Composition and Origin of Triassic Potassium-Rich. Rhyolites of the Silicicum Superunit, Western Carpathians, Central Slovakia

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Triassic acid volcanic rocks of the Drienok and Muráň nappes formerly known as “melaphyres” and quartz porphyries (Zorkovský 1959a, 1959b, Slavkay 1965) belong to tectonically uppermost Alpine nappe structure in the Western Carpathians overlaying the Veporicum, Hronicum and Gemericum Superunits, which is known as Silicicum Superunit. Our investigated rocks were defined as potassium-rich rhyolites, enriched in K(4.9–8.7 wt.% K2O), Si(72.8–76.7 wt.% SiO₂), and depleted in Ti(0.08–0.30 wt % TiO₂), Mg(0.09–1.03 wt.% MgO), and especially in Ca(0.03–1.06 wt.% CaO), Na(0.19–1.98 wt.% Na₂O) and P(0.01–0.11 wt.% P₂O₅). Trace element geochemistry shows slight enrichment in Rb, Zr, Y and depletion in Sr, Ba, and V, as well as elevated Rb/Sr and Ga/Al ratios which are typical for alkaline-rich (A-type) post-orogenic and anorogenic silicic magmatic suites (cf. Whalen et al. 1987).

Zircon typology (Pupin 1980) indicates a hot and dry magmatic environment (mainly P₄, P₅ subtypes and D types). Estimated temperature of zircon crystallization from typograms (800–900 °C) corresponds to high zircon saturation temperature (Watson and Harrison 1983), where T = 820–845 °C. BSE shows slightly oscillatory zoning of zircon, locally with small inherited(? ) oval cores. EMPA reveals Hf contents analogous to the continental crustal granite zircon: 1.0–1.7 wt% HfO₂ (cf. Pupin 1992). Contents of Y are slightly elevated: 0.4–1.0 wt. % Y₂O₃, concentrations of other elements (e.g., P, U, Th, REE) are below detection limit of the EMPA (< 0.10 wt.%). Profiles across zircon crystals do not show distinct variations between Zr, Hf and Y or systematic Hf enrichment in rims of zircon crystals.

Studied volcanic rocks close to Poniky village show specific and very similar character with the other occurrences of Triassic volcanites, especially in the Muráň nappe (Veľká Stožka, Telgárt). Moreover, A-type leucogranites of the Hrončok type in the Veporic unit show also Triassic age, as resulted from U-Pb zircon dating (Putiš et al. 2000).

Rhyolites were produced in the continental carbonate platform environment of the shallow epicontinental sea, by anatexis of probably lower crustal acid material. In the Tatricum and Veporicum Superunits, the crust was thick enough to prevent the magma from reaching the surface. Consequently, volcanism occurred only in the Silicicum Superunit area with relatively thinner continental crust, in the vicinity of the Meliata-Hallstatt oceanic through.

Chemical composition of feldspars, rock major and trace elements, zircon chemistry and typology study, reveal alkaline character and crustal origin of the Silicicum rhyolites. All these data indicate the extension regime of continental rifting during...
post-orogenic Late Hercynian or Early-Alpine pre-orogenic stage in the Silícicum Superunit.

References


Pseudotachylite from the High Tatras: Petrology and Kinetics of Crystallisation

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Pseudotachylite is a vein rock formed due to frictional melting associated with a seismic event. Fault-related pseudotachylites are relatively common in thrust zones developed in basement rocks having experienced rapid uplift (the Alps, Appalachians, Caledonides, Carpathians). They form along the so-called generation surfaces accommodating the seismic slip. Pseudotachylite was found at several places in the Vysoké Tatry (southern slope of Gerlach) and Západné Tatry Mts. The High Tatras occurrences are related to NNE striking faults with a steep dip of 75–90° both to ESE and WNW. Three samples were studied showing different pseudotachylite – host rock relations: (1) Pt-222, an injection vein in moderately cataclasized and retrograded granite, (2) Pt-226, injected dilation fractures (Riedel shears) anastomosing from a generation surface, (3) Pt-650, curly injection veins in strongly cataclasized rock (breccia). The three samples from three different places reveal similarities in mineralogical compositions on one hand, and great differences in mineral proportions and overall compositions on the other hand.

Melting relations. All samples are composed of matrix (crystallized melt) consisting of hematite (3–35%), albite and K-feldspar, and clasts dominated by feldspars and quartz. The proportions of matrix minerals are highly variable what results in melt compositional trends apparently controlled by biotite (Pt-222) and feldspar (Pt-650). In the sample Pt-226 K2O contents are very high compared to Pt-222 and Pt-650. In the sample Pt-226 K2O contents are rather low compared to Pt-222 and Pt-650. Water liberated into the melt enabled further melting of quartz and feldspars. The Pt-226 and 650 samples exhibit different major element trends where the FeO (hematite) increases are not accompanied by K2O. It is noted that the hematite proportion increases towards tips of dilation fractures, so the most obvious way to explain this feature seems to be hematite fractionation. This possibility is, however, not considered plausible because no reason is seen why hematite crystals should be preferentially fractionated and transported. Rather, melt differentiation (possibly by successive melting involving earlier pseudotachylite matrix) is considered, because it is the iron- and water rich melts with low viscosity which are sucked into the most distant dilation fractures.

P-T-X conditions. The presence of hematite (instead of original granitic ilmenite) indicates high oxidation conditions in the melt. Hematite is rather pure containing only 0.5–4.5 wt.% TiO2. Thus, hematite pseudomorphs represent breakdown of earlier hematite-ilmenite lherzolite. Melamine solubility may provide an indirect estimate: the Zr concentration (170 ppm) gives the saturation temperature 755 °C. Since no zircon was found in the studied samples (SEM images) the actual melt temperature must have been higher so that zircon could not have precipitated. Cataclasite as a related rock suggests brittle conditions in the failure zone. Pressure-temperature conditions during deformation/recrystallization have been estimated from the cataclasite assemblage biotite-chlorite-plagioclase-muscovite-epidote-hematite-quartz using THERMOCALC v.2.7 program and thermodynamic data of Holland and Powell (1998). Lineary independent reactions between coexisting mineral phases in the cataclasite yield average P-T conditions of 400–450 °C and 2–3 kbar. This temperature refers to a retrogressive (re-hydration) phase in the cataclasite following the seismic event.

Kinetics. Kinetic considerations are based on hematite crystal size distribution (CSD) measurements made on more than 40 BSE images and the CSD theory of Marsh (1988, 1998).