GEOLOGIJA *43/1*, 55–59 (2000), Ljubljana 2000
https://doi.org/10.5474/geologija.2000.004

Magmatic Rocks of the Karavanke Granitic Massif, Slovenia

Magmatske kamnine karavanškega granitnega masiva

Meta DOBNIKAR[1], Tadej DOLENEC[1], Breda ČINČ-JUHANT[2] & Nina ZUPANČIČ[1]
[1]University of Ljubljana, Faculty of Natural Sciences and Engineering, departement of Geology, Aškerčeva 12, SI-1000 Ljubljana; meta.dobnikar@ntfgeo.uni-lj.si
[2]Slovene Museum of Natural History, Prešernova 20, SI-1000, Ljubljana

Key words: petrology, classification, plutonic rocks, Karavanke igneous zone, Slovenia
Ključne besede: petrologija, klasifikacija, globočnine, karavanška magmatska cona, Slovenija

Abstract

The intrusive rocks of the Karavanke Granitic Belt vary in composition from acid to most mafic. They have been analysed by different authors but the classification of the rock types is not unique. The use of TAS classification of the rocks is suggested. According to this classification the rocks of Karavanke Granitic Belt consist of predominant syenogranite and syenite with contemporaneous mafic (gabbro, monzogabbro, monzodiorite) to intermediate (monzonite) rocks wich represent about 30 % of the whole massif. Veins of porphyry syenite with rapakivi texture occasionally cut larger bodies of mafic rocks.

Kratka vsebina

Granitni masiv karavanške magmatske cone je zelo heterogen. Kamnine masiva varirajo po svoji sestavi od kislih (granitoidnih) do zelo bazičnih. V literaturi lahko zasledimo različna imena za isti tip kamnine, zato predlagamo za poimenovanje kamnin granitnega masiva TAS klasifikacijo, po kateri večino masiva gradita sienogranit in sienit, kamnine mafične (gabbro, monzogabbro, monzodiorit) in srednje (monzonit) sestave, pa predstavljajo okoli 30% celotnega masiva. Večje bloke mafičnih kamnin ponekod sečejo žile sienit porfirja z rapakivi strukturo.

Introduction

The central Karavanke magmatic zone consists of two parallel elongated massifs, the Northern Karavanke Granitic Belt, which is the object of the present paper, and the Southern Tonalitic Belt, separated by a thin belt of metamorphic rocks. The Karavanke magmatic zone lies along the Periadriatic line, and outcrops mainly in the northeastern part of Slovenia and partly in the Austrian area, where it is represented by the "Eisenkappel (Karawanken) Granite" and "Karawanken Tonalite Gneiss". It extends about 35 km from the Slovene - Austrian border on the West to the Tertiary sediments of the Pannonic Basin near Zavodnje to the East (Fig. 1).

The Granitic Belt is mainly composed of coarse to fine grained acid rocks. The mafic and intermediate rocks crop out along the massif and constitute about 30% of the

