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HIDDEN GRANITE INTRUSION NEAR ROCHOVCE WITH Mo(-W) STOCKWORK MINERALIZATION (FIRST OBJECT OF ITS KIND IN THE WEST CARPATHIANS)

(12 Figs., 3 Pls., 6 Tabs.)

Abstract: In the submitted work the authors characterize the hidden Rochovce granitoid intrusion and associated Mo(-W) mineralization. The knowledge obtained so far indicates that the Rochovce monzogranite intrusion has at least two intrusive phases which differ from each other in the presence of macroelements as well as microelements. Textural developments of the granitoid rocks of these two phases are also different. The intrusion is dominated by the first phase formed of coarse-grained to large-grained biotite porphyric granites, whereas hybrid and finer grained ones occur on the periphery. In the stock dome (?) of the 2nd intrusive phase there prevail fine-grained granites, granite-aplites and granite porphyries. This phase is characterized by the enrichment mainly in K, U, Th, Rb, REE. They are mostly peraluminous. On the basis of the $K_{57.5}$ index of 2.0 to 3.0 we assign the whole Rochovce intrusion with ist Mo mineralization to calc-alkaline Mo stockwork deposits according to Westra — Keith's (1981) classification.

The differentiated magmatic melt of the 2nd intrusive phase had inceased contents of the fluid components K and Mo. During the emplacement of the stock, an enriched dome was formed and, due to decompression and subsequent boiling of the melt, there were formed fluids with ore constituents which were deposited in pre-fractured endo- and exocontacts of the dome. The mineralization thus formed has a zonal pattern: Mo — W — mainly on the periphery Fe sulphides. The hydrothermal activity was concluded by the deposition of the low-temperature mineralization consisting of quartz-fluorite-galena-sphalerite-calcite. The intrusion, probably Cretaceous in age, is situated in the area of compression zone of the continental plate margin of the Alpine-Carpathian orogen. The discovered Mo stockwork mineralization associated with such a granite intrusion and/or stock (?) intrusion of highly differentiated granites is the first of its kind in the West Carpathians.

Резюме: В предлагаемой статьи автори характеризуют скрытую роховецкую интрузию гранироидов и с нею связанную Mo (W) минерализацию. Роховецкая интрузия монцогранитов имеет по настоящим данным две интрузивные фазы. Они отличаются друг от друга содержанием макро- и микроэлементов. В структурном развитии гранитоидных пород имеются тоже некоторые разницы. Первую интрузивную фазу образуют по объему преобладающие крупнозернистые и очень крупнозернистые биотитовые порфировидные граниты, на окраине гибридные и более мелкозернистые разновидности. В куполе штока (?) второй интрузивной фазы преобладают мелкозернистые граниты, гранит-аплиты и гранит-порфиры. Для этих пород характеристическим является обогащение K, U, Th, Rb, и REE. Они главным образом пералюминозны. По

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индексу $K_{57,5}$ = 2,0 до 3,0 всю роховецкую интрузию можно отнести к известково-щелочным Мо штокверковым месторождениям по классификации Вестра — Кейта (Westra — Keith, 1981). Дифференцированный магматический расплав второй интрузивной фазы имел повышенное содержание флюидных компонентов К и Мо, причем проникании штока (?) образовался обогащенный купол и влиянием декомпресси и следующего кипения расплава освобождаются рудные компоненты содержащие флюиды находящиеся в трещиноватостей подготовленом эндо- и экзоконтакте купола. Образовалась зональная минерализация в последовательности Mo-W и, главным образом на периферии, Fe-сульфиды. Гидротермальная деятельность окончилась низкотемпературной минерализацией кварц-флюорит-галенит-сфалерит-кальцит. Возраст интрузии правдеподобно меловый и интрузия находится в пространстве зоны компрессии окраины континентальной плиты альпийско-карпатского орогена. Определенная Мо штокверковая минерализация связанная с гранитовой интрузией, или штоковое (?) проникание высокодифференцированных гранитов, является первым объектом этого типа в Западных Карпатах.

Introduction

The territory concerned (Fig. 1) lies among the villages of Rochovce, Ochtiná, Kopráš and covers the area of some 18 km^2. Soil geochemical prospection carried out in this territory revealed a Mo-W anomaly and subsequent drilling resulted in the discovery of a stockwork-disseminated-type mineralization spatially associated with the endo- and exocontact parts of the hidden Rochovce intrusion (Václav in Molák et al., 1987; Václav — Határ — Vozárová — Beňka, 1988; Václav et al., 1988). The morphological relief of the area is very dissected, hardly accessible, mostly wooded. Roughly in its centre the territory is divided by the NE-SW trending mountain range Bredáč (694.0 m above sea level) — Magura (882.0 m). In the north the area is bordered by Štítnik brook, in the east by Ochtiná brook, in the south by Kopráš brook and in the west the boundary lies between the elevation point Vŕšok and village of Kopráš. From the orographical viewpoint, the territory is part of the Revúcka vrchovina Mts., geologically belonging into the southern-Veporicum/Gemericum contact zone (according to Vozárová — Vozár, 1982). According to the metallogenic division of the West Carpathians (Ilavský et al., 1976) the investigated territory is part of two structural-metallogenic zones — Veporican and Gemeric one. The western part of the territory, i. e. west of the Ľubeník-Margecany line, belongs into the Veporic structural-metallogenic zone, into its south-Veporic district, whereas the territory east of the Ľubeník-Margecany line is part of the Gemeric structural-metallogenic zone.

Geological structure of the territory

The geological structure of the territory concerned is characterized by the presence of the first-order tectonic line, i.e. Ľubeník-Margecany line which, roughly along the line Rochovce-Korpáš, divides the two major tectonic units — Gemericum and Veporicum. In the investigated area the latter is presented

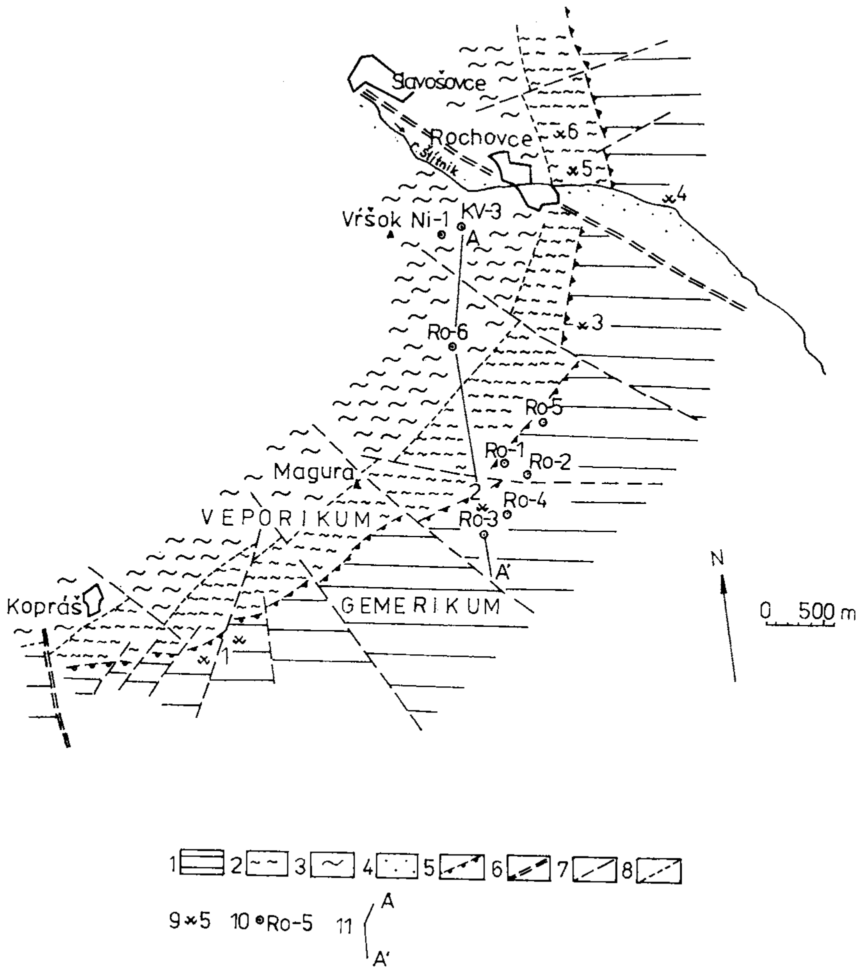

Fig. 1. Schematic geological map and drillhole location.
Explanations: 1 — Gemericum-Carboniferous-Ochtiná Formation; 2 — Veporicum--Permian-Rimava Formation; 3 — Veporicum-Carboniferous-Slatviná Formation; 4 — alluvium; 5 — Ľubeník-Margecany line; 6, 7, 8 — tectonic lines of lower orders; 9 — old mine workings for Fe, As, Pb, Zn sulphidic mineralization; 10 — drillhole location and designation; 11 — line of geological section.

by the Revúca Group of Late Paleozoic age (Vozárová — Vozár, 1982) formed of fine-grained as well as coarse-grained detrital sediments. The Revúca Group consists of two formations. The lower one — Slatviná Formation is of Late Carboniferous age, with palynological researches indicating Stephanian C-D (Planderová — Vozárová, 1978). The upper — Rimava Formation is regarded as Permian in age. Lithologically, the formation is dominated by coarser grained sediments with fairly abundant quartz, its facies considerably variable, The Gemericum is represented by the Ochtiná Formation (B a j a n í k — V o z á r o v á — R e i c h w a l d e r, 1981). The presence of conglomerates but mainly fairly abundant sandstones and graphitic schists are typical of this formation. Another characteristic sign is the presence of carbonates metasomatically replaced by dolomites and magnesites. This formation comprises also paleobasalt tuffs and tuffites. The Late Paleozoic rocks are epimetamorphosed.

The Gemericum, as a nappe megastructural unit, was overthrust onto the Veporicum along the NE-SW trending Ľubeník-Margecany line. It dips towards the SE at 15 to 55 °, extending into considerable depth (P l a n č á r et al., 1977). The line is locally exposed on the surface in the form of a steeply dipping repeatedly reactivated fault (dipping towards the SE at 70—80 °). In the overthrust unit there were found structural elements with detailed folding, principally of the Ochtiná Formation, which fringes the line throughout its length. The overthrusting of the Gemericum, which covered the upper part of the Rimava Formation, resulted in the variable shear reduction of the individual parts of the overthrust unit.

