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Whole-Rock Geochemistry and Nd Isotopic Composition of Metavolcanics from the Netvořice – Neveklov and Sedlčany – – Krásná Hora Islets: their Petrogenesis and Implications for Geodynamic Processes at the Teplá - Barrandian – Moldanubian boundary

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The boundary between two contrasting terranes of the Bohemian Massif – Teplá–Barrandian and Moldanubian – is obscured by Variscan Central Bohemian Pluton. Its roof pendants (the so-called Islet zone) is represented by Late Proterozoic to Early Palaeozoic volcanosedimentary succession of the Teplá – Barrandian affinity and Middle Devonian orthogneisses (Kachlík 1992; Košler et al. 1993). The Netvořice–Neveklov (NN) and Sedlčany–Krásná Hora (SK) islets are built by Late Proterozoic flyshoid rocks of the Svrchnice Formation (Chlupáč 1989) and associated metavolcanics. These are unconformably overlain by varied Early Palaeozoic sequences (Kachlík 1992 and references therein). Except for weak Cadomian deformation and metamorphism of Late Proterozoic complexes, the rocks of the Islet zone underwent strong Variscan LP-HT overprint associated with granitoid intrusions (Kachlík 1992).

The metavolcanic rocks in the area under the study crop out in several stratigraphic levels. Late Proterozoic metavolcanics and metadiabase dykes crop out in both islets, the presence of Cambrian volcanism is limited only to the NN islet, Ordovician felsic volcanoclastics are known from the basal part of the Krašovice Formation of the SK islet.

Metadiabase dykes penetrating all stratigraphic units are obviously the youngest.

Late Proterozoic volcanism evolved in space and time from relatively primitive tholeiites, low-Ti tholeiitic basalts and basaltic andesites to calc-alkaline basalts, andesites and felsic acid metavolcanics. The tholeiites show low SiO_2 contents (49–51%), high $TiO_2 > 1\%$, alkalis $> 3\%$ and flat REE patterns. The low-Ti basalts have higher SiO_2 (51–53 %), lower TiO_2 (0.5–0.7%), alkalis < 2% and U-shaped REE patterns.

The boninites (Le Bas 2000) often form sills or dykes intruding basaltic metavolcanics and overlying metasediments of the Svrchnice Formation. However, in the Jílové Zone were also found boninitic pillow lavas. The metaboninites have relatively high SiO_2 (52–56%), CaO (CaO/Al_2O_3 ~ 1), mg# (60–80) and Cr (400–2000 ppm) together with low TiO_2 (0.3–0.5%), and alkalis (< 2%); typical are U-shaped REE patterns. These rocks are equivalent of high Ca-(meta-) boninites (Crawford 1989). The Nd isotopic data for metaboninites and associated basalts indicate either an important mantle heterogeneity, different degrees of crustal contamination and/or variable mantle metasomatism (ε^{650}_{Nd} + 2.5 to + 6, T^{DM}_{Nd} 0.86 – 1.08 Ga). Intermediate and acid volcanics have also relatively primitive features ($\varepsilon^{650}_{Nd} = +5.0$ to +4.3, $T^{DM}_{Nd} = 0.90 – 0.95$ Ga) pointing to their unevolved, probably mantle-derived parental magma.

The characteteristic incompatible element enrichment, HFSE depletion and negative Ce anomaly on MORB-normalized spiderdiagrams suggest that all the studied Proterozoic volcanics are comparable with island arc lavas (Waldhausrová 1984; Fediuk 1992a,b). Intimate spatial and temporal relationship between tholeiitic basalts and boninites may indicate a genetic link. The tholeiitic basalts were most probably derived from a mantle diapir beneath an immature arc that became, as a consequence, quite refractory. The subsequent LP partial melting of this (harzburgitic) residue enriched by migration of subduction-derived fluids or, more likely, by small OIB-type melt fractions, would have produced high-Mg siliceous boninitic magmas and low Ti-basalts. To achieve this, anomalous thermal conditions (subduction of active spreading centre or opening of a back-arc basin) were required. Evolution of Proterozoic island arc continued by extrusion of more evolved low-K calc--alkaline basaltoandesites and acid volcanics, reflecting increasing maturity of the arc.

The **Cambrian** metavolcanics are associated with shallow--water mature metasandstones with intercalations of metaconglomerates, passing upwards into metapelitic lithologies. In contrast to Proterozoic metavolcanics, the Cambrian intermediate to acid volcanic rocks (metarhyolite, metadacite, metatrachyte) prevail over the basic ones. If compared with Proterozoic acid volcanics, the Cambrian ones are more evolved, with higher SiO_2 (66–76%) and alkali contents (4–8%), as well as steeper REE patterns. On the other hand, U-shaped REE patterns and depletion in HFSE are typical of both age groups. Nd isotopic data (ε^{530}_{Nd}+1.5 to + 8.6, $T^{DM}_{Nd} = 0.51 – 1.04$ Ga) show some role for recycled Precambrian material besides more important juvenile, depleted-mantle derived component. The Cambrian volcanism probably represented a vaning stage of destructive margin setting and an onset of extension, which caused an origin of narrow intracontinental basins on the Proterozoic basement.