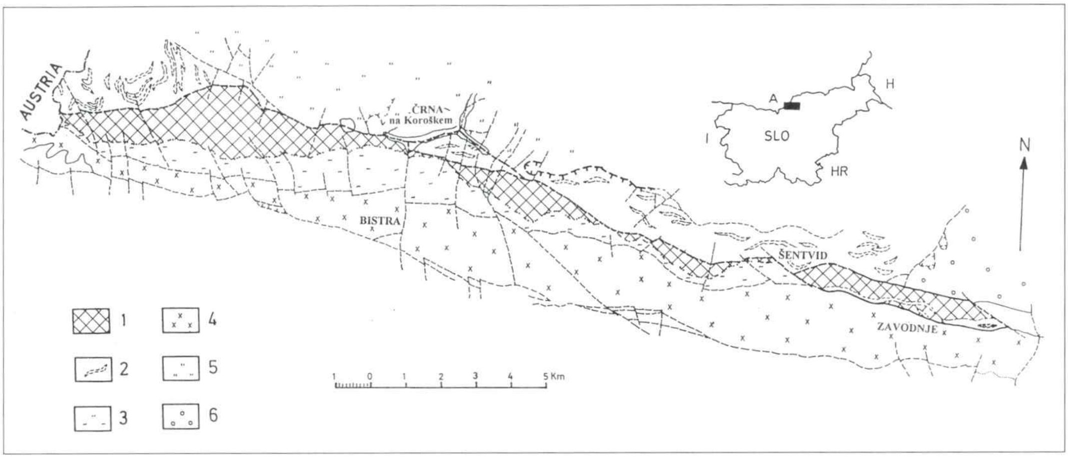

Fig. 1. Geological sketch map of Karavanke Igneous zone and investigated area (simplified after M i o č & Ž n i d a r č i č , 1978). 1) granitic belt, 2) Paleozoic green schist with diabase lenses, 3) fine grained gneiss, 4) tonalite, 5) Triassic dolomite, 6) Miocene conglomerate, gravel and sand

Sl. 1. Shematska geološka karta karavanške magmatske cone (prirejeno po M i o č & Ž n i d a r č i č , 1978). 1) granitni pas, 2) paleozojski zeleni skrilavci z lečami diabaza, 3) drobno zrnat gnajs, 4) tonalit, 5) triasni dolomit, 6) miocenski konglomerat, prod in pesek

whole body. They range in size from decimetric rounded enclaves, to larger, decametric bodies whose shape is difficult to obtain due to soil and vegetation. In the vicinity of the enclaves, K-feldspar megacrysts of acid rock are mantled by plagioclase. Veins of porphyry acid rock occasionally cut larger bodies of mafic rocks.

The Granitic Belt borders to Paleozoic phyllitoid shales with diabase dikes and Triassic dolomite to the North and to metamorphic complex to the South (M i o č & Ž n i d a r č i č , 1978; M i o č , 1983). Metamorphic xenoliths are common near the contacts with the country rocks. Granite intrusion caused contact metamorphose on both, northern and southern side of the massif (E x n e r , 1971; H i n t e r l e c h n e r - R a v n i k , 1978), but the contacts have later been tectonised.

The rock types have been determined by Exner (1971) as granite, granodiorite porphyry (with rapakivi texture), granodiorite, diorite and gabbro. The succession from mafic to acid rocks of the Granitic Belt has been interpreted as the result of the evolution of the same parent magma during crystallisation (E x n e r, 1971, 1976; F a n i n g e r , 1974). Diorite, monzonite, syenite, quartz syenite and granodiorite porphyry with rapakivi texture which appears as dikes between diorite and granite, are considered to be rocks of mixed origin produced in the reaction zones (E x n e r , 1971).

F a n i n g e r (1976) classified the rocks of the Granitic belt on the basis of modal analysis as granite, porphyry granite, monzonitic granite and gabbro.

The stratigraphic age of the Granitic Belt was long a matter of debate. I s a i l o v i ć & M i l i ć e v i ć (1964) found blocks of metamorphic rocks, impregnated by granite inside the tonalite massif, which suggests that the Granitic Belt is older then the Tonalitic Belt.

According to stratigraphic position, Š t r u c l (1970) dates the Granite Belt as Variscian and Tonalite Belt as Alpine. Faninger (1974) suggests granite to be somewhat younger then Northern Palaeozoic shales, since granite induced contact metamorphism on them. He also demonstrated, based on modal and chemical composition of rocks, that the Granitic and Tonalitic belt are related to two distinct magmatic events (F a n i n g e r , 1976).

Radiometric data show that Granite Belt is of Late Permian to Triassic age. According to L i p o l l t & P i d g e o n (1974), the rocks of the Granitic Belt yield ages of 227±7 Ma measured on biotite (K/Ar), 244±8 Ma on hornblende (K/Ar) and 230±5 Ma on sphene (U/Pb). S c h a r b e t (1975) obtained approximately the same ages of 224±9 Ma and 216±9 Ma, dating the granodiorite porphyry (according to E x n e r 's (1971) classification) with Rb/Sr method. D o l e n e c (1994) obtained initial $^{87}Sr/^{86}Sr$ isotopic value of 0.71437 on porphyry granite (corrected for 220 Ma, according to Scharbet's (1975) dating) which suggests a crustal source for this magma.