From geological but mainly metallogenic viewpoint, the discovery of an extensive hidden granitoid intrusion (F i l o et al., 1974; K l i n e c et al., 1979;

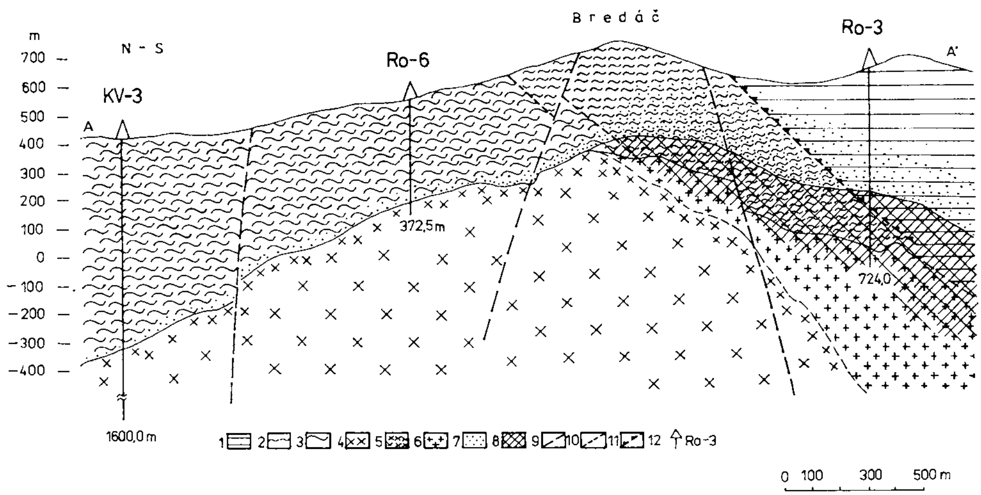

Fig. 2. Schematic section across granite intrusion and its metamorphic mantle (N-S trending, see Fig. 1., A-A′).

Explations: 1 — Gemericum-Carboniferous-Ochtiná Formation; 2 — Veporicum-Permian-Rimava Formation; 3 — Veporicum-Carboniferous-Slatviná Formation; 4 — coarse-grained porphyric biotite granites of 1st intrusive phase; 5 — marginal fine-grained facies of granites of 1st intrusive phase; 6 — granites of 2nd intrusive phase; 7 — mineralized zone with sulphides and W above 2nd intrusive phase; 8 — intrusive-mineralized endo- and exocontact zones with MoS_2; 9, 10 tectonic lines of lower orders; 11 — Ľubeník-Margecany line; 12 — drillhole location and designation.

Václav et al., 1988) is of great importance. It penetrated into the area of the already Alpine-deformed Ľubeník-Margecany line and occurs in the Veporicum as well as Gemericum. The intrusion is oblong, E-W trending and plunges towards the east and south-east. Geophisical data (Filo et al., 1981) suggest that the intrusion at depth follows the NE-SW trending Ľubeník-Margecany line. In the NE and E the intrusion is probably confined by and sunken along the younger Štítnik fault system, whereas in the north it is restricted by the Rochovce fault situated in the Valley Ochtiná-Rochovce-Slavošovce. In addition to these significant young faults, block structure forming E-W as well as N-E trending horst structures can be seen throughout the territory. Preliminary data suggest that the ore structures are also displaced along these faults. The granitoid body is nowhere exposed on the surface. It is delineated by geophysical surveys and intersected by the drillholes KV-3, Ro-2, Ro-3, Ro-5, Ro-6 and Ni-1. The drillholes of the Ro series (Václav et al., 1988) revealed a Mo-W mineralization which gives rise to an extensive surficial secondary aureole of Mo, W and other metallic elements (Václav — Snopko, 1983; Václav et al., 1988). In the Rochovce-Kopráš area the aureole is likely to overlap the productive part of the delineated body of the granitoid intrusion.

Petrographic characteristics

Granitoid rocks of the 1st phase

Coarse-grained to large-grained biotite granites with phenocrysts of pink feldspars were intersected by the drillhole KV-3 and partly Ro-2. This granite type has been described in detail by Klinec et al. (1980) who have distinguished three stages of the formation of the granite intrusion. In the first stage, accessory minerals, biotite and plagioclase I crystallized. The plagioclase I bears signs of magmatic corrosion, is only weakly zoned or is not zoned at all, its basicity amounting to An36—An45. It often forms cores within plagioclase II and frequently surrounds biotite. After a partial break in the crystallization, bipyramidal quartz I and plagioclase crystallized. The plagioclase II has a complicated structure, is polysynthetic lamellated, most often according to albite, albite-Carlsbad, less frequently pericline laws. The lamellae are distributed in variously oriented blocks. Oscillated and spotted zoning is very abundant. The lamellae are frequently protoclastic-fractured. Klinec et al. (l. c.) have determined basicity in the plagioclase II cores of An18—An38, in the spotted part An28—An32 and in the marginal part An15—An22. Oscillating alternations of the zones An24—An28 and An32—An36 are characteristic. The plagioclase II encloses the plagioclase I, biotite and magnetite. K-feldspars consist of two varieties-phenocrysts several cm large and interstitial K-feldspars. Our observations suggest that the phenocrysts are relatively older and probably crystallized after quartz I and plagioclase II, the latter two minerals being surrounded by the phenocrysts. The youngest generation is represented by interstitial xenomorphic K-feldspar which locally forms phenocrysts and crystallized along with quartz of the 2nd generation. The K-feldspars frequently constitute perthites.

Table 1

Plagioclase composition from granites of 1st intrusive phase determined by a JEOL--733A electron microprobe

	plagioclases						
drillhole	KV-3	KV-3	RO-2	RO-2	RO-2	RO-2	RO-6
depth	369.50	1369.50	597.00	597.00	597.00	537.00	372.40
rock	HzG	HzG	GpjzaZh	GpjzaZh	GpjzaZh	GpjzaZh	GpjzaZh
phase	1.	1.	1.	1.	1.	1.	1.
point location	centre	margin	centre	margin	margin	margin	margin
generation	2.	2.	2.	1.	2.	2.	2.
point No.	1.	2.	3.	4.	5.	6.	7.
SiO_2	59.65	64.94	56.11	60.98	65.31	62.48	63.86
TiO_2	0.00	0.00	0.07	0.04	0.00	0.00	0.00
Al_2O_3	23.53	22.23	28.12	24.86	22.92	23.20	23.35
FeO	0.14	0.13	0.10	0.06	0.04	0.17	0.02
MnO	0.00	0.02	0.10	0.08	0.00	0.00	0.00
MgO	0.00	0.00	0.00	0.00	0.01	0.00	0.02
CaO	5.31	2.64	10.06	6.07	3.43	3.91	4.07
Na_2O	8.02	10.39	5.49	7.55	9.11	9.22	8.62
K_2O	1.33	0.11	0.24	0.48	0.29	0.20	0.19
BaO			0.07	0.08	0.00		
SrO			0.20	0.16	0.00		
Total	97.98	100.46	100.56	100.36	101.11	99.18	100.13
	after recalculation to 8 oxygens						
albite	67.80	87.16	48.90	67.20	81.40	80.10	78.40
anorthite	24.80	12.23	49.50	29.90	16.90	18.70	20.40
orthoclase	7.40	0.61	1.14	2.80	1.70	1.15	1.14

Hzg — coarse-grained granite; GpjzaZh — granite porphyry with fine-grained aplitic groundmass. Operated by RNDr. F. Caňo.

Granite-porphyries usually occur in the marginal parts of the granite intrusion (drillholes Ro-2, Ro-6, rarely also KV-3). The 1st-stage granite porphyries often alternate in a finger-like pattern with more felsic varieties of the 2nd-phase granitoid rocks in the area of their mutual contact. Macroscopically, the rocks are of gray colour, mostly confining-structured. In places they surround enclaves of more mafic biotite tonalite porphyries. The phenocrysts are constituted by plagioclase, bipyramidal quartz, biotite and rare K--feldspar. The fact that the K-feldspar forms rare or no phenocrysts in the granite porphyries indicates that these phenocrysts in the coarse-grained biotite type predominantly postdated the emplacement of magma into the magmatic chamber. Like in the coarse-grained porphyric type, polystage crystallization of the rocks can be observed also here. The 1st-generation plagioclases often form magmatically corroded cores in the plagioclases II, with the latter often being distinctly oscillation-zoned. At depths of 596—598 m (drillhole Ro-2) we have observed changing basicity of the plagioclase from the centre of the crystal towards its margin: An49.5—An30—An17. The marginal zones of the plagioclase often crystallized along with the fine-grained groundmass (Pl. 2, Fig. 3). Scarce K-feldspar phenocrysts enclose, mainly in the marginal parts, small lath-shaped plagioclases. In the marginal parts of the K-feldspar, its crystallization was locally interrupted and fringes of acid plagioclase were formed. In the cross-section, the quartz I phenocrysts are represented by isometric grains with corrosion embayments. Biotite is enclosed in the plagioclase II or constitutes phenocrysts in the groundmass.

The groundmass is microaplitic and comprises plagioclases, xenomorphic quartz II and K-feldspar II. The plagiosclases are represented by two generations, the younger of which crystallized soon after the older one. The plagioclase III is larger, hypidiomorphic to xenomorphic, plagioclase IV crystallized together with the xenomorphic quartz II and K-feldspar II. The composition of the plagioclases is given in Tab. 1. (measured by electron microprobe JEOL JCX-733A).

The phenocryst/groundmass quantitative ratio is variable, the groundmass slightly prevailing.

Biotite tonalite porphyrites form mafic enclaves in the granite-porphyries. Their phenocrysts are represented by distinctly oscillation-zoned, complexy intergrown, magmatic-corroded plagioclase and magmatic corroded quartz. The microaplitic, distinctly oriented groundmass is composed of biotite, quartz and xenomorphic plagioclase.

Biotite microdiorites constituting mafic enclaves have been found in the drillhole KV-3. The rock consists of lath-shaped plagioclases and biotite as well as minor amounts of quartz, amphibole, K-feldspar and accessory minerals.

Granitoid rocks of the 2nd phase

These rocks include leucovarieties of biotite granite-porphyries of monzogranite to syenogranite composition, biotite leucogranites rich in medium-grained K-feldspar, aplites as well as aplitic rocks whose composition corresponds to alkali-feldspar granite (alaskite) — found in the drillhole Ro-3.

Leucogranite-porphyries, in contrast to the 1st-phase granite porphyries, have phenocrysts richer in K-feldspar relative to plagioclase, with diverse proportions of the individual minerals in the phenocrysts as well as variable phenocryst/groundmass ratio. The crystallization degree of the groundmass in rocks of similar composition is also variable, which might be due to inhomogeneous distribution of fluid constituents during the melt crystallization. Following types are distinguished according to the crystallization degree of the groundmass:

— granite-porphyries with microaplitic groundmass and plagioclase, K-feldspar, quartz as well as biotite phenocrysts

— granite-porphyries with older fine-grained granitic and younger even finer-grained microaplitic matrix, and plagioclase, K-feldspar, quartz as well as biotite phenocrysts. The plagioclase II phenocrysts are idiomorphic to hypidiomorphic, 2—4 mm large. They surround the plagioclases I and biotite. Oscillation zonning is rare and indistinct, with spotted zoning being more abundant.

K-feldspars are hypidiomorphic, 2—4 cm large and form Carlsbad twins, whose twin plane is frequently disrupted. In places the K-feldspar is cataclastic-deformed and penetrated by a younger aplitic constituent composed of quartz, K-feldspar and plagioclase. Perthite occurs frequently. The quartz I is often deformed into spindle-shaped grains (Pl. 2, Fig. 2). Biotite scales are frequently chloritized. The fine-grained granitic groundmass consists of plagioclase III, K-feldspar II and quartz II, the latter postdating the first two minerals. The final crystallization stage is represented by fine-grained to very fine-grained groundmass composed of plagioclase IV, quartz III and K-feldspar III.

