porphyroids that frequently suffered from these later alteration the mentioned explanation is also the most likely.

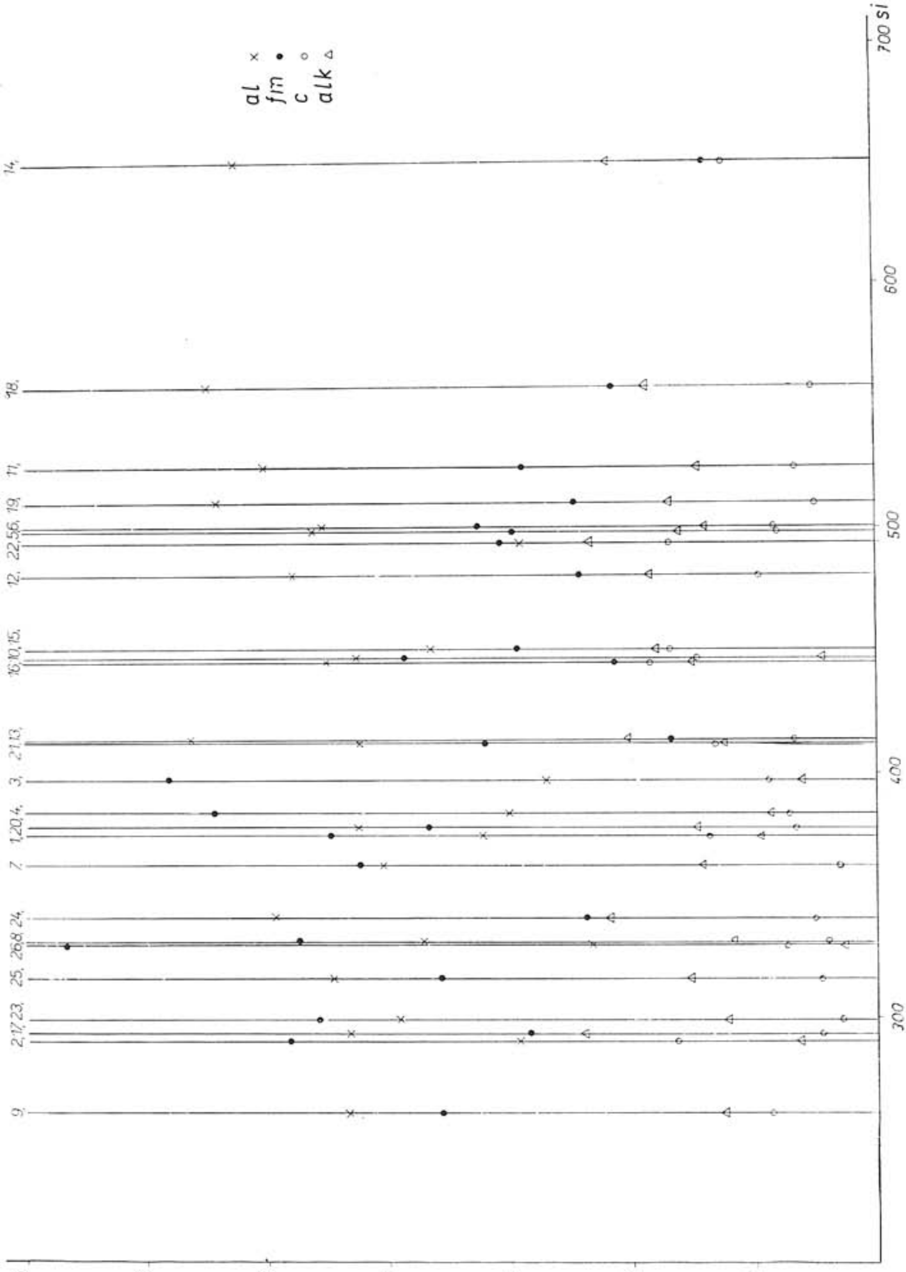

Fig. 5. Diagram of Niggli's values of si, al, fm, c, alk.

Table 2. Silicate Analyses (in Per Cent)

No	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	CO_2	SO_3	H_2O-	H_2O+	Sum	Variety
1	71,31	0,20	10,39	0,94	3,26	0,10	3,38	2,41	0,55	2,00	0,09	3,30	0,01	0,25	2,32	100,51	GQP, b
2	65,31	0,27	11,14	1,01	3,69	0,10	4,67	3,42	0,42	1,70	0,16	5,13	0,01	0,21	2,77	100,01	GQP, b
3	73,14	0,30	8,47	1,56	3,52	0,04	4,38	1,54	0,32	1,26	0,04			0,22	4,55	99,34	GQP, c
4	71,09	0,22	9,40	2,45	4,21	0,04	3,19	1,23	0,65	1,65	0,25		2,42	0,16	3,58	100,54	GQP, c
5	75,48	0,20	11,79	1,75	1,17	0,08	1,39	1,15	0,46	3,20	0,04	1,20	0,01	0,17	1,66	99,75	GQP, b
6	75,16	0,12	11,54	1,29	1,95	0,06	1,49	1,16	0,56	2,46	0,05	1,39	0,01	0,31	2,09	99,64	GQP, c
7	70,08	0,26	13,28	4,28	1,14	0,02	2,63	0,57	0,30	3,95	0,13			0,24	3,22	100,10	GQP
8	69,59	0,35	13,22	0,76	3,25	0,04	4,48	0,77	1,45	1,74	0,10			0,39	4,18	100,32	GQP
9	61,35	0,40	17,25	7,08	0,78	0,08	1,56	1,91	0,28	4,12	0,19	1,88	0,02	0,32	2,70	99,92	VQP
10	73,32	0,18	11,82	2,24	1,01	0,11	2,52	2,26	0,32	0,69	0,03			0,25	5,89	100,64	VQP
11	75,70	0,13	12,22	1,62	1,52	0,08	1,09	0,91	0,30	2,84	0,05	1,13	0,02	0,22	1,86	99,69	VQP
12	75,10	0,19	12,62	0,55	1,63	0,04	1,43	1,38	1,10	2,85	0,04			0,08	2,94	99,95	VQP, a
13	72,54	0,19	16,66	1,03	1,20	0,02	0,80	1,07	1,80	2,85	0,02			0,12	2,05	100,35	VQP, a
14	79,62	0,15	10,78	0,90	0,57	0,01	0,35	1,44	0,53	3,40	0,05	0,93	0,01	0,15	0,92	99,81	VQP, a
15	74,40	0,23	10,18	0,99	2,12	0,10	1,56	2,52	2,05	1,55	0,05			0,06	4,25	100,06	VQP, a
16	72,47	0,48	12,42	2,37	0,57	0,03	0,80	2,82	0,61	2,94	0,04	1,85	st	0,24	1,78	99,42	VQP
17	66,10	0,43	16,47	2,55	1,18	0,04	2,26	0,94	2,77	4,16	0,35	0,13	0,03	0,40	1,88	99,69	VQP
18	76,69	0,22	12,72	2,46	0,36	0,03	0,48	0,65	0,59	3,12	0,19	0,75	0,03	0,30	2,05	100,64	VQP
19	75,10	0,17	13,46	1,24	0,82	0,03	1,41	0,66	0,27	3,50	0,09	0,93	0,02	0,30	2,14	100,19	VQP
20	69,49	0,48	13,30	6,92	0,54	0,02	0,77	1,08	0,25	3,93	0,26	1,21	0,01	0,33	2,10	100,69	VQP
21	71,12	0,15	12,29	1,71	1,67	0,08	1,79	2,11	0,34	2,94	0,05	3,44	0,02	0,78	2,24	100,73	GQP, c
22	77,45	0,13	7,77	0,30	2,83	0,11	1,46	2,45	3,80	st	0,15			0,09	2,99	99,53	WQP, a
23	67,20	0,34	14,89	0,82	3,66	0,04	4,44	0,60	1,17	2,50	0,08			0,32	4,31	100,37	P
24	68,21	0,12	16,74	0,91	0,72	0,01	2,30	0,96	1,44	4,74	0,27	0,83	0,01	0,17	1,80	99,28	P
25	66,95	0,13	15,96	0,13	2,64	0,04	3,56	0,94	0,96	3,64	0,03	0,75	0,01	0,44	3,42	99,65	P
26	71,78	0,20	8,61	0,16	2,29	0,05	8,31	1,54	0,20	0,66	0,11	1,69	0,04	0,38	3,92	99,94	P

Analyst: Hemžalová — 1, 2, 5, 6, 9, 11, 14, 16, 17, 18, 19, 20, 21, 24, 25, 26; Jirásková — 12, 13, 15, 22; Geologický prieskum, Spišská Nová Ves: 3, 8, 10, 23; Saturová — 4, 7.
Variety: Explanation in table 1.
Locality: Explanation in table 3.

