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**PETROLOGY OF MAFIC AND FELSIC DYKES
FROM THE EASTERN PART OF THE KARKONOSZE MASSIF**

Abstract: The late Palaeozoic dykes cutting the Karkonosze granite comprise lamprophyres (richterite minettes, minettes, vogesites), monzodiorites (fine-grained monzodiorites and micromonzodiorites) and granitoids (microgranites, aplites). The potassic minettes represent primitive mantle melts, and the other mafic and felsic rocks of calc-alkaline affinities possibly formed due to fractionation, assimilation and magma mixing processes within the crust.

Keywords: lamprophyres, potassic rocks, granitoids, petrology, the Sudetes

INTRODUCTION

The late Variscan, post-kinematic Karkonosze granite intrusion was emplaced at mid-crustal levels within the crystalline complexes of the Karkonosze-Izera Block (West Sudetes) at ca. 328-304 Ma (Mierzejewski, Oberc-Dziedzic 1990; Duthou *et al.* 1991). Subsequently (in Carboniferous-Permian times?), numerous felsic and mafic dykes intruded the granite and its country rocks. The felsic dykes are mainly aplites and microgranites (“granitic porphyries”). The mafic rocks were variably classified as malchites, syenites and kersantites (*e.g.* Berg 1923) or spessartites and kersantites (Borkowska 1966), and several mafic dykes were generally mapped as “lamprophyres” (*e.g.* Szalamacha 1957). No systematic petrological or geochemical studies on these rocks were carried out during the last decades.

The most distinctive, ca. 20 km long and 10 km wide, NNE-trending dyke swarm cuts the eastern part of the Karkonosze intrusion south-east of Jelenia Góra, above the inferred feeder of the granitic pluton (Mierzejewski, Oberc-Dziedzic 1990, and references therein). This paper provides an outline of new petrographic and geochemical data on these dykes and magma origin and differentiation are briefly discussed.

METHODS

80 samples collected from 35 dykes between Karpacz and Janowice Wlk were examined in 90 thin sections. 29 representative, the freshest specimens were analysed for major and trace elements at ACME Analytical Laboratories Ltd., Canada, using the ICP-ES and -MS methods. Mineral chemistry was determined in 3 lamprophyre samples using electron microprobes at Université B. Pascal, Clermont-Ferrand, France and at Wrocław University, Poland.

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PETROGRAPHY

The previous classifications of the hypabyssal rocks in the study area are unsatisfactory and, in many places, the exposed rocks are different from those marked on geological maps: e.g. none of the collected samples is a syenite or a kersantite. In this paper the hypabyssal rocks are provisionally subdivided into three main groups and a few subtypes: 1) lamprophyres (richterite minettes, minettes, vogesites), 2) monzodiorites (fine-grained monzodiorites, micromonzodiorites), and 3) granitoids (microgranites, aplites).

The modal composition of five representative samples of the lamprophyres and monzodiorites is shown in Tab. 1. The rare *richterite minettes* contain phenocrysts of phlogopite-biotite in a groundmass of K-feldspar, greenish and blue amphiboles (richterite, winchite, riebeckite) and Ti-Fe oxides (Awdankiewicz *et al.* 2005). The more common *minettes* are characterised by phenocrysts of phlogopite and chlorite pseudomorphs after olivine(?) in a groundmass of alkali feldspars, augite and opaques. The *vogesites* are mainly composed of prismatic kaersutite, Ca-albite laths and anhedral K(Na)-feldspar, with less abundant chlorite pseudomorphs after olivine(?). The *fine-grained monzodiorites* consist of plagioclase, alkali feldspars, chloritised biotite, relic clinopyroxene and, rarely, brown hornblende. The *micromonzodiorites* show a similar composition (with less alkali feldspar and more clinopyroxene), and phenocrysts of plagioclase and clinopyroxene are common. The *granitoids* are rich in quartz and alkali feldspar, poor in biotite and strongly porphyritic to aphanitic. Chlorite, sericite, epidotes and carbonates are common post-magmatic minerals in both mafic and felsic rocks.