Intensive pressure locally took place during the crystallization of the groundmass, which resulted in deformation of the phenocrysts and oriented pattern of the groundmass.

Intensive hydrothermal alternation gave rise to sericitization of plagioclases, formation of carbonates and chloritization of biotite.

Medium-grained to fine-grained biotite leucogranites. This type is characterized by less abundant phenocrysts, with gradual transitions to the granite-porphyries. In comparison with the granite-porphyries, its groundmass is relatively coarser grained. The granites are leucocratic, rich in K-feldspar.

Granite-aplites to aplites form mostly thin veins cutting older granites and are composed of quartz, K-feldspar and oligoclase.

Alkaline-feldspar syenite aplite — aplite porphyry to alkali-feldspar granite aplite (alaskite) consists of very fine-grained groundmass of K-feldspar and quartz in aplitic development. Phenocrysts of xenomorphic K-feldspars are scarce.

Plate 1

Figs. 1, 2 — Granites of 2nd intrusive phase intruding Late Paleozoic metasediments, discordant relative to their foliation.
Fig. 3. — Granite veinlet of 2nd intrusive phase cutting marginal fine-grained hybrid biotite granite (with a mafic enclave) of 1st intrusive phase.

Plate 2

Fig. 1. — Principal type of coarse-grained porphyric biotite granite (diminished 2x).
Fg. 2. — Granite porphyry of 2nd intrusive phase, partly oriented-structured, with pulled out quartz I grains.
Fig. 3. — Plagioclase phenocryst in K-feldspar-plagioclase-quartz groundmass. Plagioclase basicity: light-coloured centre-49.5 % An, lighter fringe-30 % An, darker margin-17 % An. 1st intrusive phase. Scanning microscope photo — RNDr. D. Barátová.
Fig. 4. — Deformed phenocrysts of plagioclase, quartz and K-feldspar in oriented groundmass. 2nd intrusive phase. Scanning microscope photo K. Horák.

Plate 1

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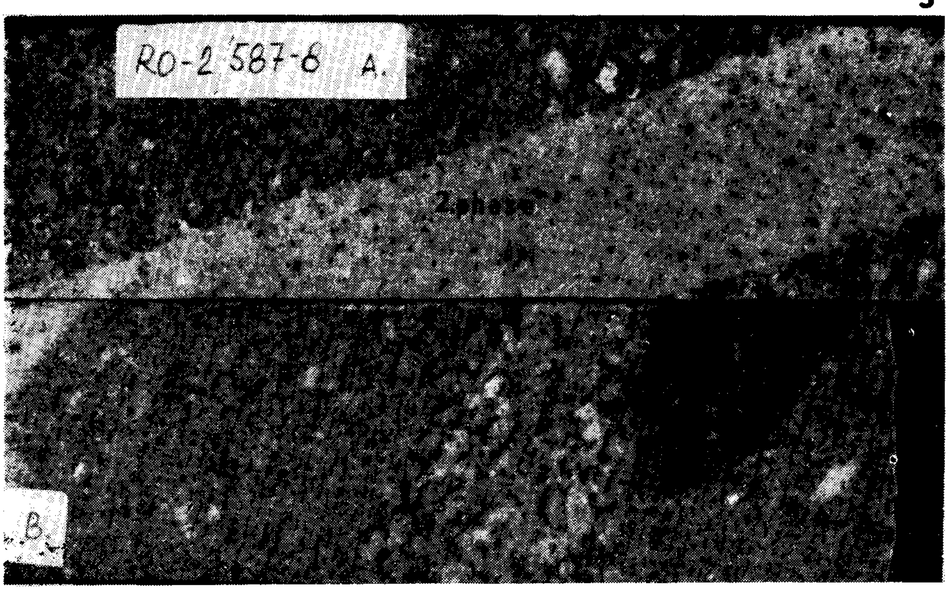
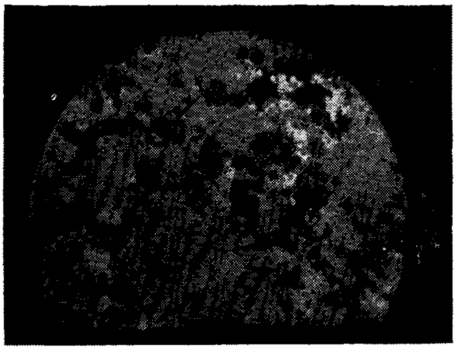


Plate 2



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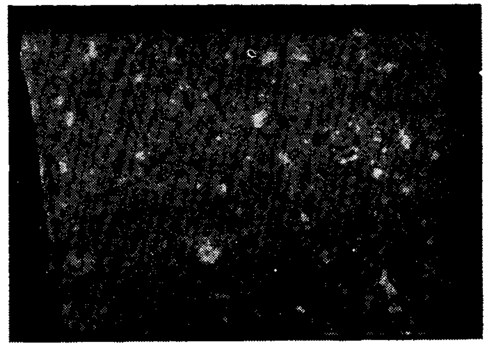

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Biotites

Biotite is an important petrogenetic indicator in granitoid rocks. For this reason we employed the electron microprobe JEOL JCX-733A to study the chemical composition of biotites from various above-described types of the 1st- and 2nd-phase granitoids. The chemical composition of the biotites is marked by a high, fairly constant Mg content. The $Fe_{tot}/Fe_{tot} + Mg$ ratio varies from 0.38 to 0.45 (on the basis of 18 analyses of biotites). Unlike Ď u r k o v i č o v á (1967) who has found that leucocratic granitoids of the West Carpathians are enriched in Fe, we have observed no such enrichment in the leucocratic granitoids studied. In comparison with biotites of the West Carpathian granitoids (data from Ď u r k o v i č o v á, 1967; P e t r í k, 1980), biotites of the Rochovce granites contain much more magnesium. This suggests different conditions under which the granites studied were formed. The difference is probably due to different temperature and oxygen fugacity, with Mg-richer biotites being more stable at higher temperatures and higher oxygen fugacity (W o n e s — E u g s t e r, 1965).

The biotites are frequently associated with magnetite or maghemite, K-feldspar, or are enclosed in plagioclases. Although the biotites were formed at different times within the mineral succession, we have observed no differences in their composition. Tab. 2 shows chemical compositions of the biotites,

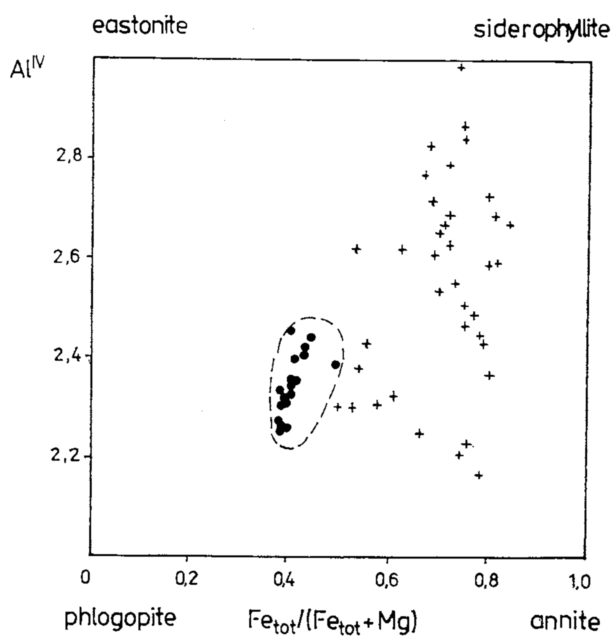


Fig. 3. Biotite composition in diagram eastonite-siderophyllite-phlogopite-annite. *Explanations:* solid circles - biotites from Rochovce granites, crosses - biotites from West Carpathian granitoids (data from Ď u r k o v i č o v á, 1967; P e t r í k, 1980).

Table 2

Biotite composition from Rochovce granites determined by a JEOL JCX-733A electron microprobe

	biotites from Rochovce granite							
drillhole	KV-3	KV-3	KV-3	KV-3	KV-3	KV-3	RO-2	RO-2
depth	896.50	896.50	896.50	1369.50	1369.50	1369.50	537.00	537.00
rock	HzG	HzG	HzG	HzG	HzG	HzG	GpjzaZh	GpjzaZh
phase	1.	1.	1.	1.	1.	1.	1.	1.
point location	margin		margin				centre	margin
point No.	1.	2.	3.	4.	5.	6.	7.	8.
SiO_2	37.90	37.09	37.21	36.75	35.56	36.34	38.13	37.89
TiO_2	3.48	3.69	3.79	3.06	3.38	3.47	3.12	3.07
Al_2O_3	13.81	14.19	13.62	13.74	13.76	13.46	14.17	14.05
FeO	15.84	17.57	16.47	16.83	16.47	16.56	15.43	15.38
MnO	0.28	0.33	0.26	0.93	0.91	0.68	0.38	0.34
MgO	14.11	13.10	13.66	13.36	13.56	13.34	14.15	13.97
CaO	0.00	0.04	0.01	0.08	0.07	0.00	0.00	0.00
Na_2O	0.05	0.09	0.10	0.09	0.12	0.08	0.13	0.12
K_2O	10.08	9.48	10.[illegible]	9.20	8.77	10.44	9.51	9.70
Cr_2O_3	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.01
Total	95.55	95.58	95.17	94.04	92.60	94.37	95.06	94.53
	recalculation to 22 oxygens							
Si	5.96	5.61	5.64	5.65	5.55	5.60	5.72	5.73
Al—IV	2.31	2.39	2.36	2.36	2.46	2.40	2.28	2.27
Al—VI	0.14	0.14	0.08	0.13	0.07	0.05	0.23	0.23
Ti	0.39	0.42	0.43	0.35	0.40	0.40	0.35	0.35
Fe 2+	1.99	2.22	2.09	2.16	2.15	2.13	1.94	1.94
Mn	0.04	0.04	0.03	0.12	0.12	0.09	0.05	0.04
Mg	3.16	2.95	3.09	3.06	3.15	3.07	3.17	3.15
Ca	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.00
Na	0.02	0.03	0.03	0.03	0.04	0.02	0.04	0.04
K	1.93	1.83	1.94	1.80	1.75	2.05	1.82	1.87
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Fe/(Fe + Mg)	0.39	0.49	0.40	0.41	0.41	0.41	0.38	0.38

Operated by RNDr. F. Caňo. All Fe as ferrous.

with biotites in points Nos. 2, 16 forming xenoliths in plagioclases, biotites in points Nos 11, 12 associated with plagioclase and quartz, biotites in points Nos. 17, 18 forming phenocrysts in the groundmass, and those in points Nos. 7, 8 enclosed in K-feldspar. Other biotites occur in association with K-feldspar and magnetite.

Accessory minerals

Study of thin-sections and concentrates of accessory minerals have revealed substantial differences between the 1st and 2nd intrusive phase regarding their presence, content and distribution.