Table 3. Niggli's Values

No	si	al	fm	c	alk	k	mg	π	γ	α	μ	Q.	L.	M	qz	c/fm	Variety
1	374,49	32,18	44,79	13,57	9,46	0,70	0,95	0,42	0	10,11	0,59	65,44	18,88	15,68	236,65	0,30	GQP, b
2	290,60	29,14	48,13	16,31	6,42	0,75	0,64	0,56	0	7,28	0,64	60,28	20,52	19,20	164,92	0,34	GQP, b
3	396,80	27,04	57,98	8,79	6,19	0,74	0,61	0,41	0	9,11	0,61	68,20	11,98	19,82	272,04	0,15	GQP, c
4	383,76	29,87	54,22	7,14	8,77	0,63	0,47	0,29	0	8,70	0,47	66,25	14,17	19,58	248,68	0,13	GQP, c
5	498,79	46,03	29,76	7,94	16,27	0,83	0,47	0,20	0	14,79	0,47	69,93	18,37	11,70	333,71	0,27	GQP, b
6	500,40	45,20	32,40	8,40	14,00	0,74	0,46	0,23	0	14,30	0,46	70,89	16,56	12,55	344,40	0,26	GQP, b
7	362,40	40,37	42,24	3,10	14,29	0,89	0,48	0,98	0	7,10	0,48	62,70	18,38	18,92	205,24	0,07	GQP
8	331,17	36,86	47,43	4,00	11,71	0,78	0,67	0,15	0	6,99	0,67	61,41	17,15	21,44	184,33	0,08	GQP
9	261,11	43,22	35,55	8,70	12,53	0,90	0,28	0,26	0	5,62	0,28	55,00	24,30	20,70	110,99	0,24	VQP
10	446,88	42,49	38,46	14,65	4,40	0,58	0,59	0,62	0	12,40	0,59	72,51	11,85	15,64	329,28	0,38	VQP
11	525,00	50,00	28,75	6,67	14,58	0,86	0,39	0,19	0	14,75	0,39	71,90	15,59	12,51	366,68	0,23	VQP
12	480,74	47,69	24,23	9,62	18,46	0,62	0,56	0,21	0	15,89	0,56	68,25	21,58	10,16	306,90	0,40	VQP, a
13	413,32	56,16	16,78	6,85	20,21	0,51	0,41	0,14	0	12,40	0,41	64,28	24,05	11,67	232,48	0,41	VQP, a
14	653,24	52,22	13,79	12,32	21,67	0,82	0,29	0,22	0	31,28	0,29	74,00	20,19	5,81	466,56	0,89	VQP, a
15	450,50	36,36	29,45	16,36	17,83	0,33	0,48	0,31	0	18,80	0,48	66,35	25,81	7,84	279,18	0,55	VQP, a
16	445,40	45,02	21,40	18,45	15,13	0,76	0,34	0,26	0	6,70	0,34	67,73	24,13	8,14	284,88	0,86	VQP
17	293,60	43,20	28,27	4,53	24,00	0,50	0,53	0,09	0	6,23	0,53	51,82	34,20	13,98	97,60	0,16	VQP
18	557,69	54,59	21,40	5,24	18,77	0,77	0,24	0,12	0	16,90	0,24	71,78	17,55	10,67	382,61	0,24	VQP
19	510,23	53,88	24,49	4,90	16,73	0,90	0,58	0,13	0	14,24	0,58	70,60	16,90	12,50	243,31	0,20	VQP
20	376,92	42,35	36,48	6,51	14,66	0,91	0,17	0,18	0	9,31	0,17	63,67	20,13	16,20	218,28	0,18	VQP
21	412,54	42,16	32,06	13,24	12,54	0,86	0,50	0,35	0	12,51	0,50	66,92	20,27	12,81	262,38	0,41	pQP, c
22	493,89	29,12	30,65	16,86	23,37	0	0,45	0,11	0	15,39	0,33	84,91	3,26	11,83	300,41	0,55	wQP, a
23	299,22	39,04	45,72	2,94	12,30	0,59	0,64	0,11	0	6,00	0,64	58,52	18,34	23,14	150,02	0,06	P
24	340,85	49,25	23,72	5,11	21,92	0,68	0,72	0,10	0	8,65	0,72	57,86	28,68	13,46	153,17	0,21	P
25	315,89	44,48	35,69	4,53	15,30	0,70	0,70	0,13	0	6,94	0,70	58,81	22,16	19,03	154,69	0,13	P
26	330,18	23,21	66,57	7,45	2,76	0,70	0,85	0,57	0,27	6,84	0,85	65,30	8,54	26,16	219,14	0,11	P

Locality: Novoveská Huta: 1, 2, 3, 4 — the gallery No. 52, 5, 6 — the gallery No. 3, 12, 13, 14, 15, 22 — Mt. Strážovský kopec, Stratená: 7, 8, 11 — Mt. Čierna hora, 9 — Krompachy, near the road to Slovinky, 10 — Jaklovce, outcrop near the railway, 16 — to the south-east from Mt. Petrova hora, 17 — Štefanská Huta, Mt. Petrova hora, 18, 19 — Žakarovce, Mt. Dúbrava, 20 — Krompachy, to the west from the road to Slovinky, 21 — Hnilčík, the gallery No. 23, 23 — Richnava, the road to Hrišovce, 24 — Kolinovce, the brook bed to the north from the village, 25 — Štefanská Huta, the gallery to the south-east from Mt. Petrova hora, 26 — Štefanská Huta, the gallery to the south from Predné Uhliská.

Variety: Explanation in table 1.

According to Zavaricki's classification of rocks (1950) the prevailing part of them belongs to the first group of the first clarks, i. e. to rocks highly oversaturated with quartz (tab. 4). The remaining rocks belong to the second class, i. e. to rocks oversaturated with quartz, to groups rich in alkalii (3, 4, 5 and 6).

The classification of rocks already shows the rich content of quartz in quartz porphyries and porphyroids. Relative decrease in quartz is very frequently caused only secondarily due to the increased content of younger minerals (chlorite, carbonates. ore minerals etc.).

The described quartz porphyries and porphyroids belong to rocks oversaturated with Al. In two cases only the vector direction from point P_1 corresponds to normal composition (fig. 8). The change of composition is however not caused by increased content of alkalii but of Ca as a consequence of carbonatization.