Classification and petrography

The rocks of the Granitic Belt show dishomogenety in both, grain size and distribution of mineral phases. Porphyry texture is also observed. We therefore suggest to classify those rocks on the basis of their chemical composition.

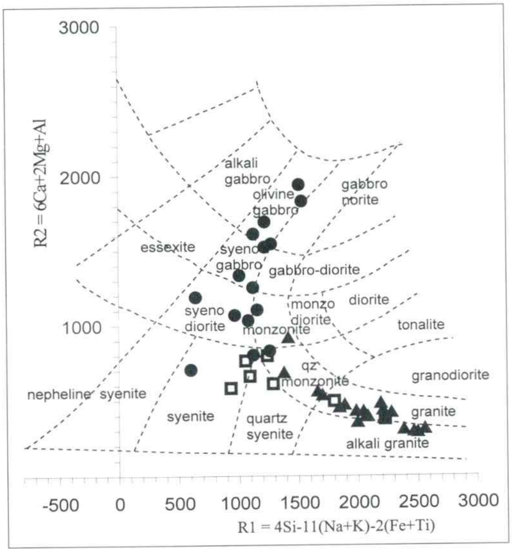

Fig. 2. Distribution of the Karavanke Granitic Belt rock types in R1-R2 diagram of D e l a R o c h e et al. (1980). ●-mafic and intermediate rocks, □-porphyry rocks, ▲-acid rocks.

Sl. 2. De la Rocheva klasifikacija kamnin karavanškega granitnega masiva. (D e l a R o c h e et al. 1980). ●-kamnine mafične in srednje sestave, □-porfirske kamnine, ▲-kisle kamnine.

D e l a R o c h e et al. (1980) proposed a classification of volcanic and plutonic rocks based on parameters R1 and R2 calculated from chemical analysis. In this classification diagram (Fig. 2), mafic and intermediate rocks of the Granitic Belt range from olivine gabbro through syeno gabbro and syeno diorite to monzonite, whereas the composition of felsic rocks falls along the line which separates quartz monzonites from syenite and quartz syenite as well as granite from alkali granite.

B e l l i e n i et al. (1995) suggest a single classification system for all igneous rocks based on TAS (Total Alkali Silica) chemical diagram. The classification is in good agreement with modal QAPF (S t r e c k e i s e n , 1976) , proposed for classification of plutonic rocks. For this reasons we suggest to classify the rocks of the Karavanke Granitic Belt according to this TAS classification (Fig. 3). The mafic rocks of the Granitic Belt therefore range from gabbro (or diorite) to monzogabbro (or monzodiorite). Intermediate rocks are represented by monzonite, while felsic rocks range from syenite to syenogranite. The porphyry rocks are all syenitic.

According to both classifications, the analysed rocks form a continuous series from most mafic to acid, with an obvious alkaline character, which was not exposed in previous classifications.

Syenogranite and syenite are fine to coarse grained and contain plagioclase, K-feldspar, quartz, biotite and hornblende. Plagioclases are often altered to sericite. K-feldspar is represented by euhedral (up to 30 mm in coarse-grained syenogranite) crystals of perthite or microcline - perthite, containing inclusions of plagioclase, quartz and biotite. Quartz forms rounded grains and small inclusions in K-feldspars. Biotite and hornblende are euhedral. In most samples, hornblende is altered to chlorite. In all felsic rocks, accessory minerals are very rare and consist of apatite, zircon and secondary epidote, ortite and clinozoisite.

Porphyry syenite has fine grained matrix of anhedral plagioclase, hornblende, biotite, K-feldspar and quartz. Phenocrysts consist of biotite, plagioclase, quartz and euhedral perthitic K-feldspar, usually rimmed with wormlike overgrown plagioclase and quartz. Phenocrysts of hornblende are rare. Accessory minerals apatite, zircon, secondary epidote, ortite and clinozoisite, and opaque minerals are very abundant, especially needles of apatite.