Continuation of Tab. 2

biotites from Rochovce granite									
RO-2	RO-2	RO-2	RO-2	RO-5	RO-5	RO-6	RO-6	RO-6	RO-6
537.00	628.50	628.50	628.50	660.00	660.00	372.40	371.00	371.00	371.00
GpjzaZh	HzG	HzG	HzG	JzG	JzG	GpjzaZh	GpjzaZh	GpjzaZh	GpjzaZh
1.	1.	1.	1.	2.	2.	1.	1.	1.	1.
		centre	margin	centre	margin		centre	centre	margin
9.	10.	11.	12.	13.	14.	15.	16.	17.	18.
36.94	38.26	37.05	38.16	37.58	37.46	38.12	36.39	36.39	36.58
3.43	3.76	3.76	3.43	3.64	3.57	3.71	3.51	3.90	3.76
13.75	13.95	13.43	13.78	14.09	13.99	14.87	13.98	14.20	14.12
15.08	15.98	15.56	15.80	16.26	16.49	15.83	17.99	18.32	17.40
0.85	0.24	0.39	0.13	0.60	0.59	0.07	0.39	0.16	0.12
13.81	13.64	13.60	14.10	13.41	13.24	13.50	13.08	12.78	12.13
0.00	0.04	0.00	0.06	0.11	0.06	0.05	0.00	0.08	0.03
0.21	0.08	0.11	0.10	0.16	0.12	0.14	0.11	0.17	0.10
9.51	9.16	9.38	9.16	9.11	9.42	9.19	9.13	8.52	9.35
0.03	0.00	0.00	0.01	0.07	0.03	0.00	0.04	0.12	0.04
93.61	95.11	93.28	94.73	95.03	94.97	95.48	94.62	94.64	94.43
recalculation to 22 oxygens									
5.66	5.74	5.69	5.74	5.67	5.67	5.68	5.57	5.56	5.60
2.34	2.26	2.31	2.26	2.33	2.33	2.32	2.43	2.44	2.41
0.14	0.20	0.12	0.19	0.18	0.17	0.30	0.10	0.11	0.14
0.40	0.42	0.43	0.39	0.41	0.41	0.42	0.40	0.45	0.43
1.93	2.00	2.00	1.99	2.05	2.09	1.97	2.31	2.34	2.23
0.11	0.03	0.05	0.02	0.08	0.08	0.01	0.05	0.02	0.02
3.16	3.05	3.12	3.16	3.02	2.99	3.00	2.99	2.91	2.95
0.00	0.01	0.00	0.01	0.02	0.01	0.01	0.00	0.01	0.01
0.06	0.02	0.03	0.03	0.05	0.04	0.04	0.03	0.05	0.03
1.86	1.75	1.84	1.76	1.75	1.82	1.75	1.78	1.66	1.82
0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.01
0.38	0.40	0.39	0.39	0.41	0.41	0.40	0.44	0.45	0.43

The 1st intrusive phase with high magnetic susceptibility is characterized by a high magnetite content (1000—5000 g/t). Titanite, apatite and allanite are abundant, epidote occurs less frequently. Minor amounts of zircon, thorite (and/or uranothorite) as well as traces of ilmenite and garnet are also disseminated minerals of hydrothermal origin — pyrite, chalcopyrite, molybdenite, galena, sphalerite, fluorite, calcite. These minerals occur despite the fast that we do not regard the 1st intrusive phase as ore-bearing, or it deposited only mineralogical amounts of mineralization.

As regards the products of the 2nd intrusive phase, the situation is different. Within the rock series fine-grained granite — granite-porphyry — aplite (aplite porphyry) we have observed decreasing contents or absence of magnetite, allanite and titanite. On the other hand, these rock types contain disseminated Ti-U-REE mineralization in the form of accumulations of mutually intergrown irregular grains of rutile, brannerite-monazite-xenotime-apatite. These accumulations are usually 1—2 mm large, exceptionally larger. The prevailing rutile is characterized by an increased WO_3 content (up to 5 wt. %) and presence of SnO_2. The Ti-U-REE mineral aggregates become more abundant from fine-grained granites towards aplites and K-metasomatites. These minerals are conspicuous in light-coloured and pink varieties because their radioactivity gives rise to red colour of the surrounding rock.

There are clear differences in the presence of Ti, Th, U, REE in minerals, but mainly in magnetite content between the granitoids of the 1st and 2nd intrusive phase. The 2nd-phase rocks also contain increased contents of hydrothermal-stage minerals (molybdenite, chalcopyrite, pyrite, galena, sphalerite, fluorite). The molybdenite and pyrite constitute also disseminated mineralization and thin (several cm) veins with quartz or calcite, almost exclusively spatially associated with the products of the 2nd intrusive phase and with their exocontact.

These differences in the presence of accessories result in changes of some physical properties of the granitoid rocks of the 1st and 2nd intrusive phases — this regards mainly magnetic susceptibility and gamma activity. The presence or absence of magnetism in some parts of the intrusion thus become an important geophysical-prospecting criterion which may be employed to distinguish ore-bearing productive parts of the hidden Rochovce monzogranite intrusion.

Employed classifications

The modal composition of the granites from the drillholes near Rochovce illustrated in Streckeisen's (1967) QAP diagram shows that the studied rocks correspond to monzogranites, and the most important variations in the rock composition of the granites of the 1st and 2nd intrusive phases are caused by different quartz/K-feldspar ratios, with fairly constant plagioclase content. The granites and granite porphyries of the 2nd intrusive phase contain lesser amounts of mafic minerals. Their composition is closer to the syenogranite field. To determine the modal composition of the rocks, we have used planimetry of polished coloured polished-sections for coarse-grained types, and point planimeter for fine-grained varieties. The modal composition of the rocks is shown in Tab. 3.

For the classification of the rocks based on their chemical composition with application of mesonormative calculation (Mielke—Winkler, 1979) we used the Q'-ANOR diagram (Streckeisen—Le Maitre, 1979) which provides information similar to that of modal composition diagram. In the sense of mesonormative classification, most samples correspond to monzogranites and only a small part is represented by granodiorite, even less frequently by syenogranite to alkali-feldspar granite (Fig. 5). Some samples, mainly those of vein differentiates, had a substantially increased SiO_2 content.

Table 3

Modal composition of Rochovce granites

drill-hole	depth m	quartz	K-feldspar	plagioclase	biotite	ore minerals	titanite	apatite	chlorite	sericite	albite	measured area (cm²) / number of points	petrographic denomination
KV-3	723.5	31.0	29.5	32.7	6.2	0.6	+	+	—	+		25	coarse-grained porphyr. granite
	896.5	26.6	34.9	32.6	5.3	0.5	0.04	+	—	+		22	coarse-grained porphyr. granite
	1353.5	25.0	27.8	36.8	9.7	0.7	+	+	—	+		15	coarse-grained porphyr. granite
	1369.5	23.5	43.0	26.4	6.0	1.0	0.08	+	—	+		24	coarse-grained porphyr. granite
	1502.5	39.1	23.2	30.0	7.1	0.5	+	+	+	+		22	coarse-grained porphyr. granite
Ro-2	510—514	37.3	26.8	34.1	1.3	0.3	—	+	+	+	+	2110p.	granite porphyry
	565.5	34.3	43.5	20.6	1.5	0.1	—	+	+	+	1.5	15	aplitic granite
	607—608.2	21.1	38.0	35.7	3.0	2.3	+	+	+	+	+	10	granite porphyry
	632.5	32.2	34.3	28.4	4.4	0.7	+	+	—	+	+	23	medium- to coarse-grained granite
Ro-3	712.4	33.8	35.6	29.9	—	0.1	—	+	0.4	+		2210p.	granite porphyry
Ro-5	559.5—561.3	33.6	29.9	30.2	5.0	0.6	+	0.04	0.1	0.4		2500p.	granite porphyry
	577.5—578	35.4	45.4	16.4	0.7	0.2	—	+	0.4	+		15	medium-grained aplitic gran.
	612.3—613.8	33.5	29.5	33.9	2.01	0.4	—	+	0.2	+		2100p.	granite porphyry
	649.7—650	31.9	36.6	30.0	1.3	0.2	—	+	+	+		14	medium-grained aplitic granite

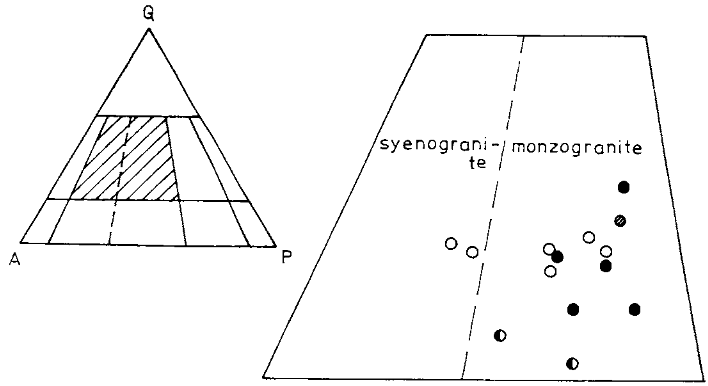


Fig. 4. Classification diagram of QAP modal composition (Streckeisen, 1967). For explanations see Fig. 5.

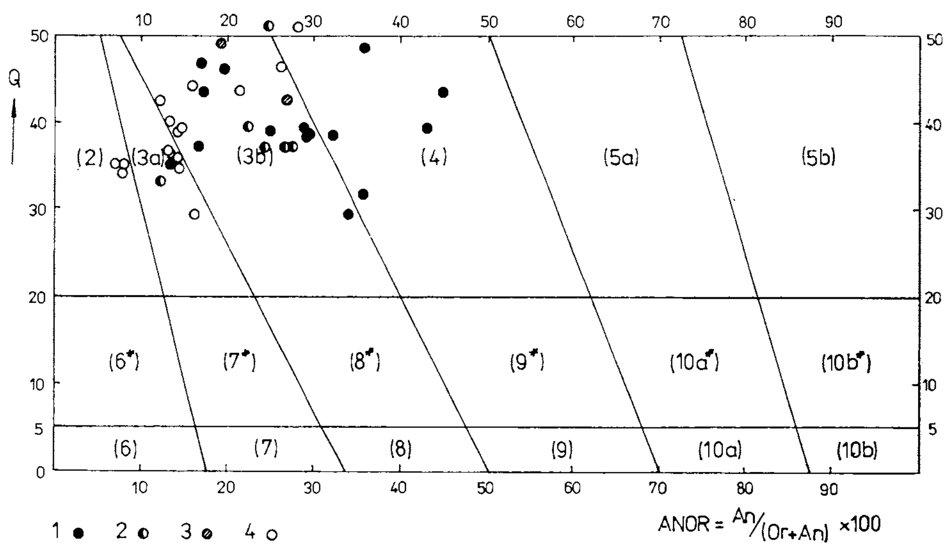


Fig. 5. Q′-ANOR classification diagram (Streckeisen — Le Maitre, 1979). Data are obtained by mesonormative recalculation.
Fields: 2 — alkaline-feldspar granite, 3a — syenogranite, 3b — monzogranite, 4 — granodiorite.
Symbols: 1 — granites of 1st intrusive phase, 2 — K-feldspar-rich granites of 1st intrusive phase, 3 — undivided acid vein differentiates, 4 — granites of 2nd intrusive phase.