Microelements

The difficulty of mineralogical observation, caused by finely dispersed character of mineralization (I. Rojkovič 1968), required to a greater degree than in the tuffitic

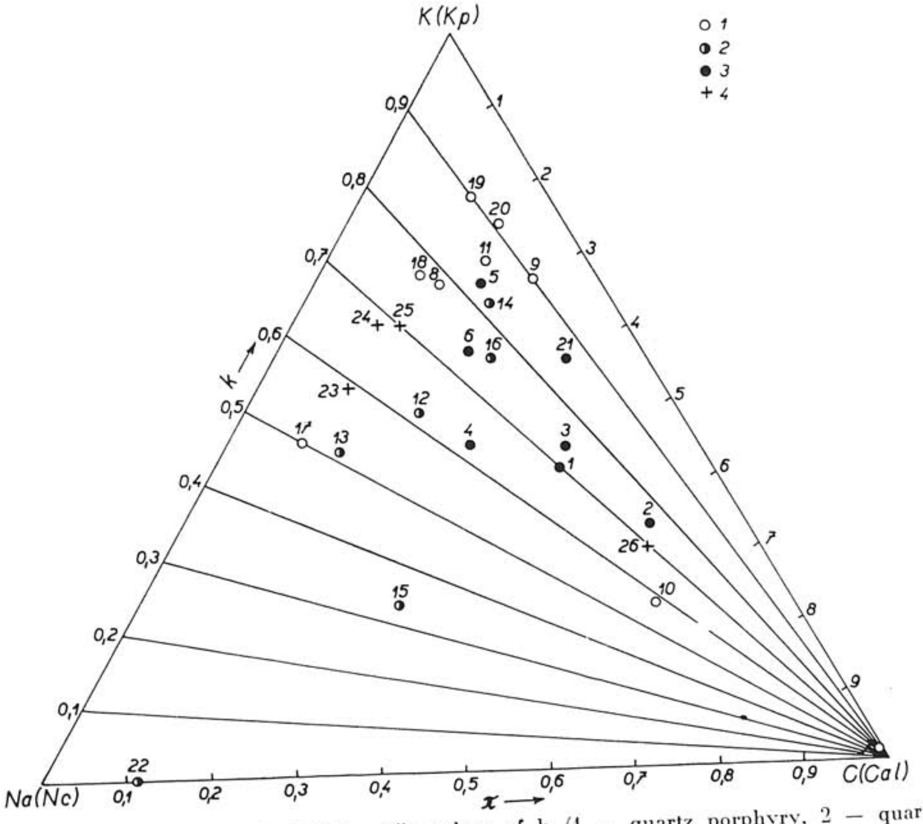

Fig. 6. Diagram of K-Na-C of Niggli's values of k (1 — quartz porphyry, 2 — quartz porphyry overlying the mineralized horizon near Novoveská Huta, 3 — quartz porphyry underlying the mineralized horizon and pebbles in this horizon, 4 — porphyroid).

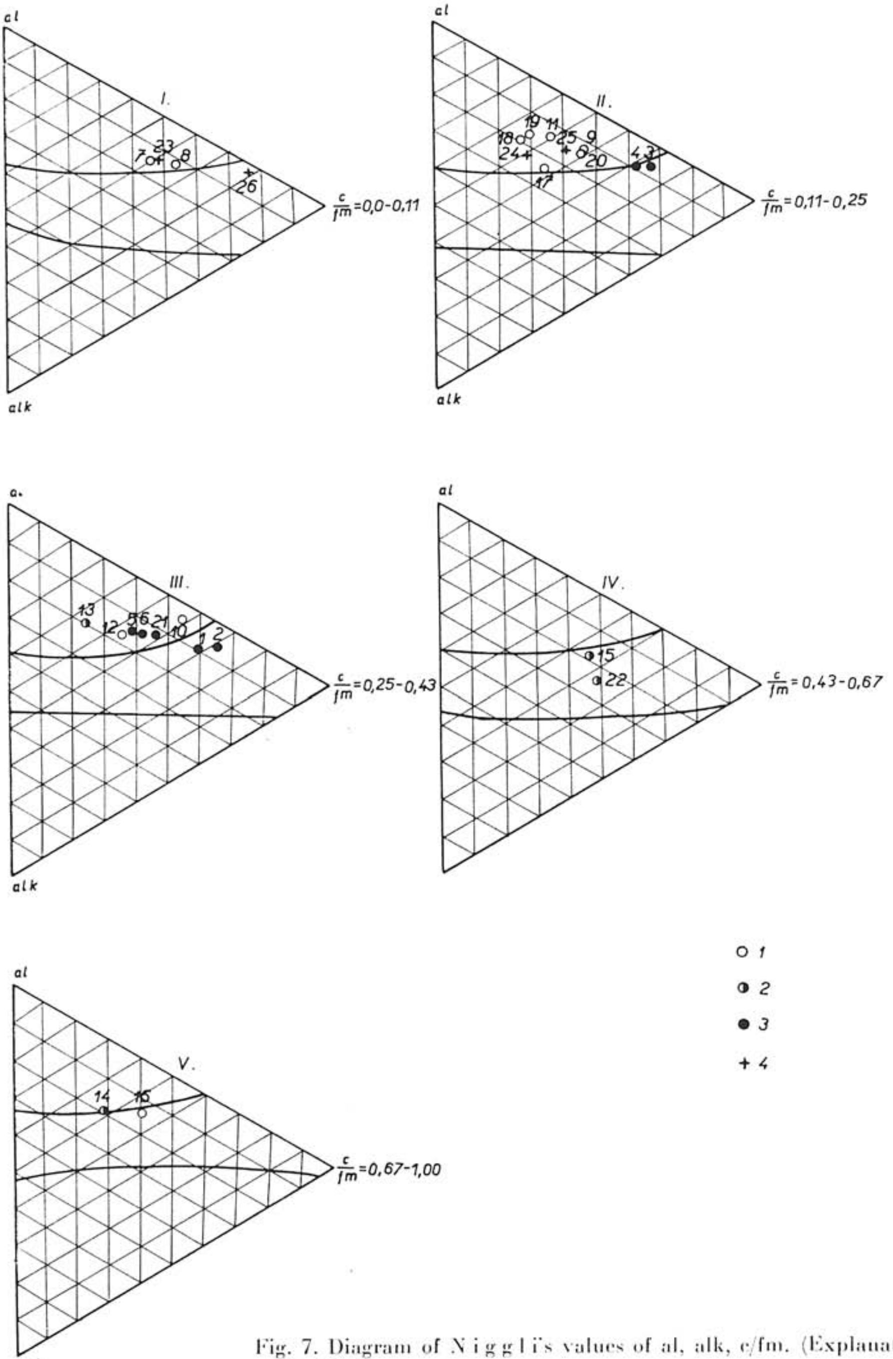

Fig. 7. Diagram of Niggli's values of al, alk, c/fm. (Explanations as in fig. 6).

horizon employing of luminiscent analysis on uranium and of spectral analysis on other trace elements in order to make characterization of their distribution possible (tab. 5).

Uranium is present in the studied quartz porphyries in pitchblende. uranium blacks an to a lesser degree in zircon.

From the average contents of uranium distinct increase in the Lower Quartz Porphyries and especially in mineralized pebbles of quartz porphyries in tuffitic conglomerates is to be observed.

The presence of higher contents of uranium in more acid and especially in effusive rocks is mentioned by many authors. M. R. Klepper and D. G. Wyant (1956) found out effusive rocks to contain 1.5 to twice uranium than the intrusive rocks

