The orthogneisses of the Orlica-Śnieżnik dome (West Sudetes, Poland): Sr-Nd isotope characteristics and Rb-Sr geochronology

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The magmatic, metamorphic and structural evolution of the Orlica-Śnieżnik dome (OSD) is controversially discussed. A better understanding of the OSD history is currently hampered by the difficulty to date precisely distinct stages in its complex evolution. The geochronological prospects to unravel the metamorphic record are limited. Very rapid cooling has caused a situation where different isotopic systems provide overlapping ages for different segments of the P-T-deformation path. For example, Sm-Nd dating of eclogites (garnet, omphacite, whole rock) and Rb-Sr phengite chronology of amphibolite-facies gneisses both provided ages of c. 340 Ma (e.g. Lange et al., 2002 and references therein). Further complexities arise from unclear genetic relationships between different orthogneiss varieties. The orthogneisses represent the dominant rock type of the study area and traditionally are subdivided into two groups: the Śnieżnik and Gierałtów gneisses. Unsolved questions concern the importance of reported textural, bulk and mineral chemical differences (Borkowska et al., 1990, Don et al., 1990, Grześkowiak – Żelaźniewicz, 2002). There seems to be a general consensus that some orthogneisses have Cadomian protolith ages and that all types underwent at least one episode of high-temperature metamorphism during Variscan times (Turniak et al., 2000; Lange et al., 2002). However, field observations and chemical data (bulk compositions, REE, Sr-Nd isotopes) are not sufficient to reconcile contrasting views about the origin of both gneiss varieties. This study is a contribution to this debate and focuses on two aspects of the OSD evolution: the genetic relationship between different types of orthogneisses and the timing of the post-orogenic cooling history. In order to ensure a representative regional characterization, we have systematically collected c. 40 samples across the OSD for conventional geochemical analyses (including REE) and Sr-Nd isotope studies. Our results represent the most comprehensive geochemical database for orthogneisses of the study area. An important finding is the observation that geochemical and geochronological charac-teristics of Śnieżnik and Gierałtów gneisses are very similar. Based on bulk compositions and REE patterns systematic differences between both rock types cannot be documented. For Śnieżnik and Gierałtów gneisses, Rb-Sr whole rock isochrons yield indistinguishable dates of 474 ± 17 Ma and 456 ± 8 Ma, respectively, including the data from Borkowska et al. (1990). The Rb-Sr isochron age of 474 ± 17 Ma for the Śnieżnik orthogneisses is interpreted as currently best estimate for the time of emplacement (initial $^{87}Sr/^{86}Sr = 0.7065 \pm 0.0023$; MSWD = 156). The very high MSWD value either is a primary feature related to heterogeneous source rocks or is controlled by disturbances of the Rb/Sr isotope system during subsequent metamorphism. In a Sm-Nd isochron diagram the data show a large scatter and no geologically meaningful age information was obtained. This scatter is interpreted to indicate modification of the Sm/Nd ratio during migmatisation. Therefore, model age calculations are based on the two stage model of Liew and Hofmann (1988), considering Sm/Nd modifications due to high-T metamorphism and melt fractionation in igneous rocks. Most T_{DM} model ages fall in the range of 1.4 to 1.6 Ga. Gierałtów gneisses show a larger range (1.1 to 1.8 Ga). The importance of this apparent difference is unclear but might be an artefact of the sampling strategy (sample population of Śnieżnik gneisses is too small), or indicates changes of the Sm-Nd systematics by metamorphic overprinting, which only affected the Gierałtów gneisses.

Our previous geochronological studies in the OSD focused on the timing of deformation by dating samples representing the continuous transition from weakly deformed augen gneisses to finely laminated mylonites on outcrop-scale (Lange et al., 2002). Direct dating of deformation was not possible, but the record of the cooling history, as documented by slightly different Rb-Sr phengite and biotite ages, indicates a minimum age of c. 340 Ma for the development of the ductile shearing and the last migmatisation event. In order to obtain further constraints for the cooling history on a regional scale, we have selected 12 additional samples for Rb-Sr phengite and biotite dating. The samples were collected around the locations Nowa Wieś, Międzygórze, Idzikow, Nowa Morawa, Stronie Słaskie, Strachocin and Lądek-Zdrój. According to previous classifications, 7 samples represent Gierałtów gneisses and 5 samples belong to the group of Śnieżnik gneisses. The phengite and biotite ages further support previous interpretations based on a limited dataset from a single outcrop at Międzygórze (Lange et al., 2002). Phengite- and biotite-whole rock pairs of

Gierałtów gneisses yield Rb-Sr ages of 340–330 Ma and 337–319 Ma, respectively (errors ± 7 Ma, 2σ). For Śnieżnik gneisses, phengite-ages range from 342–334 Ma and biotite ages from 334–327 Ma. Within individual samples, phengite and biotite ages overlap within error, but phengite ages show a trend towards slightly older values. Due to their different closure temperatures for the Rb-Sr system, these differences are interpreted to indicate cooling after a thermal event.

In conclusion, the new isotope data are compatible with the interpretation that the Śnieżnik and Gierałtów gneisses are derived from identical source rocks and possibly represent a large batholith. It is suggested that the petrographic variability was mainly caused by superimposed modifications during deformation and migmatisation. We postulate that Śnieżnik and Gierałtów gneisses simply represent different textural variants of the same protolith. Mica geochronology further documents the importance of Variscan metamorphism in the western Sudetes. Within the study area, no regional differences in the cooling history are recognized.

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