Petrochemistry

Despite the fact that in most cases the drilling intersected only the apical part of the body, the variation diagrams of the main elements versus SiO_2 (Fig. 6) indicate considerable variability in the chemical composition which reflects intensive differentiation processes within the magmatic melt. We may state that increased SiO_2 content corresponds to lower contents of TiO_2, Al_2O_3, Fe_2O_3, FeO, MgO, CaO and MnO. Na_2O content is fairly constant in the differentiation process. The K_2O/SiO_2 ratio is interesting — K_2O content, plotted against increasing SiO_2, rises until it reaches 5—6 % corresponding to 74—75 % SiO_2. At SiO_2 values over 74—75%, K_2O content begins to drop and predominantly silicification takes place. SiO_2 content in the granites of the 1st phase is lower than that of the 2nd phase. The 2nd phase granites are fairly acid differentiates. with SiO_2 content in excess of 74 %, except for the hybridized varieties. Greater variations of some macroelements can also be observed in these high-silica rocks, the fact that might be related to their occurrence near the metamorphic

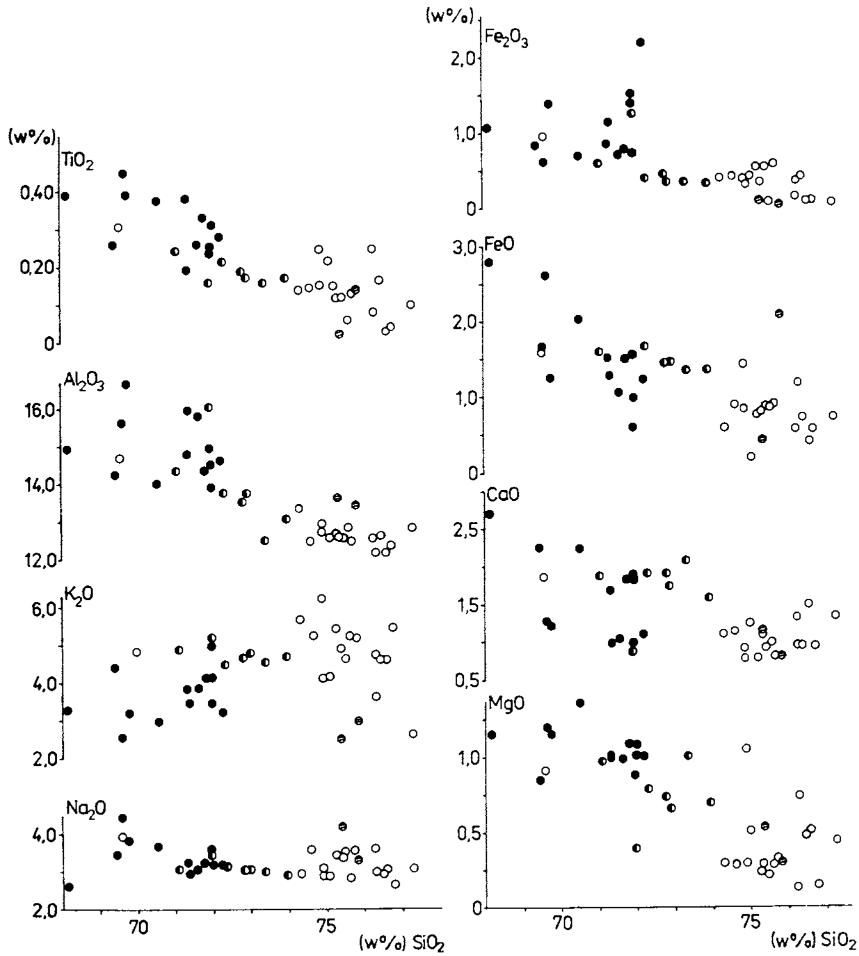


Fig. 6. Variation diagram SiO_2 versus TiO_2, Al_2O_3, K_2O, Na_2O, Fe_2O_3, FeO, CaO, MgO in Rochovce granites.

For symbols see Fig. 5.

mantle of the granite intrusion and irregular assimilation phenomena, or the melt saturated by volatile components could have differentiated into potassium--rich and silica-rich constituents. The effects of the volatile components may, in a granite system, result in the immiscibility of acid melts and their differentiation (Glyuk — Skhmakin, 1986) under conditions close to the pegmatite stage. This can clear up the existence of high-silica low-potassium rocks along with the high-potassium rocks of the 2nd intrusive phase.

Two- to three-times higher F and Cl contents in the granites of the 2nd intrusive phase (Tab. 4a) in comparison with the granites of the 1st intrusive phase suggest that during the final stages of the differentiation, the fluid regime was characterized by increased contents of these components in the fluid phase, the fact which is likely to have played an important role by the formation of ore accumulations.

Compared to the average assays of macrocomponents of the West Carpathian granites (Cambel — Walzel, 1982), the Rochovce granites of the 1st and 2nd phase contain on average more K_2O and FeO and less Na_2O and Fe_2O_3.

In the differentiation process, Ba, Sr, V, Co, Zn, Zr, Cu, Li, Nb? Y, light TR behaved like compatible elements, their contents in the rocks of the 1st intrusive phase being higher than those of the 2nd intrusive phase. U, Pb, Ta, Sc, Be, heavy TR behaved as incompatible elements with tendency to accumulate in the residual melt. Th, Cr, Ni, Rb, Cs contents show no marked variations.

Table 4a

Average values of chemical composition of Rochovce granites

	I. intrusive phase				II. intrusive phase			
wt. %	$\bar{x}$	min.	max.	number of samples	$\bar{x}$	min.	max.	number of samples
SiO_2	71.43	66.25	74.32	22	75.37	69.55	77.24	16
TiO_2	0.28	0.14	0.59	22	0.14	0.03	0.31	16
Al_2O_3	14.51	12.49	16.68	22	12.67	12.03	14.71	16
Fe_2O_3	0.89	0.35	2.23	22	0.38	0.09	0.99	16
FeO	1.53	0.61	2.80	22	0.90	0.44	1.58	16
MgO	0.89	0.09	1.40	22	0.43	0.13	1.05	16
CaO	1.68	0.88	2.78	22	1.11	0.78	1.88	16
MnO	0.05	0.017	0.12	22	0.02	0.006	0.049	16
Na_2O	3.23	2.58	4.45	22	3.21	2.63	3.93	16
K_2O	4.09	2.53	5.62	22	4.68	2.59	6.20	16
H_2O^-	0.13	0.02	0.43	22	0.21	0.06	0.43	16
H_2O^+	0.54	0.12	2.01	22	0.41	0.15	0.74	8
SO_3 tot.	0.13	0.09	0.50	11	0.07	0.04	0.33	16
CO_2	0.57	0.41	1.06	11	0.46	0.28	0.92	16
P_2O_5	0.20	0.02	0.43	22	0.05	0.03	0.11	16
F	0.013	0.005	0.21	11	0.027	0.001	0.07	16
Cl	0.0023	0.002	0.04	11	0.0062	0.002	0.10	15
Total	99.73				99.87			

Table 4b

Average values of chemical composition of Rochovce granites

	I. intrusive phase				II. intrusive phase			
ppm	x̄	min.	max.	number of samples	x̄	min.	max.	number of samples
Ba	963	339	2818	18	166	36	267	14
Sr	354	220	560	18	108	40	200	14
V	49.8	23	76	18	20.7	10	35	14
Cr	44	37	54	7	49.6	39.5	66	10
Co	3.92	2.51	7.24	7	1.75	1.17	2.14	10
Ni	6	3	14	18	6.9	2	18	14
Zr	87.9	7	197	18	74.7	54	111	14
U	7.34	4.58	9.49	7	12.04	6.07	17.6	11
Th	31.3	24.6	45.9	7	32.08	28.8	35.6	10
Zn	31.3	11	55	18	19.5	12	27	14
Pb	25.5	2	45	18	28.3	2	57	14
Cu	10	1	48	18	5.1	1	20	14
Nb	41.9	20	78	16	n. a.			
Ta	1.38	0.95	1.78	29	2.67	1.12	4.32	11
Rb	200	138	297	18	186	110	240	15
Li	23.7	12	51	12	12	5	35	15
Cs	5.7	4.6	7.3	7	5.4	4.3	7.3	10
Be	3.3	2.3	5.1	23	4.1	2.8	5.9	19
Sc	6.8	2.2	12.3	23	7.5	6.26	10.2	11
Y	26.9	11	44	10	16.9	11	25	7
Mo	4.0	3	10	10	7.2	3	25	14
W	3.0	3	5	10	7.4	3	30	14

The average Rb/Sr ratio in the rocks of the 1st intrusive phase is 0.56, whereas in those of the 2nd intrusive phase it amounts to 1.72. This rise can be explained mainly by the fractionation of plagioclase which results in the increased Rb/Sr ratio in residual melt (Hanson, 1978). Similarly, the Sr/Ba ratio in the rocks of the 1st intrusive phase (0.37) is lower than in the 2nd intrusive-phase rocks (0.65), which is mainly due to the biotite fractionation (Hanson, l.c.).

Compared to the average data on trace elements in the West Carpathian granites (Cambel — Medveď, 1981), the Rochovce granites are on average richer in V, Cr, Ni, Pb, Cu, Sc, Y and on the other hand contain less Zr. The Rochovce granites contain more alkalies — Rb, Cs (mainly Rb) than the average West Carpathian monzogranites (Cambel — Martiny — Pitoňák, 1983), the feature in which the former resemble the Gemeric Granites.

In comparison with the other West Carpathian granites, the Rochovce granites are very distinctly enriched (two- to three times) in U and Th (Kátlovský, 1982), with the two elements behaving quite differently in the process of differentiation. Both these elements are bound predominantly to accessory minerals. In the granites of the 1st intrusive phase these elements occur in allanite and titanite as well as in their own mineral phase-uranothorite. In the granites of the 2nd intrusive phase, Th is bound mainly to monazite, whereas

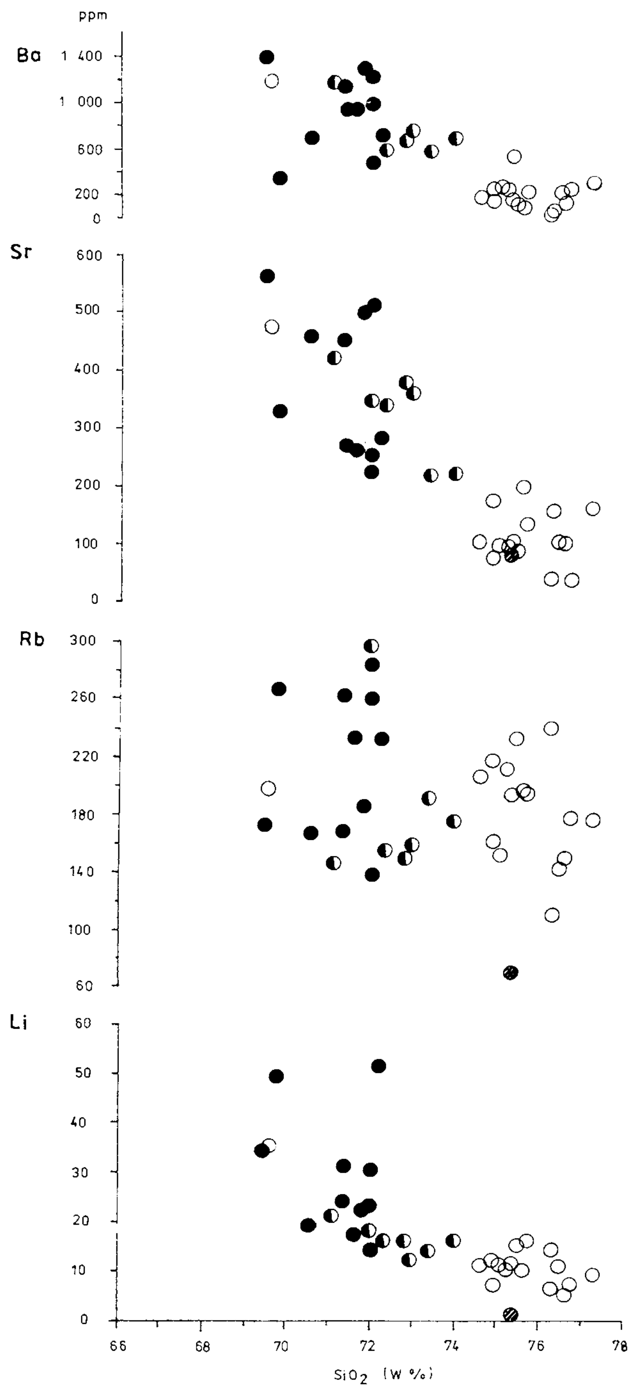


Fig. 7. Variation diagram SiO_2 versus Rb, Ba, Sr, Li in Rochovce granites. For symbols see Fig. 5.

