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MINERAL, WHOLE-ROCK CHEMISTRY AND Sr-Nd ISOTOPE STUDY OF KARKONOSZE-KOWARY GNEISSES (WEST SUDETES)

INTRODUCTION

Rocks of granite composition occurring in the southern part of East Karkonosze and eastern part of South Karkonosze are diversified structurally from coarse-grained granites, augen-gneisses to medium and fine-layered gneisses. Their intrusion age has been determined by Oliver et al. (1993) and Kröner et al. (2001), using single zircon U/Pb method, as 503 to 481 Ma. Analogous granites and gneisses occur in the Iżera complex, north of the late Variscan Karkonosze Granite intrusion. The preliminary Rb-Sr study of the Karkonosze-Kowary Gneisses was reported in Bachliński and Smulikowski (2002). The present report is its continuation. The samples from the Czech territory were collected by the courtesy of Dr František Patočka from the Geological Institute of the Academy of Sciences of the Czech Republic and Dr Jan Vanek from Krkonoše National Park.

MINERAL CHEMISTRY

The electron micro-probe study revealed that *plagioclase*, with two exceptions only is represented by albite most often almost An-free. K-feldspar in most of the rocks shows better or worse developed cross-hatched twinning typical of *microcline*. Its Ab and An contents are very low. High proportion of the pure albite perthitic intergrowths indicates a high degree of secondary albitization rather than exsolution. *White mica* (muscovite), which almost always is more abundant than biotite, shows the Si/Al^{IV} ratios from 3.01 to 7.09 (6.007 – 7.011 Si p.f.u.) corresponding to *phengite*. *Biotite* has Mg/(Mg+Fe+Mn) ratios from 0.12 to 0.44. The TiO₂ content of the prevailing dark brown variety is about 2% and is distinctly higher than in the green variety (about 0.3%). *Titanite* of granites and gneisses is unusually rich in Al₂O₃. Often titanite forms thin rims around *ilmenite* grains. *Garnet* has been observed in quite many samples as usually scarce, small and relict grains. It contains almost equal but varying proportions of *almandine* and *grossular* with higher *grossular* content in the centres of the grains. *Spessartine* content is lower and rather stable but *pyrope* is very low. Other accessory minerals are represented by common *apatite*, *zircon*, *allanite*, *monazite*, *rutile* and one analysed grain of *xenotime*. Dark brown biotite present in granites and coarse grained augen gneisses is consi-

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dered as magmatic mineral. It is often replaced by chlorite. Similarly garnet (Grs \cong Alm > Sps >> Prp) of relict character may represent late magmatic stage. It is also replaced by chlorite \pm light mica. Plagioclase represented by albite only, even in the rocks of higher CaO content, and epidote/clinozoisite inclusions in albite, indicate that conditions corresponded to epidote-amphibolite or greenschist facies. This is confirmed by the metabasic rocks associated with Karkonosze-Kowary gneisses. The widespread presence of phengite indicates a relatively high pressure of metamorphism. It appears that protolite granites were transformed into gneisses predominantly under the conditions of higher pressure part of the greenschist facies.

WHOLE-ROCK CHEMISTRY

Primitive mantle normalised trace element patterns (spider graphs) show no distinct differences between the rocks. The general shapes of the lines are the same, differing only in absolute values. However, in the LREE part of the graph all the samples have the same course, but in HREE part small differences may be observed. A strong Eu negative anomaly, most probably related to the low content of CaO, is conspicuous in all analysed samples.

On the major element discrimination diagram R1-R2 by Batchelor et al. (1985) all samples from the study area are located within syncollision granites. Also the detailed discrimination by Maniar and Piccoli (1989) shows that the Karkonosze-Kowary gneisses are characterised as CCG (continental collision granitoids). The trace element diagrams constructed after Pearce et al. (1984) may indicate that geochemical characteristics of the protolite is close to syncollision granites. Kachlik and Patočka (1999) however relate the Karkonosze-Izera gneisses to an extensional continental rift environment while Kröner et al. (2001) attributed them to a volcanic arc environment.

Sr AND Nd ISOTOPE STUDY

18 whole rock samples for Rb-Sr and 11 whole rock samples for Sm-Nd analyses were prepared by a standard chemical procedure for isotopes (Bachliński, Smulikowski, 2002). Newly constructed Rb-Sr isochron based on 16 samples of the Karkonosze-Kowary gneisses and granites (without samples 513a and 565 which show distinctly different isotopic ratios) yields 447 ± 21 Ma and the initial ratio 0.7056 ± 0.0087 (Fig. 1a). It appears that this age of Rb-Sr homogenization may corresponded rather to regional metamorphism (Maluski, Patočka, 1997) than the time of intrusion. The isochron based on 4 points of the Kowary granites only gave 472.7 ± 8 Ma and the initial ratio 0.7074 ± 0.0028 (op. cit). Sm-Nd isochron based on 11 samples was not possible to appoint, because all $^{143}\text{Nd}/^{144}\text{Nd}$ isotopic ratios were similar. The examination of diagram $\epsilon(\text{Sr})$ vs $\epsilon(\text{Nd})$ (Fig. 1b) (DePaolo, 1981) shows that points representing the Kowary granites are located along the mixing line between the mantle and the upper crust (paleozoic) including, however, more

mantle material. Points of other samples, representing gneisses (rocks deformed during metamorphism) are located outside the mixing line.

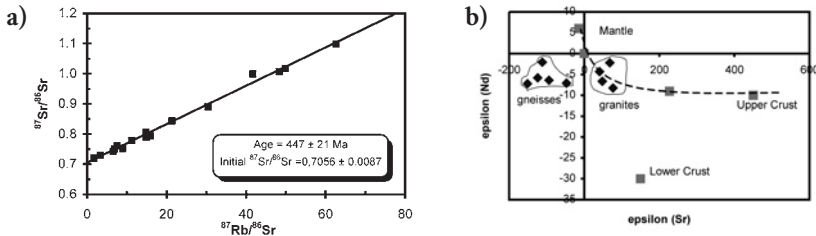


Fig. 1. a - Rb-Sr isochron for Karkonosze-Kowary gneisses and granites; b - diagram $\epsilon(\text{Sr})$ vs $\epsilon(\text{Nd})$ with mixing line between the mantle and upper crust (after DePaolo, 1981)

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