The youngest volcanic products are metadiabase **dykes**, sometimes preserving ophitic textures where relics of mostly amphibolized pyroxenes are locked among randomly distributed plagioclase laths. They have basaltic composition (SiO_2=46–52%), high contents of TiO_2(>2%), Al_2O_3(16.6–17.7%), relatively low mg# (39–56) and flat REE patterns mostly without Eu anomalies and with pronounced negative Ce anomalies. Slight incompatible element enrichment together with negative HFSE anomalies on MORB-normalized spiderdiagrams show that these basalts originated in suprasubduction zone environment. Nd isotopic data are quite primitive (ε^{400}_{Nd}+8.6 to +9.1, T^{DM}_{Nd} = 0.37– 0.41), suggesting that the dykes represent closed-system fractionation products of Devonian depleted-mantle derived magmas. These rocks may reflect a major change in geodynamic regime from Silurian extension to Early (?) Devonian onset of the Variscan subduction.

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Cambrian in the Netvořice–Neveklov Metamorphic Islet (Roof of the Central Bohemian Pluton)

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The Cambrian represents relatively independent sedimentary and tecto-magmatic cycle of the Teplá–Barrandian terrane (TBT). Its lower limit is given by noteworthy unconformity separating the Cadomian basement. The high-grade LP–HT metamorphism at the SW and possibly NW margin of the TBT, dated at *c.* 550–540 Ma (Zulauf et al. 1999), was followed by intrusion of syntectonic calc-alkaline granitoids (520–510 Ma: Dörr et al. 1998) and subaerial Late Cambrian volcanism. The upper limit is marked by unconformably deposited Ordovician–Devonian volcano-sedimentary complexes of the Prague Basin.

The paleogeographic extent of Early and Late Cambrian continental and Middle Cambrian marine sedimentation is only poorly known. This is due to only limited extent of Cambrian intracontinental NE-SW trending fault-bound troughs, in conjunction with pre-Ordovician as well as strong Variscan basin inversion.

Except for the paleontologically documented Cambrian in the Příbram–Jince, Skryje–Týřovice nad Železné Hory Mts. regions (Havlíček 1980 and references therein), its presence was assumed also in the Islet Zone of the Central Bohemian Pluton (Tehov and Ondřejov Islets – Havlíček and Šnajdr 1955, Vajner (1962, 1963). Moreover, expected Cambrian sequences to occur in the Rožmitál metamorphic Islet, which lithologically resembles the undisputedly Cambrian sediments in the Příbram–Jince area further to the NE.

In contrast to previous opinions, the new lithostratigraphic study of the Islet Zone showed that the basal parts of the Tehov islet, unconformably overlying the folded Late Proterozoic basement of the Kralupy–Zbraslav Group (Kachlík 1992), might be correlated with basal part of the Ordovician Krašovice Formation in the Sedlčany–Krásná Hora Islet (*sensu* Chlupáč 1989). As no evidence for the existence of an unconformity in the succession of the Tehov and Ondřejov islets could have been found (even though it was assumed by Vajner 1962), the whole stratigraphic sequence was assigned to the Ordovician (Kachlík 1992).

The new lithostratigraphic investigations and Sm-Nd isotopic study of metavolcanic rocks showed that the Cambrian is preserved in the Netvořice–Neveklov (NN) Islet and in small relics in the Zbořený Kostelec (ZK) Islet. In the NN islet, the Cambrian succession forms asymmetric NE-SW striking syncline overlying a range of Proterozoic units. The succession begins with mature yellow to grey quartz metasandstone with conglomerate intercalations, alternating with predominantly acid calc-alkaline volcanics in the eastern flank of the syncline. These rocks pass upwards into a thick succession of metaaleurites and metapelites transformed into various types of muscovite-biotite knotted schists and hornfelses.

The following evidence indicates the presence of Cambrian in the NN islet:

(1) The presumed Cambrian volcanosedimentary succession differs lithologically and geochemically from underlying Proterozoic metasediments and volcanics as well as, to a lesser degree, from the overlying, undoubtedly Ordovician siliciclastics (see Kachlík 1992 for details). Geochemical trends observed in the metasediments and metavolcanics of the NN islet strongly resemble those known from unmetamorphosed Cambrian analogues in the Barrandian area.

(2) Flat, gently to the E dipping, basal horizon of mature sandstone with conglomeratic intercalation overlies an anticline of the rocks of the Štěchovice Group at the western margin of the NN islet and, further to the S, also the volcanoclastics of