U occurs predominantly in its mineral — brannerite. Generally, the trend of increasing U contents towards the granites of the 2nd intrusive phase is fairly distinct.

Rare earths

The compatibility of light rare earths is responsible for the fact that they are depleted in the residual melt in the course of differentiation. In contrast, heavy rare earths are slightly enriched in the rocks of the 2nd intrusive phase. A weak negative anomaly in the granites of the 1st phase increases in the granites of the 2nd intrusive phase, which might be due to the fractionation of plagioclases. The distribution coefficient plagioclase/melt for Eu depends on the oxidation potential in the environment concerned (D r a k e — W e i l l, 1975). The overall drop in the rare earth contents from the granites of the 1st intrusive phase towards those of the 2nd intrusive phase can be explained mainly by the fractionation of allanite.

Rocks of the 1st intrusive phase have increased contents of rare earth elements in comparison with the West Carpathian granites (data after H o v o r k a — S p i š i a k, 1983). Only several rare earth analyses from the Bratislava Massif (C a m b e l — V i l i n o v i č, 1987) attain values comparable with the TR values in the Rochovce granites. The average contents of rare earths in the granites of the 1st and 2nd phases are shown in Tab. 5. Some analyses of the 1st-phase granites have been taken from I v a n o v (1984).

T a b l e 5

Average contents of rare earths in Rochovce granites

content in ppm	I. intrusive phase					II. intrusive phase			
	$\bar{x}$	min.	max.	number of samples		$\bar{x}$	min.	max.	number of samples
La	64.6	47	118	19	La	18.7	14.1	24.3	10
Ce	129.90	92.5	215	19	Ce	47.2	35.5	60.1	10
Sm	9.70	7.2	17	19	Sm	5.2	3.7	6.9	10
Eu	1.70	1.3	2.5	19	Eu	0.72	0.54	0.84	10
Tb	1.40	0.74	2.27	19	Tb	1.7	1.33	2.02	10
Yb	2.90	2.2	4.3	19	Yb	4.1	3.08	4.89	10
Lu	0.50	0.24	0.78	19	Lu	0.65	0.42	0.84	10

Complete analyses are given in V á c l a v et al. (1988).

Increased contents of lithopile elements with large ion radii — K, Rb, Th, U, light rare earths etc. and also increased Nb, Ta contents in granitoids are regarded by some authors as a sign of "maturity" of the magmatic arc (B r o w n et al., 1984).

The Rochovce granites are mostly of peraluminous character (Fig. 9) less frequently of metaaluminous one (molar Al_2O_3/ ($CaO + Na_2O + K_2O$) >, < 1; according to S h a n d, 1927 in C l a r k e, 1981). This predominantly peraluminous character of the Rochovce granites may be partly caused by abundant postmagmatic alterations, although its formation due to the fractionation of amphibole from metaaluminous magma during the early stages of its differentiation cannot be excluded (C a w t h o r n — B r o w n, 1976). This differentiation results in the formation of the monzogranites of the 1st intrusive phase and amphibole occurs sporadically in plagioclases or in cluster with biotite.

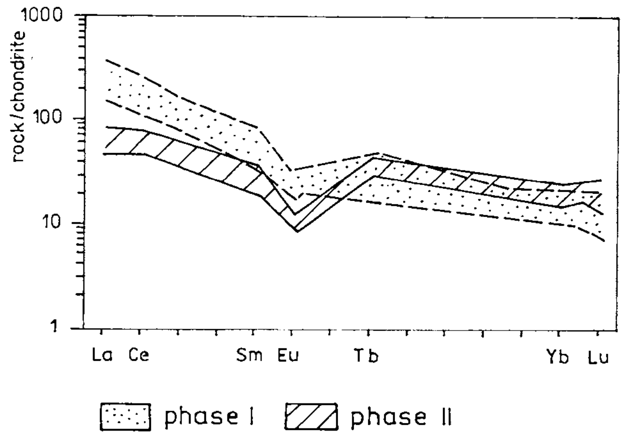


Fig. 8 Rock/chondrite diagram for REE. Maximum and minimum values in granites of 1st and 2nd intrusive phase are illustrated. Coefficients from B o y n t o n in H e n d e r s o n (1984).

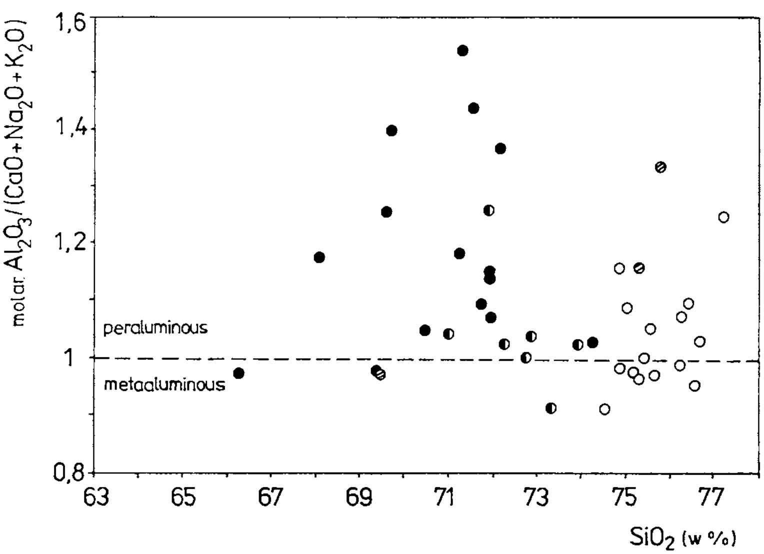


Fig. 9. Discrimination diagram SiO_2 versus molar Al_2O_3 $CaO+Na_2O+K_2O$) for peraluminous and metaaluminous granites (after S h a n d, 1927 in C l a r k e, 1981). For symbols see Fig. 5.

To assign the Rochovce granites to a certain magmatic series we applied the $K_2O + Na_2O$ versus SiO_2 diagram (K u n o, 1969) which, despite considerable dispersion of its values, suggests that the investigated granites fall into the calc-alkaline suite.

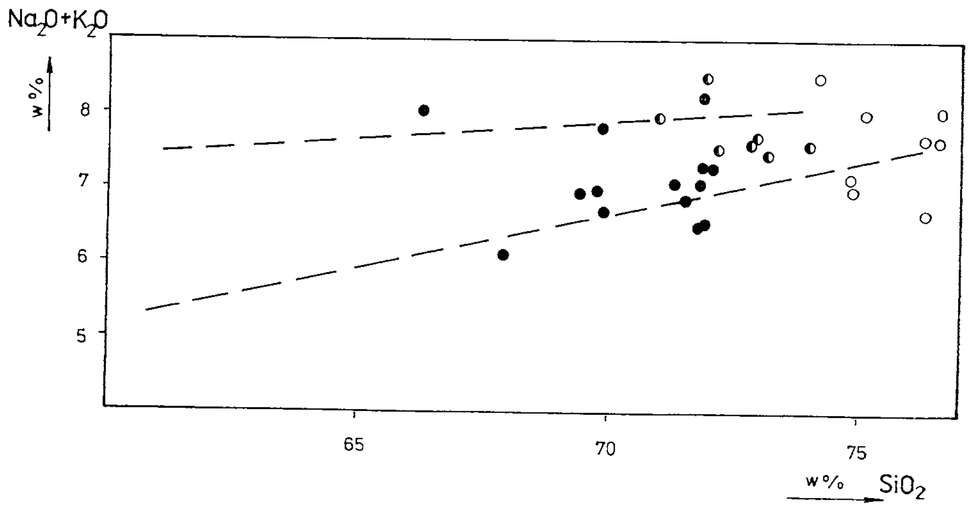


Fig. 10. Diagram SiO_2 versus Na_2O+K_2O (K u n o, 1969). Dashed lines confine field of calc-alkaline eruptives.
For symbols see Fig. 5.

The P e a c o k's (1931) index determined by graphic extrapolation is approximately 61—62 and corresponds to the transition between the calc-alkaline and lime suite. This assignation to a certain magmatic suite, however, is fairly inaccurate because of the absence of analyses of more mafic rock members of the Rochovce intrusion as well as considerable dispersion of the total values of alkalies at constant SiO_2 content, the fact related to local K-metasomatism.

Relationship of the granite intrusion to Mo-W mineralization

The relationship between the Mo-W mineralization and the granite intrusion at Rochovce, including zoning; is determined by the "productive" and ore--bearing 2nd intrusive phase which penetrated into the area of the drillhole Ro-3, and/or further to the south (Figs. 1, 2). Neither its shape, nor its vertical continuation are known for the time being. We assume that it may be a dome of an idenpendent stock (?). Mineralization manifestations and surficial secondary aureole suggest that the 2nd intrusive phase is elongated in the NE-SW direction roughly following the first-order Ľubeník-Margecany line on the SE flank of the "Rochovce" intrusion.

The Mo-W mineralization verified so far by drilling is developed at the endo- and exocontact of an intrusion of line-grained pink granites, granite porphyries and/or aplitic granites probably forming the dome of an assumed stock.

The Mo mineralization in these rocks occurs in the form of disseminations (isometric clusters of molybdenite 1—3 mm large) or thin monomineral molybdenite stringers and quartz-molybdenite ± pyrite veins. The W mineralization has not been found in the granitoid rocks themselves. In the area explored by drilling, stockwork-type Mo-W mineralization at the endocontact formed of Late Paleozoic metasediments is of prime importance. In the lower part there is a Mo-zone, in places with gradual transitions between the granite and metasediments. It consists of a network of quartz-molybdenite ± pyrite (carbonate) stringers, their thickness amounting to 0.5—3 cm, rarely more. 2—3 mineralization stages with molybdenite are present. The older stringers mostly consist of quartz and molybdenite fringed by sericite. The amount of the sericite decreases over time and distance from the intrusions.