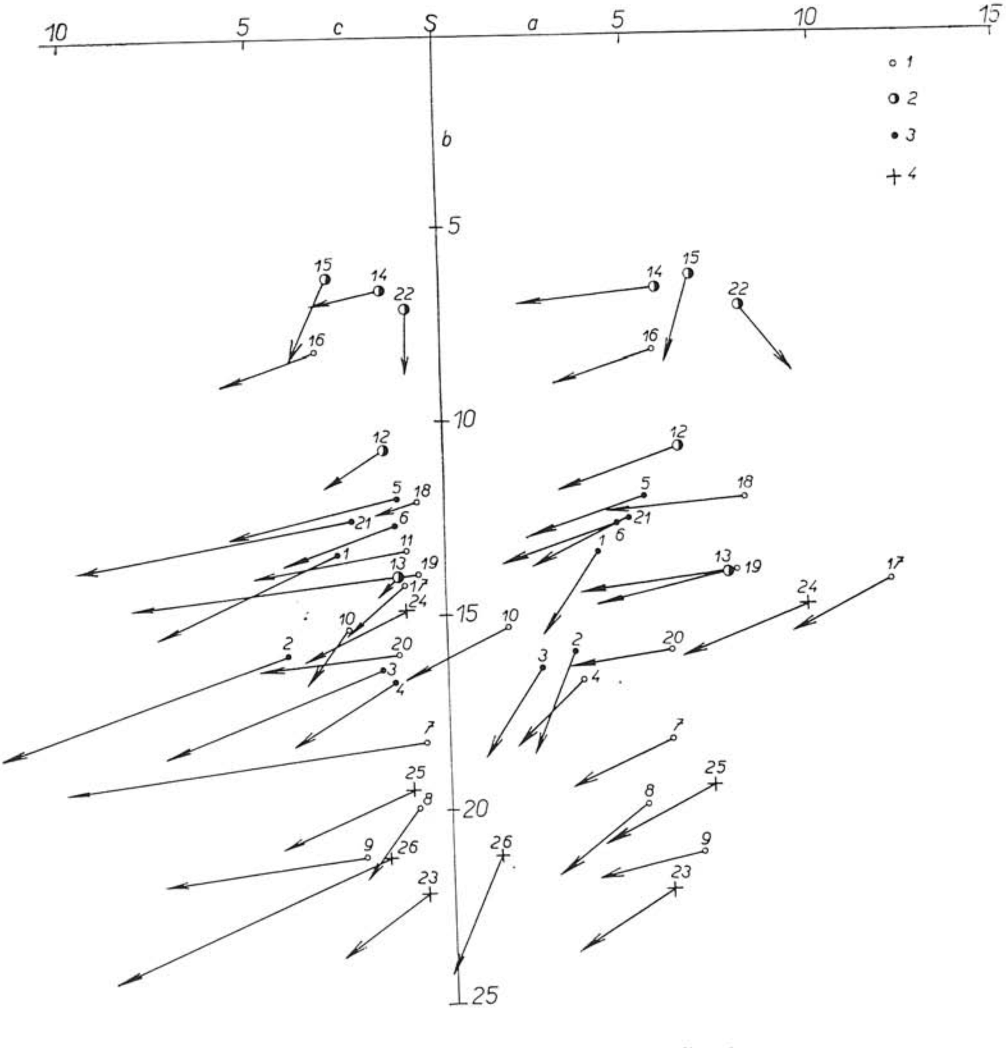

Fig. 8. Diagram of Zavaricki's values. (Explanations as in fig. 6).

Table 4. Zavaritskii's Values

No	a	c	b	s	f′	m′	a′	c′	n	t	φ	S	A	C	B	Q	a : c	C	G	Qz	A	Variety
1	4,02	2,88	13,39	79,71	29,00	42,03	29,00		30,03	0,25	6,00	1190	63	43	200	48,50	1,40	1	1	vr		GQP, b
2	3,36	4,27	15,97	76,40	28,07	50,88	21,05		25,03	0,37	5,26	1091	43	61	228	41,81	0,79	2	6	r	p	GQP, b
3	2,47	1,75	16,38	79,40	27,38	43,25	29,36		7,93	0,33	7,94	1222	38	27	252	52,11	1,41	1	1	vr		GQP, c
4	3,57	1,45	16,71	78,27	34,78	31,22	33,99		3,70	0,25	11,85	1185	54	22	253	47,95	2,46	1	1	vr		GQP, c
5	5,30	1,29	11,96	81,45	21,62	18,92	59,46		17,07	0,24	11,89	1260	82	20	185	51,01	4,11	1	1	vr		GQP, b
6	4,55	1,37	12,68	81,40	22,56	18,98	58,46		25,71	0,08	8,21	1252	70	21	195	52,33	3,32	1	1	vr		GQP, b
7	5,91	0,64	18,24	75,21	24,65	23,24	52,11		10,87	0,34	19,01	1171	92	10	284	37,95	9,23	2	3	r	r	GQP
8	5,21	0,89	19,96	73,94	17,51	35,35	47,13		56,09	0,34	3,18	1163	82	14	314	36,57	5,85	2	4	r	mr	GQP
9	6,67	2,31	21,17	69,85	32,15	12,54	55,31		10,20	0,49	28,30	1026	98	34	311	24,05	2,89	2	5	r	p	VQP
10	1,58	2,63	15,33	80,46	18,45	26,61	54,93		58,33	0,24	12,02	1223	24	40	233	55,13	0,60	1	1	vr		VQP
11	4,50	1,03	13,32	81,15	20,29	13,04	66,67		14,29	0,79	9,66	1261	70	16	207	52,27	4,37	1	1	vr		VQP
12	6,24	1,62	10,72	81,42	16,97	21,21	61,82		37,50	0,24	3,64	1253	96	25	165	48,74	3,85	1	1	vr		VQP, a
13	7,53	1,28	13,97	77,22	13,24	19,13	77,63		49,15	0,25	5,48	1210	118	20	219	38,19	5,88	2	4	r	mr	VQP, a
14	5,70	1,62	6,61	86,07	19,61	7,84	72,55		18,18	0,15	11,76	1328	88	25	102	59,12	3,52	1	1	vr		VQP, a
15	6,63	3,05	6,29	84,03	45,16	41,94	12,90		67,35	0,24	12,90	1242	98	45	93	51,75	2,17	1	1	vr		VQP, a
16	5,60	3,41	8,19	82,80	31,67	16,66	51,67		24,39	0,49	25,00	1213	82	50	120	51,01	1,64	1	1	vr		VQP
17	11,85	1,12	14,22	72,81	23,15	25,92	50,93		50,00	0,45	14,81	1106	180	17	216	20,80	10,58	2	3	r	r	VQP
18	5,49	0,77	12,05	81,68	19,58	6,35	74,07		23,26	0,23	16,93	1280	86	12	189	51,61	7,13	1	1	vr		VQP
19	5,24	0,77	13,93	89,05	11,47	16,05	72,48		8,76	0,24	6,42	1253	82	12	218	48,87	6,81	1	1	vr		VQP
20	5,94	1,32	15,97	76,77	38,43	7,85	53,72		8,89	0,52	35,54	1163	90	20	242	40,34	4,50	2	4	r	mr	VQP
21	4,83	2,53	12,55	80,03	25,27	24,19	50,54		13,89	0,17	11,83	1186	72	38	186	47,78	1,90	1	1	vr		pQP, c
22	7,94	0,93	7,09	83,99	40,37	33,03	51,00		100,00	0,15	3,67	1290	122	15	109	51,12	8,10	1	1	vr		wQP, a
23	5,84	0,70	22,16	71,30	17,48	31,52		22,60	41,30	0,35	2,86	1123	92	11	349	30,22	8,34	2	3	r	r	P
24	9,57	1,11	14,88	74,44	9,69	25,11	65,20		31,51		5,29	1136	146	17	227	28,63	8,62	2	3	r	r	P
25	7,01	1,04	19,48	72,47	12,67	29,33	58,00		29,63	0,03	0,67	1116	108	16	300	29,88	6,74	2	4	r	mr	P
26	1,27	1,71	21,20	75,82	10,45	61,49	28,06		30,00	0,25	0,60	1198	20	27	335	47,39	0,74	1	1	vr		P

Explanation: C — class, G — group, Qz — Quartz (r — rich, vr — very rich contents), A — alkalii (r — rich, mr — moderately rich, p — poor, vp — very poor contents of alkalii).
Variety: Explanation in table 1.