Monzonite is fine grained, consisting of plagioclase, K-feldspar, quartz, hornblende and biotite. In some samples, biotite

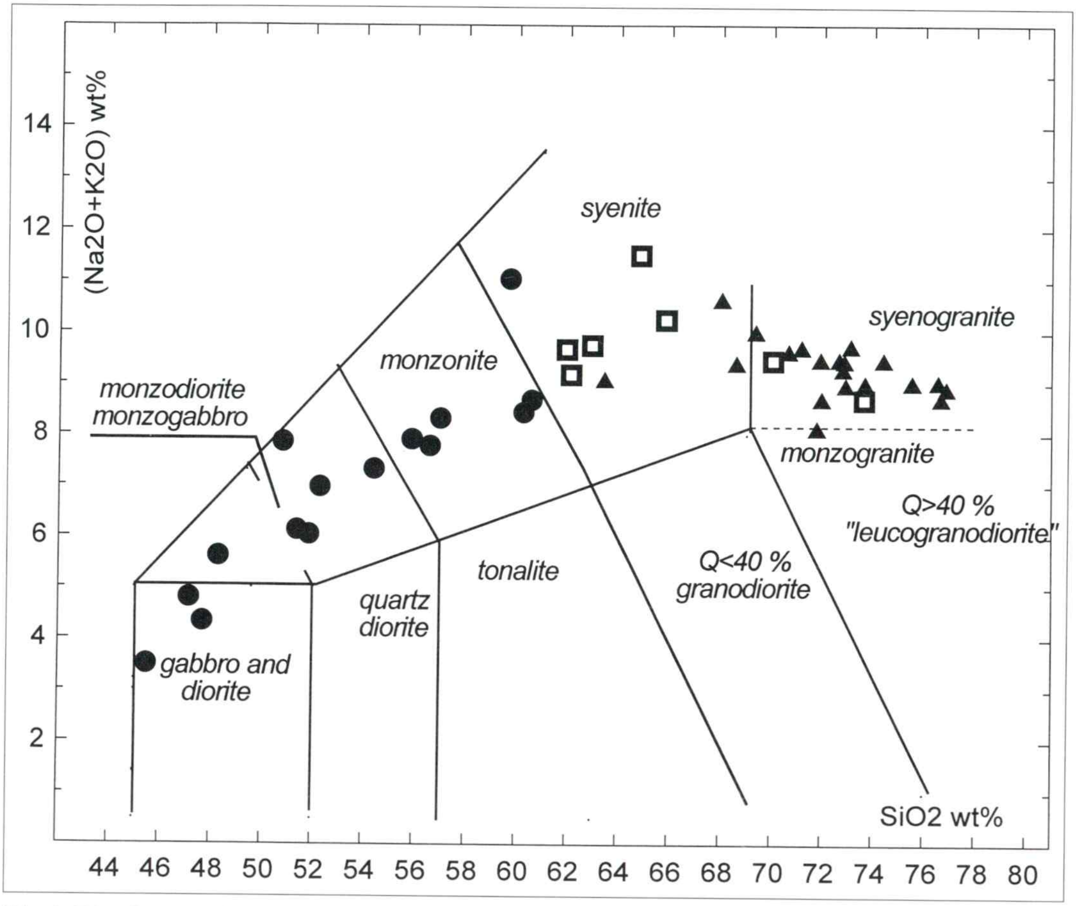

Fig. 3. Distribution of the Karavanke Granitic Belt rock types in TAS diagram (Bellieni et al., 1995). Symbols as in Fig. 2.

Sl. 3. TAS klasifikacija kamnin karavanškega granitnega masiva (Bellieni et al., 1995). Simboli so enaki kot na sliki 2.

replaces hornblende. Quartz forms rounded grains, surrounded by hornblende and biotite, sometimes together with pyroxene or plagioclase. Monzonite contains a lot of accessory apatite, zircon, secondary epidote, as well as opaque minerals. Hornblende and biotite are often altered to chlorite. Muscovite and secondary carbonate occur in these rocks as well.

Monzogabbro and monzodiorite are fine to coarse grained, containing amphibole, plagioclase, biotite and pyroxene. In monzodiorite, green hornblende sometimes contains a brown core. Hornblende is partly altered to chlorite. Plagioclases are euhedral, elongated, with core altered to sericite. Anhedral sphene prevails among accessory minerals, and apatite, opaque minerals, secondary epidote and carbonate are common as well.