The W zone is linked to the Mo one, but these two zones may also be spatially divided. The former overlaps the sulphidic, mainly pyrite zone. Wolframite dominated by ferberite member is present. MnO content is up to 4 wt. % and a high MgO content of up to 6 wt. % is characteristic. The wolframite content locally decreases in favour of scheelite, locally the former may be completely replaced by the latter. The W mineralization occurs in quartz-pyrite (pyrrhotite) ± carbonate veins.

,According to the classification proposed by Mutschler — Wright — Ludington — Abbott (1981) based on petrological evaluation of source granitoid rocks which distinguished two principal groups of stockwork molybdenite systems:

— granodiorite molybdenite systems

— granite molybdenite systems

we assign the "Rochovce" hidden Mo-W productive intrusion to the granite Mo-systems.

The above-mentioned authors state that such systems are associated with:

— small epizonal rhyolite porphyries (Climax, Henderson-Urad etc.)

— granite porphyries (deposits in Idaho, Montana, Colorado etc., both types are associated with similar plutons)

— fairly large stocks of aplite porphyries and granite porphyries (deposit Questa, New Mexico).

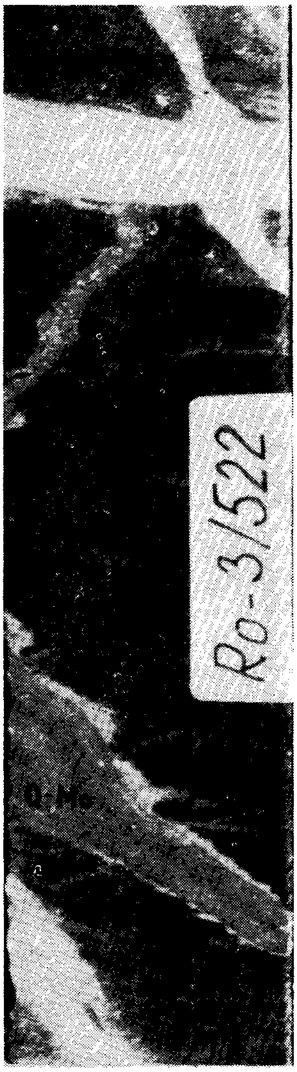
Generally, they are small cylindrical granites, or rhyolite porphyries whose typical dimensions are 0.5—1.5 km and known vertical range to 2 km or more. Geophysical measurements suggest that the granites usually form domes above silica-rich batholiths with the following typical zoning of their mineralization:

1. molybdenite zone forming stockwork quartz-molybdenite-fluorite veins;

Plate 3

Figs. 1, 2, 3 — Generations of quartz-molybdenite ± pyrite veins and/or barren quartz veins at exocontact of granites of 2nd intrusive phase.
Fig. 2. — Hydrothermal granite breccia at contact with metasediments subsequently infilled by quartz and molybdenite.
Fig. 3. — Molybdenite mineralization in fractures in fine-grained granite of 2nd intrusive phase with disseminated Ti-U-TR mineralization (rutile, brannerite, monazite, xenotime, apatite).
Fig. 4. — Disseminated molybdenite mineralization in fine-grained grained granite of 2nd intrusive phase with younger quartz veins.

Plate 3



1

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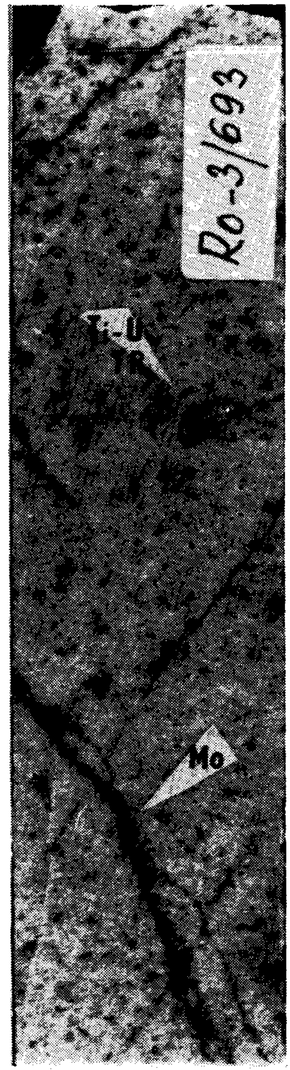

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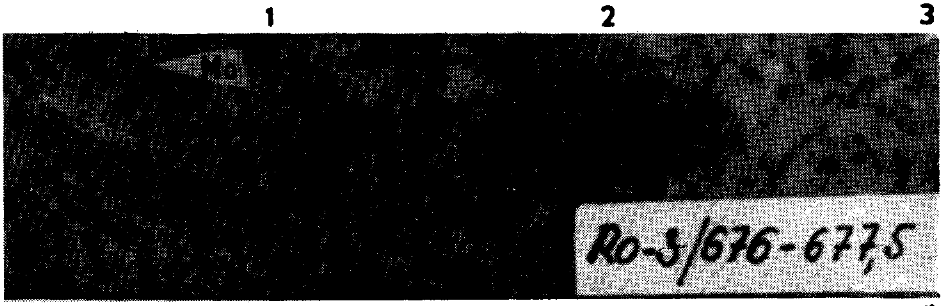

4

2. tungsten zone generally containing huebnerite in quartz-pyrite ± molybdenite veins;

3. pyrite and base-metal sulphides in higher zones.

The tungsten mineralization always overlies the molybdenium one and these two mineralizations may partly overlap each other. The geometry of the two zones in roughly the same. We may state that the situation at Rochovce is very similar to this generalized model. The situation is well characterized by the generalized spatial-time development scheme on stockwork molybdenium deposits (Fig. 11). In our case, the hydrothermal activity was concluded by

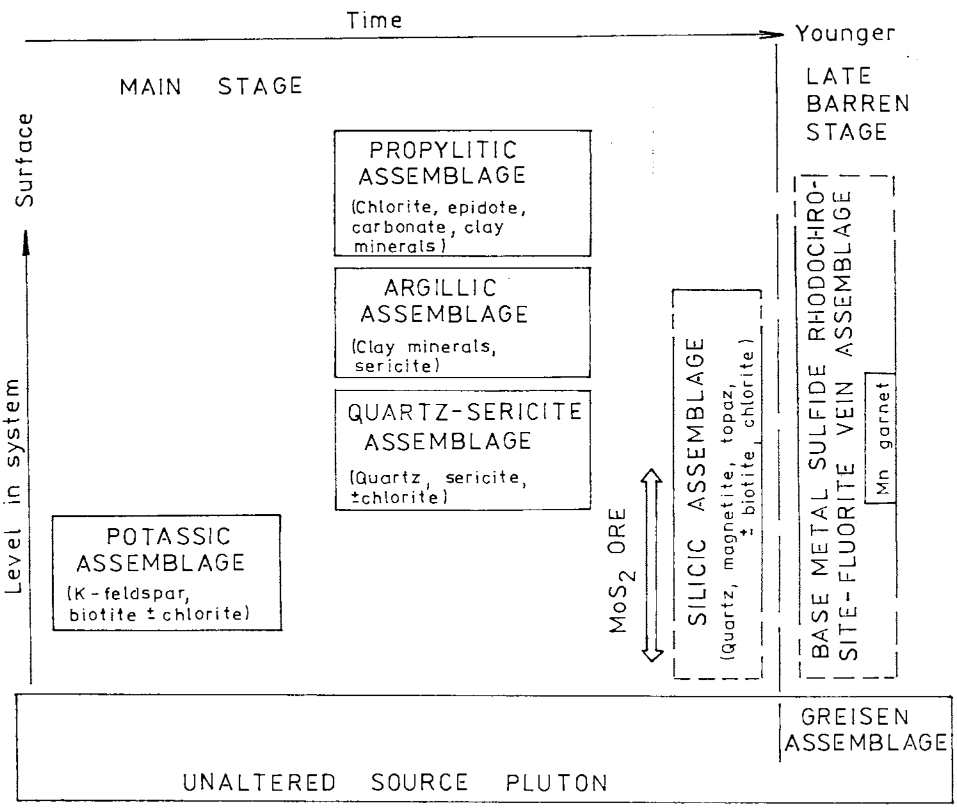

Fig. 11. Spatial-time development scheme for molybdenium deposits (after Mutschler et al., 1981).

quartz-fluorite-galena-sphalerite-calcite veins in the granite endocontact as well as near exocontact. Away from the contact, only quartz-fluorite-calcite and chlorite-calcite veins occur. To characterize the magmatic suite of the granitoid rocks in more detail we applied, apart from the above-mentioned classifications, also the classification proposed by Westra — Keith (1981). As the principal criterion we used the $K_{57.5}$ index, which is essentially a modified alkaline-lime index (Peacok, 1931). The $K_{57.5}$ index is expressed by the trend of K_2O/SiO_2 ratio at a constant SiO_2 value of 57.5 wt. % in rocks of the particular magmatic suite. The value of the index also has a direct relationship to F content in rocks (Fig. 12). For the Rochovce intrusion (1st and 2nd intrusive phase) we have calculated the value $K_{57.5} = 3.0$ for a set of 38 analyses. For a narrowed set of 36 analyses (two anomalous analyses were omitted) we have calculated the value $K_{57.5} = 2.0$. This value indicates that the Mo stockwork mineralization near Rochovce belongs among calc-alkaline deposits or among those transitional to alkali-lime ones (Fig. 12). This assignation is confirmed

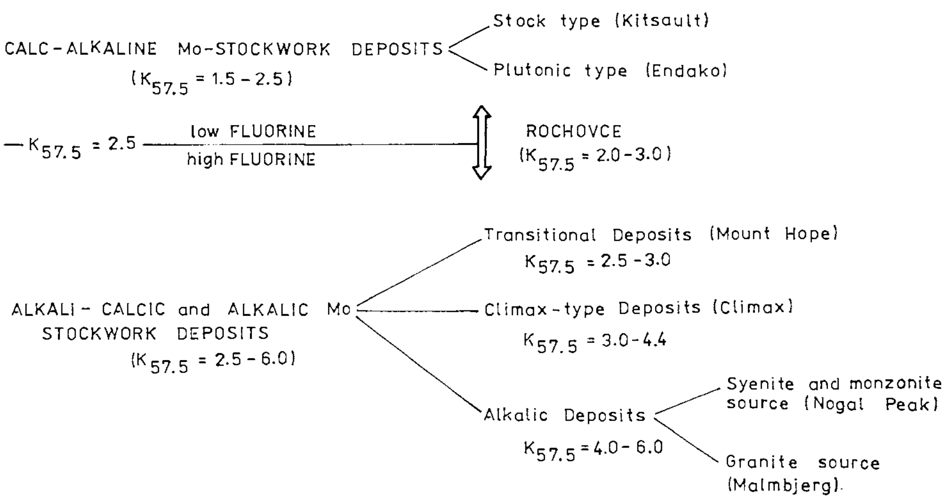

Fig. 12. Relationship of Rochovce Mo-bearing intrusion to calc-alkaline and alkali--lime to alkaline Mo-stockwork-type deposits according to $K_{57.5}$ index (after Westra — Keith, 1981).

also by the $K_2O + Na_2O/SiO_2$ ratio in the investigated rocks (Kuno, 1969; Fig. 10). If we compare also other characteristics of Mo stockwork deposits (Westra — Keith, 1981), some of which we take over (Tab. 6) with the characteristics of the Mo mineralization at Rochovce, this similarity is even more distinct. Of great importance is the emplacement of the Rochovce intrusion and associated Mo mineralization into the compression zone of the continenetal plate margin of the Cretaceous Carpathian orogen, whose part is also the investigated territory (Tomek et al., 1989). The southern block was overthrust onto the Variscan-consolidated block with granitoid plutons positioned in the north. The Veporicum here is likely to represent a cross-crustal collision scar, probably Late Cretaceous in age, seismically as well as tectonically comparable with that of the Paleozoic collision orogen in the Appalachian Mts. or with the structure of the main central overthrust fault in the Himalayas (Tomek et al., 1989). This process could have led to subsequent intrusion of Cretaceous (?) Mo-specialized granitoids (K/Ar dating yielded ages of 88 and 75 m.y. Kantor — Rybár, 1979) from lower crustal horizons into this zone. In the years ahead, further similar intrusions will be probably discovered in this area.