Table 5. Analyses of microelements (in ppm)[1]

No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
U	44	9	43,7	160	49,5	89,5	2,1	2,6	6	4,3	10	1,8	5,1	3	1,5
Mo	0	10	30	44	0	30	0	0	0	0	0	0	0	0	0
Pb	0	0	0	55	0	0	0	0	0	0	0	0	0	0	0
Ni	34	83	17	38	24	17	0	0	21	14	0	0	0	0	0
Co	15	35	10	43	0	68	20	29	0	0	0	0	0	0	0
Cu	0,7	135	2300	3000	0,3	7	12	29	0,5	0,1	14	5	4	8	7
Y	0		30	60	47	30	—	—	0	30	—	—	—	—	—
Zn	0	—	0	180	0	0	—	—	0	0	—	—	—	—	—
V	30	0	190	30	0	0	0	29	123	0	0	0	0	0	0
Zr	159	62	501	398	257	224	200	295	257	389	316	322	467	288	316
Cr	30	0	30	11	0	0	0	13	39	0	0	0	57	0	10
Ba	78	129	42	115	398	162	C	276	2344	118	447	490	170	42	165
Sr	0	0	0	0	0	0	22	46	100	0	0	32	18	0	36
Sn	19	0	14,5	75	48	30	0	30	23	14,5	0	30	30	0	0
Ga	—	12	—	—	—	—	19	16	—	—	19	15	31	10	10
Analyst	L	S	L		C	L	S	S	L	L	S	S	S	S	S
Variety	GQP, b	GQP, b	GQP, c	GQP, c	GQP, b	GQP, b	GQP	GQP	VQP	VQP	VQP	VQP, a	VQP, a	VQP, a	VQP, a
Locality	NH	NH	NH	NH	NH	NH	S	S	K	K	S	NH	NH	NH	NH

Tab. 5.

No	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
U	1,2	2,7	0,2	0,8	0,7	3,7	1	6,7	16,3	14,7	3,3	3,8	45,5	130	10	15
Mo	0	22	0	0	0	0	0	0	0	0	0	0	30	0	30	0
Pb	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ni	16	10	25	16	22	36	0	30	46	0	0	0	28	66	22	30
Co	0	0	10	10	10	0	0	0	0	0	15	0	14	28	14	17
Cu	15	43	34	34	32	6	12	10	11	17	10	10	2	4	3	1,5
Y	—	—	—	—	—	—	—	0	—	—	—	—	30	30	30	30
Zn	—	—	—	—	—	—	—	0	—	—	—	—	0	0	0	0
V	0	51	0	10	96	0	41	55	0	0	0	0	63	30	30	30
Zr	512	224	380	100	282	406	126	123	71	138	89	362	62	47	41	145
Cr	0	0	0	0	20	0	0	45	13	0	0	0	30	30	0	30
Ba	850	447	1070	647	536	229	65	186	195	229	63	323	562	155	89	81
Sr	30	10	23	13	29	28	62	0	0	0	0	0	0	0	100	100
Sn	0	74	23	23	32	0	0	95	0	0	37	0	60	48	39	23
Ga	25	15	16	20	14	13	10	—	20	17	11	28	—	—	—	—
Analyst	S	L	L	L	L	S	S	L	S	S	S	S	L	L	L	L
Variety	VQP	VQP	VQP	VQP	VQP	pQP, c	wQP, a	P	P	P	P	GQP, a	GQP, b	GQP, b	GQP, b	GQP, b
Locality	K	K	K	K	K	NH	NH	K	K	K	K	NH	HN	NH	NH	NH

Tab. 5.

No	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
U	59,5	11,7	3,4	34,5	51	4,2	10	6	7	6,5	4,4	1,7	2,4	1	1,5	—
Mo	0	30	0	0	0	10	0	0	0	0	0	0	0	0	0	0
Pb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ni	10	20	11	35	0	10	10	24	0	27	30	0	0	16	0	0
Co	10	23	0	59	0	0	0	0	10	35	17	16	0	0	0	0
Cu	2	7	0,2	7	8	7	162	54	45	46	8	120	4	7	9	8
Y	30	55	30	52	—	—	—	—	—	—	—	—	—	—	—	—
Zn	0	0	0	0	—	—	—	—	—	—	—	—	—	—	—	—
V	30	30	0	0	0	46	0	0	0	0	0	0	0	0	0	0
Zr	33	437	309	417	370	345	575	78	363	388	446	400	440	456	371	0
Cr	0	0	0	0	0	0	16	0	0	78	0	0	0	0	0	2.47
Ba	295	513	182	214	174	158	151	930	74	282	346	477	275	182	209	669
Sr	0	427	0	0	72	55	32	30	10	23	25	37	0	0	49	0
Sn	38	75	48	30	0	0	0	0	0	0	25	0	39	0	0	0
Ga	—	—	—	—	16	15	11	10	12	18	13	17	16	19	16	18
Analyst	L	L	L	C	S	S	S	S	S	S	S	S	S	S	S	S
Variety	GQP, b	GQP, b	GQP, b	GQP, b	GQP, b	GQP, b	GQP, b	GQP, b	GQP, c	0	pQP, c	VQP, a	VQP, a	VQP, a	VQP, a	VQP
Locality	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH	K

Tab. 5.

No	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
U	—	2,1	3,2	2,5	1,9	0,8	1,5	1,5	115	1,6	1,7	2,7	1,9	1,7	—
Mo	0	34	0	0	0	0	0	0	0	0	0	0	0	0	0
Pb	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
Ni	22	10	10	10	30	0	0	10	0	0	0	0	26	0	0
Co	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0
Cu	7	89	48	0,2	0,14	0,26	1,5	1	5	89	59	8	21	16	11
Y	—	—	—	39	30	0	0	63	—	—	—	—	—	—	—
Zn	—	—	—	0	22,5	22,5	0	0	—	—	—	—	—	—	—
V	0	30	20	25	54	30	0	29	0	155	0	0	0	0	0
Zr	204	162	295	246	234	159	66	537	89	107	132	0	112	100	98
Cr	0	10	10	35	48	0	0	0	0	13	0	0	11	11	0
Ba	775	502	524	138	141	288	155	174	191	346	297	263	240	217	276
Sr	20	10	10	0	0	0	0	0	0	0	0	31	36	30	0
Sn	0	34	42	60	120	19	145	19	0	0	0	0	40	0	0
Ga	19	15	19	—	—	—	—	—	24	18	13	16	18	19	11
Analyst	S	L	L	L	L	L	L	L	S	S	S	S	S	S	S
Variety	VQP	VQP	VQP	P	P	P	P	P	P	P	P	P	P	P	P
Locality	K	K	K	K	K	K	K	K	K	K	K	NH	NH	NH	K

Explanation: Microelements besides uranium were analysed spectroscopically and uranium was analysed luminiscently. — microelement was not analysed. Analyst: C.-J. Cubinek, L.-K. Lopašovský, S.-T. Slezák. Variety: QP — quartz porphyry, GQP — green, VQP — violet, wQP — white, pQP — pink, P — porphyroid, a — quartz porphyry overlying the mineralized tuffite horizon near Novoveská Huta, b — underlying, c — QP pebbles in tuffite horizon (cm — with the ore mineralization). Locality: K — Krompachy and surroundings, NH — Novoveská Huta, S — Stratená.

analogous to them. In rhyolites of the Hinsdale Formation in western Colorado E. S. Larsen, G. Phair et al. (1956) found out direct dependence of uranium contents on those of SiO_2. J. A. S. Adams and D. F. Saunders (1953) described

Table 5a. Analyses of uranium (in ppm)

No	U	Variety	Locality
67	6,1	GQP	NH
68	2,5	GQP	NH
69	1,8	GQP	NH
70	5,4	GQP	NH
71	1	VQP	NH
72	1	wQP	NH
73	1	wQP	NH
74	2,5	wQP	NH
75	2,1	wQP	NH
76	0,8	wQP	NH
77	1,4	wQP	NH

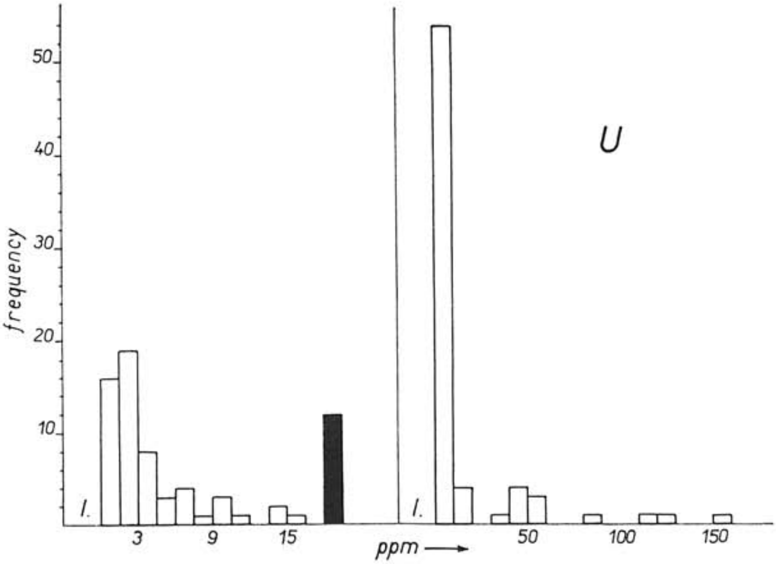

Fig. 9. Absolute frequency of uranium contents in quartz porphyries and porphyroids (70 analyses, black are designated higher concentrations included in the additional diagram).

increase in uranium contents with increased contents of K, thus with increased acidity of rocks. Changes of uranium contents in direct dependence on the sequence of the extrusion or intrusion in volcanic rocks of California (J. A. S. Adams, D. F. Saunders 1953) and Colorado (G. Phair 1952) were also found out. A similar tendency was described in volcanism of quartz porphyries (K. J. Dvorcová and A. A. Gorcevskij 1963), in which the highest contents were found in the first volcanic rhythm.