The micromonzodiorites and some lamprophyres (excluding the richterite minettes) contain mm to cm-sized inclusions of variable composition and texture. The most common are: 1) xenocrysts of plagioclase and quartz, and xenoliths of quartz-feldspathic rocks, some with abundant sillimanite, 2) glomerocrysts and small enclaves composed of clinopyroxene, plagioclase and opaques, and 3) oval microsyenitic inclusions (ocelli) and felsitic layers composed of alkali feldspars and quartz.

GEOCHEMISTRY

In the TAS diagram (Fig. 1A) the mafic rocks plot in the basaltic trachyandesite and trachyandesite fields, while the felsic rocks plot in the rhyolite field. Some scatter of the points may, in part, reflect enrichment/depletion in the 'mobile' elements due to hydrothermal alteration. However, very consistent, subparallel large-ion lithophile element (LILE) patterns, similar to those of the 'immobile' high field strength elements (HFSE) in the mantle-normalized diagrams (Fig. 1B) suggest that such mobility was very limited.

The monzodiorites and the felsic rocks show rather typical calc-alkaline geochemical signatures. However, the lamprophyres are richer in alkalis, and the minettes and the richterite minettes are potassic ($K_2O > Na_2O$). The richterite minette is gradational to lamproites in several geochemical, petrographic and mineralogical characteristics (Awdankiewicz *et al.* 2005).

The normalized trace element patterns of the mafic rocks (Fig. 1B) are subparallel and indicate LILE and light rare earth element (LREE) enrichment. The richterite minettes show a Nb-Ta enrichment and the highest contents of most trace elements, excluding some LILE and the heavy REE (HREE). The minettes (not shown) are characterized by very similar patterns. In contrast, the other rocks show a Nb-Ta depletion and lower contents of most trace elements, with the strongest negative anomalies in Sr, P, Ti (and in Ba in the aplites). The normalized REE diagrams (Fig. 1C) point to geochemical similarities of the

Table 1. Modal composition (vol.%) of selected samples of the lamprophyres and monzodiorites.

	Pl	Afs	Q	Cpx	Am	Phl/ Bt	Chl	Opq	other	M
richterite minette	0	43	5	6	20	13	0	11	2	52
minette	0	46	0	25	0	8	10	10	0	54
vogesite	0	52	4	1	26	0	9	4	4	44
fine-grained monzodiorite	40	26	4	3	0	0	20	4	4	30
micromonzodiorite	46	6	3	14	0	0	18	9	3	45

The samples represent relatively coarse-grained central portions of dykes. Pl – plagioclase, Afs – alkali feldspar, Q – quartz, Cpx- clinopyroxene, Am – amphibole, Phl/Bt – phlogopite/biotite, Chl – chlorite, Opq – opaque minerals, other – epidotes, carbonates, sphene, apatite. M – colour index.