Gabbro is fine to medium grained, containing plagioclase, amphibole, ortho pyroxene and olivine. Sometimes hornblende replaces pyroxene. Anhedral plagioclase grains show deformed twin lamellae. The accessory minerals are apatite in long needles, sphene, zircon, opaque minerals, and secondary epidote.

Conclusions

The Karavanke Granite Belt is a very heterogeneous intrusive massif consisting of rocks that range in composition from most mafic to acid. Due to heterogeneity in grain size and distribution of minerals within the massif, the chemical classification of the rocks is suggested. The TAS (Bellieni et al., 1995) classification suitable for plutonic and volcanic rocks was used as it is in good agreement with QAFP classification for plutonic rocks. According to this classification the rocks of Karavanke Granite belt represent a continuous alkaline series from gabbro (or diorite) through monzogabbro (or monzodiorite) and monzonite, to syenite and syenogranite.

The massif consists predominantly of coarse to fine grained syenogranite and syenite with contemporaneous mafic and intermediate rocks, which represent about 30% of the whole massif and are randomly distributed throughout the massif. They range in size from small decimetric enclaves to large bodies, which are occasionally cut by veins of porphyry syenite with rapakivi texture.

References

Bellieni, G., Visentin, J. E. & Zanettin, V. 1995: Use of chemical TAS diagram (Total Alkali Silica) for classification of plutonic rocks: Problems and suggestions. - Plinius, *14*, 49-52, Rome.

De la Roche, H., Leterrier, J., Grandclaude, P. & Marchal, M. 1980: A Classification of Volcanic and Plutonic Rocks Using R_1R_2-Diagram and Major-Element Analysis-Its Relationships With Current Nomenclature. - Chemical Geology, *29*, 183-210, Amsterdam.

Dolenec, T. 1994: Novi izotopski in radiometrični podatki o pohorskih magmatskih kamninah. -Rudarsko-metalurški zbornik, *41*, 147-152, Ljubljana.

Exner, Ch. 1971: Geologie der Karawankenplutone östlich Eisenkappel, Kärnten. - Mitteilungen der Geologischen Gesellschaft, *64*, 1-108, Wien.

Exner, Ch. 1976: Die geologische Position der Magmatite des periadriatischen Lineamentes. - Verh. Geol. B.-A., *2*, 3-64, Wien.

Faninger, E. 1974: Geokemijske raziskave pohorskega in karavanškega tonalita. - Arhiv Inštituta za geologijo, Univerze v Ljubljani, 20 p., Ljubljana.

Faninger, E. 1976: Karavanški tonalit. - Geologija, *19*, 153-210, Ljubljana.

Hinterlechner-Ravnik, A. 1978: Kontaktnometamorfne kamenine v okolici Črne pri Mežici.-Geologija, *21*, 77-80, Ljubljana.

Isailović, S. & Milićević, M. 1964: Geološko kartiranje granita Črne na Koroškem i obodnih tvorevina.- Arhiv Zavoda za nuklearne sirovine, 53 p, Beograd.

Lippolt, H. J. & Pidgeon, R. 1974: Isotopic Mineral Ages of a Diorite from the Eisenkappel Intrusion, Austria. - Z. Naturforsch., *29a*, 966-968, Wien.

Mioč, P. 1983: Osnovna geološka karta SFRJ 1: 100.000, tolmač za list Ravne na Koroškem (L 33-54). - Zvezni geološki zavod, 69 p., Beograd.

Mioč, P. & Žnidarčič, M. 1978: Osnovna geološka karta SFRJ 1: 100.000, tolmač za list Slovenj Gradec (L 33-55). Zvezni geološki zavod, 74 p., Beograd.

Scharbet, S. 1975: Radiometrische Altersdaten von Intrusivgesteinen im Raum Eisenkappel (Karawanken, Karnten).- Verh. Geol. B.-A., *4*, 301-304, Wien.

Štrucl, I. 1970: Stratigrafske in tektonske razmere v vzhodnem delu severnih Karavank. - Geologija, *13*, 5-20, Ljubljana.