Basites in northern part of the Izera-Karkonosze block: A magmatic record of early Devonian rifting of the Saxo-Thuringian passive margin and its subsequent subduction

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Cambro-Ordovician rifting at the Cadomian peripheries of Gondwana eventually produced a number of terranes which after N-ward drifting and mutal collisions became incorporated into the Variscan belt. The northern part of the Karkonosze-Izera Block, composed of Neoproterozoic granodiorites, greywackes and mica schists intruded by c. 500 Ma granites, belonged to the trailing edge of the Saxo-Thuringian terrane. By the early Devonian, this passive margin underwent extension and rifting (Nowak et al., in prep.). A swarm of the WNW-trending subvertical basic dykes intruded continental crust owing to NNE-SSW extension presumably parallel to the rift axis.

Geochemically (major and trace elements, ratios of incompatible elements, degree of fractionation of REE), the basites can be subdivied into 4 groups: I – alkali basalts, II – transitional basalts, III – subalkali tholeiitic basalts (IIIa – low Nb/Y ratio and IIIb – high Nb/Y ratio), and IV – calc-alkaline basalts. Groups I and IIIb represent WP basalts, group II and group IIIa are MORB-like (E- and N-types), and group IV is similar to SSZ basites (Nowak, 2003). Significant ratios of elements and isotopic (Sr, Nd) signatures allow to infer that: (1) group I basalts originated from an enriched astenospheric source of OIB type, (2) group II basalts of E-MORB type were derived from a slightly depleted source resulting from mixing of undepleted and depleted astenospheric magmas, (3) group IIIa basalts were released from a strongly depleted astenospheric source with some contamination from continental crust, (4) group IIIb came from a heterogeneously enriched mantle source with mixed E-MORB and N-MORB compositions contaminated by continental crust, and (5) group IV developed from a lithospheric source.

Magmas I to IIIa formed quite a consistent evolutionary trend A in which an enriched astenospheric region was being modified due to increasing flux of depleted material. Magmas IIIb and IV formed evolutionary trend B and were derived from signifcantly different lithospheric source region contaminated with continental crust. Trend A and trend B matched different geodynamic conditions, i.e. divergence and convergence, respectively. A switch from trend A to trend B reflected the end of lithospheric extension and the onset of subduction, or, alternatively, strong contamination occurred when magmas were passing through continental lithosphere. Trend B continued with calc-alkaline andesites which accompanied the mid/late Viséan onset of the late orogenic molasse-type sedimentation in the intramontane Intra-Sudetic basin (Turnau et al., 2003). The andesites are interpreted to represent sustained memory of subduction processes (Awdankiewicz, 2000) that must have terminated before the formation of the basin, pointing to a time lag of c. 5–10 Ma. The same is probably true about the switch between trends A and B, the subsurface intrusive manifestation of which was, as inferred from the structural observations, deleyed with respect to the relevant deformation of the descending Saxo-Thuringian slab.

Sr and Nd isotopic composition of WPB magmas of group I point to the presence of HIMU component in the source and suggest that the origin of the Izera alkali basalts was connected with mantle plume. Its presence controlled early Devonian extension of the Saxo-Thuringian passive margin, the process extensively recorded in the Izera section. As long as the extension went on, the Izera continental crust received, via plume, injections of basic magmas coming from enriched asthenospheric source which was evolving and, with time, became more and more depleted. When the extension ceased and convergence started later in the Devonian, mantle dynamics changed drastically so that the continued, yet much less extensive, growth of the Izera dyke swarm was being supplied then by magmas from lithospheric mantle strongly contaminated with continental crust material likely owing to the ongoing subduction. The subduction terminated by the Devonian/Carboniferous turn and this stopped basic injections into the Izera crust. In Tournaisian-early Viséan times, this crust underwent collisional deformation suffered by most dykes as they were rheologically weaker than granitic hosts.

The basic dykes that intruded the Izera passive margin represent a series of magmatic snap shots which reflected the evolution of extensive magmatism in the adjacent basins floored on the N and E by the attenuated continental and new oceanic crust, now comprised by the Kaczawa (Furnes et al., 1994) and East Karkonosze successions. The abundant Izera alkali and transitional basalts conform to the higher part of the Kaczawa sequence, when the Izera region was still close to the Kaczawa basin, while the scarce Izera N-MOR tholeiites correspond well with the top of the Kaczawa succesion, when the Izera region became relatively more remote from the spreading centre. The distance, however, could never be large if the MORB magmas still managed to penetrate the neighbouring passive continental margin. Similar comparison with the East Karkonosze magmatism is more complex due to controversial interpretations of magmatic evolution in this region (Floyd et al., 2000; Kozdrój, 2000).

The Izera younger trend B has counterpart neither in the Kaczawa, nor in the East Karkonosze successions. This reflects an important change in mutual geotectonic positions of these units in the course of early Carboniferous convergence and final Variscan collision.

References

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