Table 6

Comparison of Mo (W) mineralization at Rochovce with characteristics of Mo stockwork deposits (Westra-Keith, 1981)

	Calc-alkaline molybdenum stockwork deposits			Alkali-calcic and alkalic molybdenum stockwork deposits		
	Stock type	Plutonic type	Rochovce Intrusion (1. and 2. phase)	Climax type	Alkalic type Quartz-deficient source rock	Leucogranite
magma series	calc-alkalic; high K calc-alkalic		calc-alcalic	high K calc-alkalic; alkali-calcic	alkali-calcic; alkalic	
K 57.5 range		1.5—2.5	2.0—3.0	2.5—4.4	4.0—6.0	
geotectonic setting	compressive continental plate margin	compressive continental plate margin	compressive cont. plate margin	subduction-related continental back-arc spreading environment	continental back-arc spreading environment;	continental back-arc spreading environment intracratonic rift zone; rifts associated with opening of oceans; hot spots
cogenetic igneous rocks	quartz monzonite granite alaskite aplite	granodiorite quartz monzonite granite alaskite aplite	granite granite-aplite aplite alaskite	rhyolite-quartz latite granite-aplite $K_2O > 5\%$ $SiO_2 > 75\%$	monzonite-syenite $K_2O + Na_2O > 10\%$ SiO_2 61—65%	leucogranite $K_2O > 5\%$ SiO_2 73—76 %
porphyry texture	yes	yes and no	yes and no	yes	yes and no	yes
petrochemistry						
TiO2 %	> 0.2	0.1—0.2	0.28—0.14	< 0.2	> 0.5	< 0.1
Rb ppm	150—350	100—350	200—189	200—800	no data	> 200
Sr ppm	300—800	100—800	354—108	< 125	no data	< 100
Nb ppm	< 20	< 10	42—?	25—> 200	> 100	15—140

chemistry hydrothermal system						
max. Mo content in tons (est.)	300.000	1.600.000	prognos 150.000	2.000.000	Small	350.000
MoS2 % in ore zone	0.1—0.25	0.1—0.20	0.25—0.1	0.2—0.49	< 0.3	0.25—0.30
max. F content %	0.1—0.25	0.05—0.15	0.3—0.05	0.5—2	no data	1—> 5 %
important elements	Mo-W-Cu	Mo-Cu-(W)	Mo-W	Mo-F-W-Sn-Zn-Ag--Pb-Cu-U	Mo-F-Sn-W	Mo-F-Sn-W-(Bi)-(As)
HF/HCl ratio in fluid	low	low	?	high	no data	No data
multiple ore shells	no	no	no	common	no data	yes
examples	Kitsault Hall Buckingham	Endako Adanac Quartz Hill? Mt. Tolman East Kounrad	Rochovce	Climax Urad-Henderson Mt. Emmons Pine Grove Questa Mt. Hope Glacier Gulch. transitional	Three Rivers stock Rialto stock	Cave Peak Malmbjerg Bordvika? Mt. Pleasant

The presence of petrographic rocks types of the 1st but mainly 2nd intrusive phase as well as presence of porphyric structures also well correspond to the characteristics of calc-alkaline Mo stockwork deposits (W e s t r a — K e i t h, pers. comm.). Our investigations, however can be based mainly on petrochemistry (TiO_2, Rb, Sr, Nb), on similarity in the chemistry of the hydrothermal system as regards assumed Mo and molybdenite contents in the ore zone as well as content of F (Tab. 6). The comparison clearly indicates similarity to calc-alkaline stock types but also plutonic types of Mo stockwork deposits. The distribution of the mineralization in the plutonic types is usually irregular and linkage to individual intrusive phases is not invariably unequivocal. At such deposits, mineralization is controlled predominantly significant structures and intrabatholith contacts. In some cases, the mineralization can also be related to small satellite stocks (W e s t r a — K e i t h, 1981). On the contrary, the ore zone of the stock-type deposits has the shape an overturned shell (glass). The presence of brecciated zones — pipes may significantly influence the ore distribution in this type. Although the facts observed at Rochovce suggest rather the latter type, there is not sufficient information available to make final evaluation.

Discussion

The granites of the 1st intrusive phase are coarse-grained- to large-grained--structured with abundant phenocrysts of rosy potassic feldspars. The crystallization history of these granites was fairly long and polystage. The granite intruded into relatively high crustal levels, the fact indicated also by measurements of PT conditions of contact metamorphism in the neighbourhood of the Rochovce intrusion. The values observed are: T = 450—490 °C and P = 100—150 MPa (K o r i k o v s k y et al., 1986). The long crystallization history of the granite (W h i t n e y, 1988) and its ability to ascend into higher crustal horizons (C a n n, 1970) suggest that the granite magma, from which the Rochovce granites were formed, was fairly high-temperature, water-unsaturated one. The fairly high temperature of the magma is indicated also by magnesium-rich biotites, the composition of which is almost constant throughout the granite crystallization history. Similarly, also plagioclase cores, whose basicity attains 48—49 % An, suggest the relatively high initial crystallization temperature. The oscillation zoning of the plagioclases, which is formed when the growth rate of crystals is higher than the diffusion rate in magma (S i b l e y et al., 1976), was caused predominantly by the fact that the melt was water-unsaturated.

We assume that the younger differentiates (represented mainly by the 2nd intrusive phase) contained more water in the melt, and its distribution in the melt may have been considerably irregular. Abundant occurrences of the granite porphyries, which frequently contain rounded (magmatic-corroded) quartz phenocrysts, suggest a low water content in the magmatic melt during the phenocryst growth. The phenocrysts were subsequently corroded in the course of the ascending of the melt. By the rapid ascending due to isothermal decompression (W h i t n e y, 1988), fine groundmass began to crystallize and at the same time the residual melt became water-saturated. On the other hand, the presence of medium- to fine-grained granites with abundant aplitic textures as well as occurrences of aplites indicate crystallization under water-saturated conditions. From phase diagrams (W h i t n e y, 1988) it results that the maximum rate of granite crystallization from water-suturated granitic melts, leading to the formation of fine-grained textures, is at a pressure of about 100 MPa. The granitoid rocks of the Rochovce intrusion show some anomalies in microelement contents in comparison with granites of the West Carpathian core mountains. They are enriched mainly in K, U, Th, Rb and some other elements: V, Cr, Ni, Pb, Cu, Sc, Y, Nb? Cs and rare earths. These different concentrations of particular elements may result from the different character of the source. Some authors (H i l d r e t h, 1979) explain the concentration of certain elements, mainly K, U, Th, Rb, Cs, in the fractionation column of ascending magma by means of thermogravity diffusion mechanism which implies mechanisms of Soret's diffusion and convection. The primary magma is not likely to have had very high Mo and W contents. These elements began to accumulate as late as in the final stages of the formation of the granite intrusion, the process in which fluid constituents played an important role. Decompression by the abrupt intrusion of the magma into higher horizons resulted in the release of fluids and in secondary boiling which might have been repeated several times giving rise to multiple Mo-bearing mineralizing pulses. Fracturing of the already solidified granitoid rocks and their metamorphosed basement made the rocks accessible for the deposition of the Mo stockwork mineralization. At Rochovce, this mechanism is suggested by the presence of 2 to 3 generations of mutually cutting quartz-molybdenite veins which differ from one another in decreasing intensity of near-vein alterations and molybdenite content. The Mo was probably carried by potassium-rich fluids, because the molybdenite mineralization is frequently disseminated in K-rich fine-grained leucovarieties of granitoid rocks including K-metasomatites. The existence of K-rich fluids in also confirmed by the strongly developed K-metasomatic zone at the endocontact as well as exocontact of the Mo-mineralized part (dome) of the 2nd intrusive phase-stock (?) of the Rochovce monzogranite intrusion.

Conclusion

1. Knowledge obtained so far indicates that the hidden Rochovce monzogranite intrusion consists of at least two intrusive phases. These differ from one another in macro- as well as microelement contents. Differences occur also in the structural development of the granitoid rocks. The dominant 1st intrusive phase is formed of coarse- to large-grained biotite porphyric granites, on the periphery hybrid and finer grained. In the stock (?) dome of the 2nd intrusive phase there prevail fine-grained granites, granite-aplites and granite-porphyries.

2. On the basis of the $K_{57.5}$ index amounting to 2.0—3.0, we assign the whole Rochovce intrusion with Mo mineralization to calc-alkaline Mo stockwork deposite according to W e s t r a — K e i t h's (1981) classification.

3. Comparison of the Rochovce prospect with the characteristics of Mo stockwork deposits found in literature indicates that the former bears great resemblance to the deposits of the calc-alkaline suite and/or transitional to alkali-lime one with stock or plutonic (?) types.

4. Differentiated magmatic melt of the 2nd intrusive phase had an increased content of the fluid constituents K and Mo which, during the stock's (?) intrusion, accumulated in an enriched dome. As a result of decompresion and subsequent boiling of the melt, ore-bearing fluids were released and their ore content was laid down at pre-fractured endo- and exocontact of the dome.

5. The deposited mineralization had a zonal pattern: Mo-W-Fe sulphides characteristic of granite Mo stockwork deposits. In the case of the Rochovce prospect, the hydrothermal activity was concluded by low-temperature quartz-fluorite-galena-sphalerite-calcite veins, in the upper parts without the sulphides or composed entirely of calcite. These are situated at the endocontact and exocontact of the granites, predominantly in the older and higher-temperature Mo-zone.

6. The succession of the mineralized veins and the way in which the veins cut each other suggest the existence of at least three successive stages of decompression, boiling and separation of fluid mineralization phases. The molybdenite content in the ore zone ranges from 0.1 to 0.25 wt. %, locally more. The F content varies from 0.05 to 0.3 wt. %, exceptionally attaining 0.8 wt. %

7. The intrusion, probably Cretaceous in age, is situated in the area of the compression zone of the continental plate margin of the Alpine Carpathian orogen. The discovery of a Mo stockwork mineralization associated with this granite intrusion, or stock (?) intrusion of highly differentiated granites, is the first object of its kind in the West Carpathians. In the years to come, another similar intrusion will probably be found in this area.

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