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New $^{207}\text{Pb}/^{206}\text{Pb}$ Zircon Ages from the East Karkonosze Metamorphic Complex, West Sudetes – Evidence of the Late Cambrian – Early Ordovician Magmatism

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The East Karkonosze Metamorphic Complex located in the Rudawy Janowickie Mts with continuation in the Rychory Mts (West Sudetes) forms an eastern envelope of the Carboniferous Karkonosze granite and is composed of two main litho-tectonic units: Kowary-Czarnów Unit (KCU) and Leszczyniec Unit (LU) (Kozdrój 2003).

The Kowary-Czarnów Unit is built of a metamorphosed sedimentary – volcanic succession of Neoproterozoic (?) to Cambrian age which hosts several elongated bodies of ortho-gneisses representing S-type granite intrusions. One body from Kowary was dated on c. 492–481 Ma (U-Pb, zircon: Oliver et al. 1993). Comparable Karkonosze gneisses from the South Karkonosze Metamorphic Complex yielded an age of c. 503–505 Ma (Pb-Pb zircon ages: Kröner et al. 2001). The Cambrian age of KCU meta-sediments was recently confirmed by recognition of Lower Cambrian archaeocytha remnants found in crystalline limestones nearby Dolní Albeřice in Rychory Mts (Hladil et al. 2003). Volcanics of KCU prevailing occur at the top of the succession and are represented by metabasites (from alkaline, within-plate to tholeiitic N-MORB types) and subordinate interlayers of acid metavolcanics (= porphyroids, leptynites) which are of extrusive or subvolcanic origin. Porphyroids from Dolní Albeřice were dated on 501 ± 8 Ma (Rb-Sr, whole rock; Bendl and Patočka 1995). All these rocks are strongly sheared and metamorphosed up to amphibolite facies (partly in HP blue-schists conditions) due to Variscan nappe stacking.

The Leszczyniec Unit is devoid of sedimentary strata and consists exclusively of a few km thick meta-volcanogenic, Na-rich spilite-keratophyre association (originally: tuffs, volcanoclastics and lavas) penetrated by meta-igneous rocks, numerous bodies of so called Paczyn gneisses and less frequent meta-gabbros and diorites. Spilites, at present epidote-amphibolites, greenstones and greenschists, showing mostly N-MORB chemical characteristics, are closely interbedded with keratophyres – now laminated quartz-albite-chlorite schists or massive granofelses – derived

from dacite - rhyodacite - rhyolite suite. These rocks are metamorphosed up to higher level of the greenschist facies but show less intense shearing than observed in KCU. Paczyn gneisses form concordant, sill-like or cross-cutting, irregular intrusions (within, in between the) spilite-keratophyre association. They represent different petrographic varieties including granodiorites, granites and leucotonalites but are chemically rather uniform and very similar to keratophyres. They resemble Na-rich plagiogranites interpreted as intrusives of the ocean ridge ophiolite sequence (Szalamacha & Szalamacha 1991) or trondhjemites - magmatites related with volcanic arc (Narębski et al. 1986). The age of one small pod of these acid rocks was determined at 505 ± 5 Ma (U-Pb, zircon: Oliver et al. 1993). The youngest rocks of the LU are hornblende-zoisite amphibolites derived from gabbros and diorites which intruded at c. 494 ± 2 Ma (U-Pb, zircon: Oliver et al., op.cit.). These meta-gabbros & diorites have low Zr and Y concentrations and a distinct Nb negative anomaly typical of primitive low-K island arc basalts.

New isotope datings using the zircon evaporation $^{207}\text{Pb}/^{206}\text{Pb}$ method were performed with the aim to check out previous geochronological results and to precise the time of magmatic events in the East Karkonosze Metamorphic Complex. Single zircons or groups of 3 to 10 crystals were evaporated and for the following samples – listed below – a mean age from 5 to 8 measurements for each rock was obtained.

Samples from Kowary-Czarnów Unit:

- leptynite, locality: Janowice Stare (sample JSTR); pinkish, fine-grained quartz-feldspar schists with well developed foliation, possible protolith: acid subvolcanic rock, mean age: 493 ± 11 Ma,
- meta-porphyrroid, locality: Dolní Albeřice (sample HA-KVK2); yellowish, thinly laminated gneiss with a perfect mylonitic foliation, possible protolith: acid subvolcanic rock with porphyritic fabric, mean age: 512,0 ± 8 Ma,

- leptynite, locality: Horni Marsov (sample HO.MA); pinkish, fine-grained quartz-feldspar schists forming few m thick syn-sedimentary interlayer within dark micaschists, possible protolith: acid extrusive, pyroclastic rock (ash fall?), mean age: 507 ± 11 Ma,
- Kowary gneiss, locality: Kowary-Pogórze (sample KOW); coarse-grain augen gneiss, protolith: porphyritic granite, mean age: 500 ± 11 Ma. For this sample also other zircon ages were determined: $564,0 \pm 8,4$ Ma, $767,6 \pm 7,3$ Ma and $1700,8 \pm 24,1$ Ma, which seem to reflect an influence of older cores, inherited from zircons of melted source rocks.

Samples from Leszczyniec Unit:

- Paczyn gneiss, locality: Ogorzelec quarry (sample OGOR); undeformed to weakly deformed leucocratic, medium-grained albite-granitoid, protolith: leuco-tonalite, mean age: $496,5 \pm 8,4$ Ma,
- Paczyn gneiss, locality: outcrops N of Klatka (sample KL1A); medium-grained, augen chlorite-albite-quartz gneiss, possible protolith: granite, mean age: $499,3 \pm 8,0$ Ma,
- Paczyn gneiss, locality: Klatka quarry (sample KLAT); weakly deformed fine- to medium-grained albite gneiss with amphibole and epidote, possible protolith: granodiorite, mean age: $497,9 \pm 6,2$ Ma,
- Paczyn gneiss, locality: Raszów (sample RAS); weakly deformed coarse-grained chlorite-albite granite-gneiss, possible protolith: granite, mean age: $507,2 \pm 9,0$ Ma.

The new isotope data for KCU framed in a range of ca. 493 to 512 Ma – approximately covering the period from Late Cambrian to Early Ordovician – clearly indicate that volcanic activity documented by leptynites and meta-porphyrroids are of nearly the same age with subsequent plutonism expressed by intrusion of the protolith of the Kowary gneisses.

Unfortunately no zircons were found in samples representing acid volcanics of the spilite-keratophyre association and meta-diorites from LU and all new isotope ages for this unit register only the time of emplacement of its acid igneous members, i.e. Paczyn gneisses. The ages are bracketed between 507–496 Ma and unequivocally point out that the time of plutonic activity in LU is very similar to that in KCU. Zircons from Paczyn gneisses yielded homogeneous ages around 500 Ma and show no disturbances from

inherited constituents. This fact and the chemical affinity with surrounding meta-keratophyres proves that magmas of the Paczyn gneisses were fed from the same magma chamber as the nearly simultaneous spilites and keratophyres or originated by partial melting of this association.

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Anomalously Hot Gradient of Barrovian Sequence in the Silesian Zone (Bohemian Massif): an Interplay between Devonian Rifting and Carboniferous Collision

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Tectonically inverted Barrovian metamorphic zonation is a characteristic feature of 180 km long belt of deformed Brunia micro-continent emerging through high-grade rocks of the internal Varis-

can root exposed along the eastern Variscan collisional front. Investigations of metamorphic evolution in the northernmost part of collisional margin have shown an anomalously hot geothermal