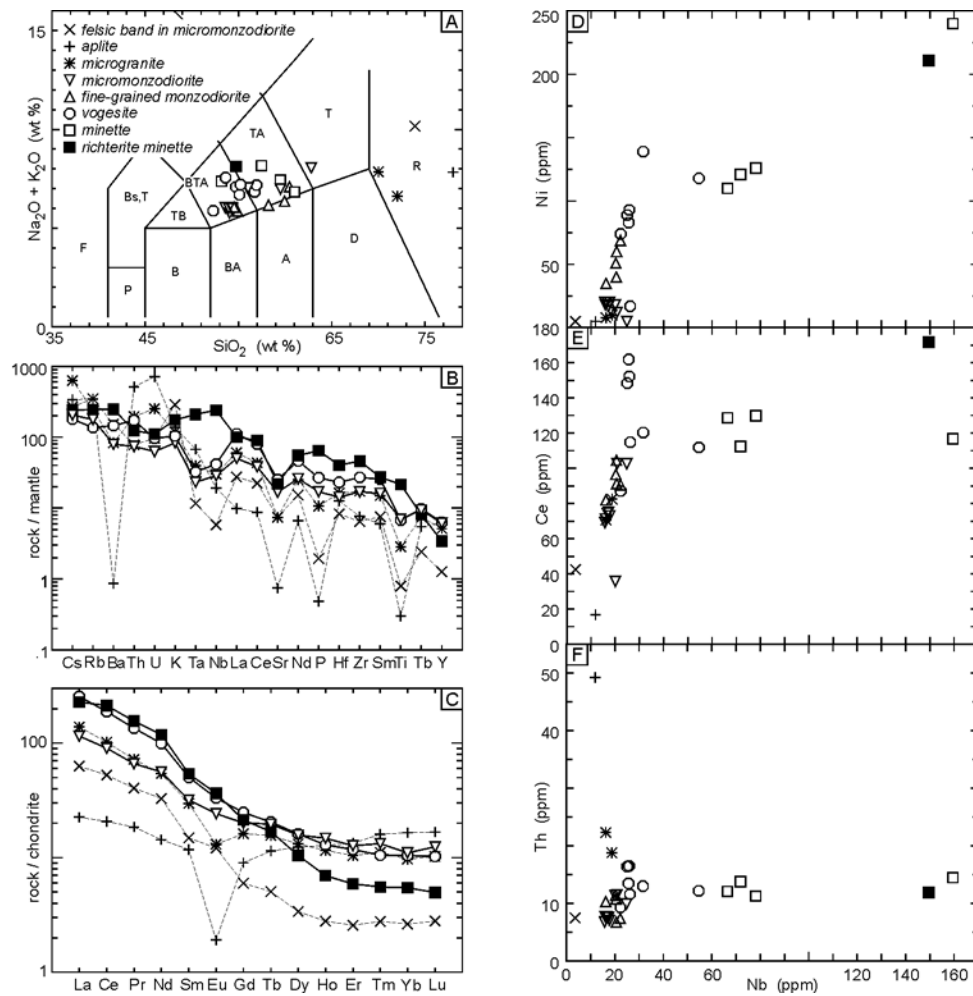


Fig. 1. Selected diagrams illustrating the geochemical variation of the dykes. Primitive mantle after Wood *et al.* (1979) and chondrite normalization after Boynton (1984).

normalization felsic band sample and the richterite minette (parallel patterns), and between the micromonzodiorites and the microgranites (overlapping patterns). The vogesites are gradational between the richterite minettes and the micromonzodiorites, showing high LREE like the former, and high HREE similar to the latter. The aplites show distinctively flat REE pattern and Eu depletion. The other diagrams (Fig. 1D-F) stress some specific characteristics of the richterite minettes and the minettes (e.g. high contents of Nb, Ce, Ni) and a linear grouping of most other rocks at lower Nb, Ce and Ni contents, with their decrease from the vogesites, thorough the monzodiorites, to the felsic rocks. However, the microgranites and the aplites show a specific trend towards high Th contents (Fig. 1F).

ORIGIN AND DIFFERENTIATION OF MAGMAS

The richterite minettes and the minettes probably represent relatively primitive (undifferentiated) magmas derived from phlogopite and garnet-bearing(?), metasomatically enriched mantle source (see also Awdankiewicz et al. 2005). The other mafic rocks show geochemical and petrographic evidence (Nb-Ta depletion, xenoliths, enclaves, banding) suggestive of a significant contribution of crustally-derived components in their genesis, related to contamination and/or magma mixing. Possibly, the suite of minettes-vogesites-monzodiorites represents the product of progressive assimilation-fractional crystallization of the minette magmas at a high assimilation/fractionation ratio. However, the melting of heterogeneous mantle sources and subsequent magma mixing could have also been influential. The felsic rocks are probably of various origin and may represent advanced differentiation products of the mafic magmas (microgranites, aplites) as well as melts of crustal origin (felsic bands in lamprophyres).

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