In the histograms (fig. 9—10) we observe certain irregularities of the distribution of uranium contents. In the Upper Quartz Porphyries of the area of the deposit we may observe the highest concentration of contents within the range of 0—4 mm while in the Lower Quartz Porphyries we see two maxima. One maximum is a Clark one (2—8 ppm), higher than in the Upper Quartz Porphyries while the second maximum (40—60 ppm) causes U-Mo-Cu mineralization.

As it may be concluded from the mentioned, the distribution of uranium as well as of accompanying elements of U-Mo-Cu mineralization was more complicated in the Lower Quartz Porphyries, where manifestations of hydrothermal enrichment in these elements are evident. This is also provable from the calculated values of the variation coefficient of trace elements in all quartz porphyries and porphyroids. The trace elements bound to rock-forming minerals, which do not show as great dispersion of values as elements of U-Mo-Cu mineralization, show much lower values of the variation coefficient.

Molybdenum. In mineralized tuffitic rocks it is molybdenite that is the bearer of molybdenum. In quartz porphyries molybdenite has not been found. The low sensi-

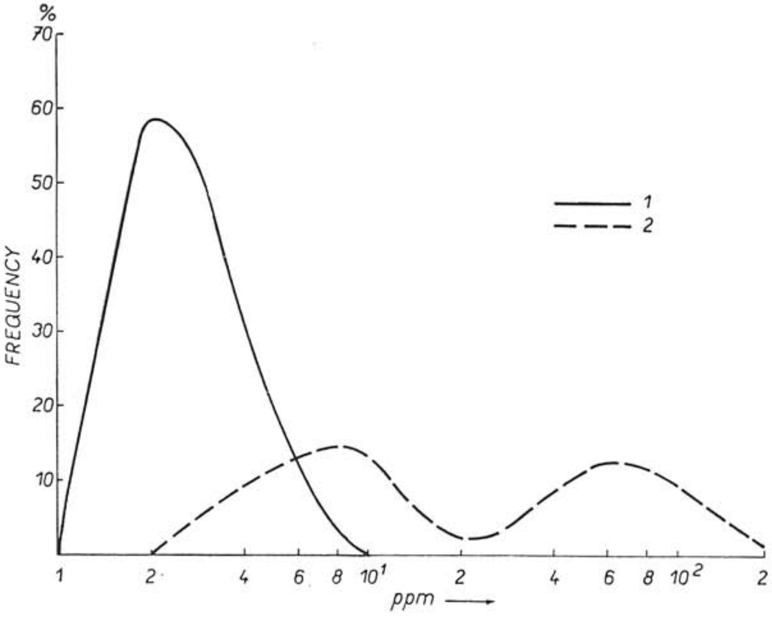

Fig. 10. Frequency curves of relative frequency of (%) contents of uranium in the Upper (1) and Lower (2) Quartz Porphyries near Novoveská Huta (1—20 analyses, 2—23 analyses).

bility of quantitative spectral analysis (10 ppm) made possible observation of molybdenum contents practically only in samples attested by the mineralization studied. The increased contents were caught only in layers of the Lower Quartz Porphyries and in pebbles in the tuffitic horizon. Molybdenum is here most probably bound to molybdenite, even when to a much lesser degree than in mineralized tuffites. Moderate correlation with uranium indicates similar association of elements as in the tuffitic horizon.

Copper is bound to sulphides equally as in the mineralized tuffitic horizon, especially to chalcopyrite and to a lesser degree to tetrahedrite-tennantite, which are most abundant in pebbles of quartz porphyries in the tuffitic horizon. In these also the highest contents of Cu are present as understandable. A significant correlation of copper with uranium confirms their common occurrence.

Lead is bound as radiogenic lead especially in uranium minerals and in galenite in the rocks studied. Due to its binding to uranium minerals the association of U and Pb is close as also confirmed by their distinct mutual correlation. The contents of Pb were however only found in samples with higher contents of U while in other samples they were present under the sensibility limit of the spectral analysis.

Cobalt and nickel do not form own minerals. The near radii of ions of Co^{+2} (0.82) ani Ni^{+2} (0.78) with Fe^{+2} (0.83) and Mg^{+2} (0.78) make possible cobalt and nickel to enter minerals of iron or magnesium. In the rocks studied contents of Ni and Co were found in pyrites and on the basis of higher contents of these elements in rocks rich in magnetite and chlorite their presence in these minerals may be concluded. Essential occurrence of Ni and Co in pyrite, which is an ore mineral of U-Mo-Cu mineralization, causes their moderate correlation with uranium.

Vanadium and chromium. The near radii of ions of three-valent vanadium (0.65 Å) with three-valent iron (0.67 Å), aluminium (0.57 Å) and four-valent titanium (0.64 Å) make possible these elements to enter iron and aluminium or titanium minerals. Microscopic study as well as positive correlation of V and Cr with Al_2O_3 and Fe_2O_3 indicate V and Cr present in oxides of iron and titanium and also in micas, especially in sericite and chlorites. Since both the elements are not bound to minerals of U-Mo-Cu mineralization in quartz porphyries we do not observe their correlation with uranium.

Yttrium was found in the mineralized tuffitic horizon in pitchblende. In quartz porphyries, where uranium minerals are present to a lesser degree than in the tuffitic horizon, it is especially bound to zircon. This relation is also confirmed by the coefficient of correlation of Y/Zr being more distinct in contrast to the coefficient of correlation of U/Y.

Tin and zinc. They mostly do not form own minerals. Only in mineralized pebbles of quartz porphyry sphalerite was found, which is an accompanying mineral of U-Mo-Cu mineralization. Radii of ions of Zn^{+2} (0.83 Å) and Sn^{+4} (0.74 Å) make possible these elements to enter minerals of Fe^{+2} (0.83 Å) and Sn^{+4} even substitutes Ti^{+4} (0.64 Å). Besides the significant correlation of U/Zn caused by the presence of Zn in sphalerite positive correlation of Sn and Zn with FeO was found out particularly in non-mineralized rocks. At tin also considerable proximity of mutual relation with TiO_2 was found out, making possible to suppose Zn and Sn present in magnetites and concerning Sn also in ilmenites and rutile in connection with microscopic study.

Zirconium is bound to the mineral zircon, a current accessory in the described rocks. With the increase in the content of quartz (Zavarickĭ's coefficient Q) a tendency analogous at Zr and to a lesser degree also at U is to be noticed (fig. 11). Relative enrichment in zirconium in Permian quartz porphyries and sediments in con-

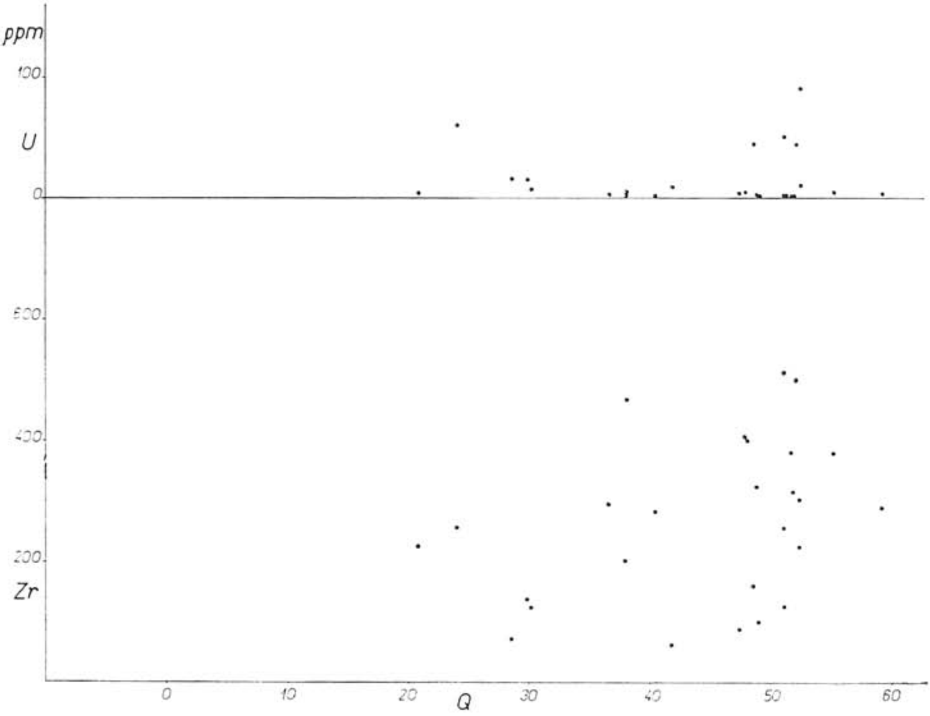

Fig. 11. Correlation diagram of contents of U and Zr with the Zavaricki's value of Q (26 analyses).

trast to similar rocks of the Mountains of Spišsko-gemerské rudohorie was indicated by M. Ivanov, G. Kupčo (1965). Most dictinct enrichment in the Permian was however found in the tuffitic horizon in which U-Mo-Cu mineralization is present (I. Rojkovič 1968). The equable distribution of zirconium, also confirmed by the low variation coefficient, is not connected with the ore mineralization mentioned as proved by the absence of positive correlation of Zr to U.

Barium and strontium. Due to the radius of ion (Ba^{+2} 1.43 Å) close to potassium (K 1.33 Å) barium is present in minerals of potassium. In the studied Permian rocks including sediments and effusive rocks the highest contents of barium were found in rather acid igneous rocks quartz porphyries rich in potash feldspars or sericite and in sericite (muscovite) as confirmed by very good positive correlation of Ba with K_2O.

Strontium is present in the studied rocks especially in plagioklases and carbonates, where it substitutes calcium, what is made possible by near radii of ions of Sr^{+2} (1.27 Å) and Ca^{+2} (1.06 Å). In the studied rocks this dependence is to a certain degree confirmed by correlation of Sr and CaO contents. The dependence of Sr on the basicity of rocks is partly misrepresented by carbonatization of the rocks.

Since Sr as well as Ba are present in rock-forming minerals, which are not bound to the studied mineralization, no dependence of their contents on uranium is to be observed.

Gallium substitutes aluminium in rock-forming minerals as a consequence of its radius of ion (Ga^{+3} 0,63 Å) near to aluminium (Al^{+3} 0,57 Å). In the studied rocks the presence of gallium especially in feldspars and less in micas may be supposed. The substitution of aluminium by gallium is also confirmed by positive correlation of Ga with Al_2O_3.

GEOCHEMICAL CHARACTERIZATION OF THE INDIVIDUAL VARIETIES OF QUARTZ PORPHYRIES AND PORPHYROIDS

Macroelements

Near Novoveská Huta differences in the representation of the principal constituents in quartz porphyries overlying and underlying the ore bearing horizon are to be observed (tab. 6). The underlying quartz porphyries are near to pebbles of quartz

Table 6. Average Contents of Macroelements (in Per Cents)

	a	b	c	VQP	GQP	QP	P	P+QP
SiO_2	75,82	71,82	71,78	72,66	71,40	72,35	68,54	71,76
TiO_2	0,18	0,20	0,22	0,27	0,24	0,25	0,20	0,24
Al_2O_3	11,60	11,22	10,05	13,33	11,15	12,24	14,05	12,52
FeO_3	0,75	1,25	1,91	2,50	1,76	2,09	0,51	1,85
FeO	1,67	2,52	3,13	1,03	2,77	1,77	2,33	1,86
MnO	0,06	0,09	0,05	0,05	0,06	0,06	0,04	0,05
MgO	1,12	2,73	3,12	1,25	3,20	2,00	4,65	2,40
CaO	1,77	2,04	1,63	1,47	1,53	1,57	1,01	1,48
Na_2O	1,86	0,50	0,44	0,91	0,59	0,90	0,94	0,90
K_2O	2,13	2,34	1,95	3,00	2,25	2,58	2,89	2,63
P_2O_5	0,06	0,09	0,11	0,11	0,11	0,11	0,14	0,11
CO_2	(0,93)	(2,76)	(3,44)	(1,11)	(2,75)	(1,79)	(1,11)	(1,67)
SO_3	(0,01)	(0,01)	(1,22)	(0,02)	(0,49)	(0,19)	(0,02)	(0,16)
H_2O+	(2,63)	(2,21)	(3,46)	(2,55)	(3,05)	(2,73)	(3,36)	(2,83)
„H_2O+“	2,82	4,98	5,42	3,30	4,73	3,91	4,21	3,96
H_2O-	0,10	0,24	0,39	0,23	0,24	0,26	0,33	0,27
Sum	99,94 (100,69)	100,02 (100,02)	100,20 (102,90)	100,11 (100,49)	100,03 (101,59)	100,09 (100,89)	99,84 (100,12)	100,03 (100,73)
Number of analyses	5 (1)	4 (4)	3 (1)	12 (8)	8 (4)	22 (13)	4 (3)	26 (16)

„H_2O +“ = (H_2O) + (CO_2) + (SO_3) because CO_2 and SO_3 were not distinguished in every analyse. Their values and number of analyses are in brackets. Variety: Explanation in table 1.

porphyries in tuffitic conglomerates in their chemism. Relative decrease in SiO_2 (by 4 %) in the last two is only the reflection of the increased share of ore minerals and chlorite, manifested again in the increase in Fe_2O_3 contents (0,5—1 %), FeO (1—1,5 %), MgO (1,5—2 %) and SO_3 (up to 1 %). Another characteristic feature of the Lower Quartz Porphyries and of pebbles of quartz porphyries is the increase in the share of K_2O. While in the Upper Quartz Porphyries the share of K_2O/Na_2O (expressed in %) is 1.15, in the Lower Quartz Porphyries it is 4,68 and in the pebbles 4,43. The mentioned shows close relation between the last while the Upper Quartz Porphyries differ from them in the mentioned representation of the fundamental constituents as well as in the contents of trace elements treated in the next.

Studying quartz porphyries in the Permian of all the North Gemeride region differences in representation of FeO and Fe_2O_3 may be observed between violet and green varieties. The ratio eF_2O_3/FeO conditioning the colour of the rock displays the value of 0,64 in green quartz porphyries while in the violet ones it increases up to 2,43.

Compared with quartz porphyries, porphyroids show certain deviations in the representation of fundamental constituents which are the reflection of increased share of

Table 7. Average Contents of Microelements (in ppm)

Variety	QP, a	QP, b	QP, cm	VQP	GQP	P
U	2,1	34,1	54,3	2,6	27,6	12,2
Mo	0?	9?	18	3?	7?	0?
Pb	0?	0?	14	1?	0?	0?
Ni	2?	27	21	9?	22	11
Co	2?	18	25	2?	17	2?
Cu	19	25	1348	24	24	16
Y	—	33	45	15	33	21
Zn	—	0?	90	0?	0?	8
V	4	18	55	17	17	22
Zr	355	223	413	314	233	179
Cr	7	9	30	7	8	11
Ba	240	267	128	452*	279	212
Sr	23	51	8	21	47	6?
Sn	9	29	22	18	26	33
Ga	17	13	15	17	16	17
Number of anal.	10	16	4	20	19	16

Explanation: — microelement was not analysed, ? — Many contents of the analysed microelements are below the sensibility level of the spectral analyse. * — without the anomalous value in the sample No. 9, which is caused by the baryt mineralization, • — Number of analyses corresponds to the majority of the analysed microelements. The detail deviations of U, Y, Zn and Ga are shown in table 5.

sericite and chlorite. Although no increase in the share of alkalii is evident the content of Al_2O_3 increases (by 2 %) since in this case K_2O is to a greater degree bound to sericite. The share of Fe_2O_3/FeO (in %) decreases down to 0.22. This difference in contrast to quartz porphyries is mainly caused by carrying away of Fe^{+3} (the content of Fe_2O_3 decreased by down to 1.5 %) since the content of FeO that is considerably bound to chlorite in porphyroids keeps approximately the same level as in quartz porphyries.

In the contents of TiO_2 no greater deviations are to be observed. The highest contents were found in violet quartz porphyries, what is connected with more frequent presence of magnetite and hematite in violet varieties.

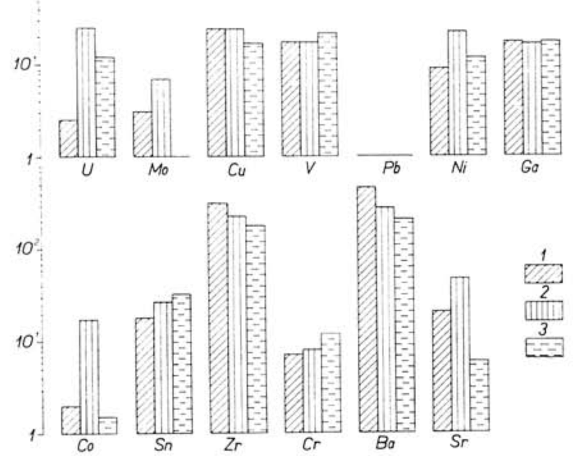

Fig. 12. Average contents of trace elements in violet (1) and green (2 — besides the mineralized) quartz porphyries and porphyroids (3). (Number of analyses: 1—20, 2—19, 3—16).

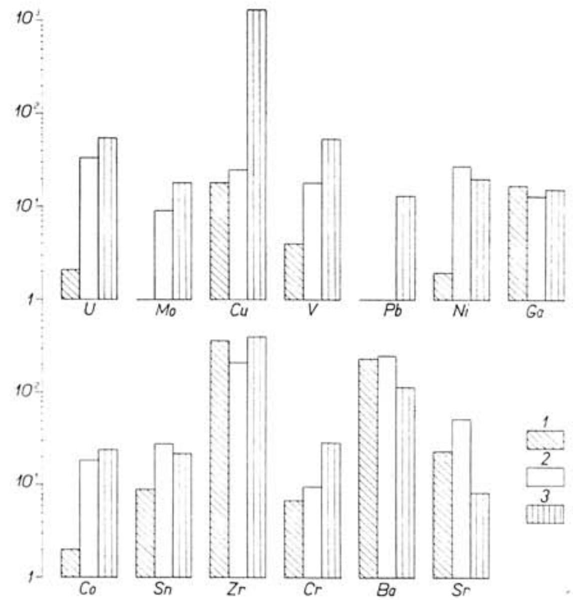

Fig. 13. Average contents of trace elements in quartz porphyries overlying the mineralized horizon (1), underlying it (2) and in mineralized pebbles in tuffitic conglomerates (3) near Novoveská Huta. (Number of analyses: 1—10, 2—16, 3—4).

Microelements

The different representation of rock-forming minerals in the individual varieties of the quartz porphyries also causes different contents of microelements bound to macro-constituents of the minerals as it was characterized at the individual trace elements (tab. 7). For example, the increased share of sericite, chlorite and rutile in porphyroids also causes the increased content of Cr, V and Sn as a consequence of the metamorphosis of these minerals (fig. 12). Certain increase in the average content of uranium in porphyroids is caused by local infiltration enrichment in uranium in several samples near Kolinovce, which is not connected with the enrichment in other ore elements (I. Rojkovič 1968).

Conspicuous differences in the contents of microelements, especially of those connected with U-Mo-Cu mineralization are to be observed near Novoveská Huta (fig. 13). In the Lower Quartz Porphyries and especially in pebbles of quartz porphyries in tuffitic conglomerates enrichment in U, Mo, Cu, V, Pb, Ni and Co is distinctly provable.

Table 8. Statistical evaluation of Microelements in Quartz Porphyries and Porphyroids

	$\overline{x}$	s^2	s	V (90)	r		r	
U	15,9	959	31	195				
Mo	4	113	11	248	U/No	0,391	Mo/Cu	0,570
Pb	12	50	7	593	P/Pb	0,525	Ni/Co	0,452
Ni	14	282	17	117	U/Ni	0,343		
Co	8	208	14	175	U/Co	0,453		
Cu	105	217 287	466	443	U/Cu	0,498		
Y	29	374	19	67	U/Y	0,240	Y/Zr	0,588
Zn	11	1 476	38	359	U/Zn	0,590		
V	18	944	31	173	U/V	0,064		
Zr	255	22 981	152	59	U/Zr	−0,117		
Cr	9	273	17	176	U/Cr	0,104	Cr/V	0,308
Ba	279	47 100	217	78	U/Ba	0,003		
Sr	26	3 293	57	223	U/Sr	−0,077		
Sn	24	943	31	130	U/Sn	0,147		
Ga	17	45	7	45	U/Ga	0,051		

$\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i$ — arithematrical number of analyses: U-70, Ga-41, Y and Zn-21, other 62

$s^2 = \frac{1}{n} \sum_{i=1}^{n} (x_i - \overline{x})^2$ — dispersion, s = standard deviation, $V\,(\%) = \frac{s}{\overline{x}} \cdot 100$ — variation coefficient, $r_{xy} = \frac{1}{n} \sum \left(\frac{x - \bar{x}}{s_x} \right) \left(\frac{y - \bar{y}}{s_y} \right)$ — correlation coefficient. The calculations were carried out by J. Klučarová (Institute of Technival Kybernetics at the Slovak Academy of Science with cumputer ZRA-1).

To a lesser degree this trend is to be observed at Cr while it is not manifested at Sn, Zr, Ba, Sr and Ga. While increased contents of V and Cr are bound to originally richer ore accessories (magnetite and ilmenite), other elements are the association of hydrothermal U-Mo-Cu mineralization. These elements also show higher variation coefficient as a consequence of their unequable distribution caused by hydrothermal ore mineralization.

The association of U-Mo-Cu mineralization in quartz porphyries is mostly confirmed by coefficients of correlation of the elements to uranium (tab. 8). A significant up to moderate correlation according to the decreasing value of the coefficient of variation was recorded at Zn, Pb, Cu, Co, Mo and Ni while low up to negative correlation was calculated at Y, Sn, Cr, Ga, Ba, V, Sr and Zr. Moderate to distinct correlation is to be observed at Cu, Mo, Ni and Co mutually. The coefficients of correlation of U/Y and Zr/Y prevailingly indicate binding of Y to zircon in contrast to tuffites with abundantly represented uranium minerals, to which also Y is bound, due to what the increase in the correlation coefficient of U/Y proceeds.

Closing it may be said that not only spatial and mineralogical connection of the U-Mo-Cu mineralization with the volcanism of quartz porphyries in tuffites (I. Rojkovič 1968) but also similar association of ore elements indicates the source of U-Mo-Cu mineralization in the tuffitic horizon in the Permian of the Mountains of Spišsko-gemerské rudohorie to have been the volcanism of quartz porphyries.

Translated by J. Pevný.

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