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Metamorphic complexes of the Precambrian Zheltavsky massif (Southern Kazakhstan)

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Paleozoic complexes of the western part of the Central Asian Orogenic Belt contain large blocks that expose Precambrian continental crust. Metamorphic complexes making up these blocks in many cases comprise HP and UHP units (e.g. Kokchetav massif (Northern Kazakhstan); Makbal and Aktyuz blocks of Northern Tian Shan). Metamorphic lithologies of the Precambrian Zheltavsky massif, located in the Chu - Ili region (S. Kazakhstan), comprise the Anrakhai metamorphic complex (AMC).

The AMC is arbitrarily subdivided into two series. The Uzunbulak series rocks are predominant. The main varieties are represented by a Neoproterozoic orthogneisses (protolith age ≈ 800 Ma), which encloses garnet amphibolites. Among the Uzunbulak series, there are also Paleoproterozoic (protolith age 1841 ± 6 Ma) subalkaline gneissic granites. In the Koyandy series of the AMC, paragneisses of variable composition are predominant. Garnet–biotite (Grt–Bt) gneisses are metasedimentary rocks, as confirmed by detrital zircons, which yielded a range of ages from 694 Ma to 2257 Ma. In some cases associated with the Grt–Bt paragneisses are HP rocks (eclogites and garnet clinopyroxenites with the metamorphic age of 489 ± 9 Ma; mylonitized acid granulites or spinel (Sp) peridotites). In the NE part of the AMC, the paragneisses are mainly Bt and Bt–muscovite schists with layers of meta-psammite and marble.

The most well studied rocks of the AMC are ultramafic varieties from the Koyandy series, revealing the different features of chemical and mineral compositions. Fe-Ti group [1] of ultramafics includes eclogites and garnet clinopyroxenites with relatively high contents of FeO and TiO_2 (13–19 and 2–4.5 wt.%, respectively) and low contents of MgO (6–11 wt.%) and corresponding to a tholeiitic group. The absence of either coesite or pseudomorphs after coesite in the rocks indicates HP formation conditions: P–T estimates show T = 750–800° C and P = 15–18 kbar at the peak. Moreover, the evolution of eclogites and garnet clinopyroxenites included a stage of prograde metamorphism under increasing P and T during burial, indicated by microinclusions of amphibole and clinozoisite of the earlier stages within Grt grains. From here, Fe-Ti rocks may have been derivatives of intraplate tholeiitic melts, introduced into the continental crust before the HP metamorphism (i.e. prior to subduction).

A Mg–Cr group of ultramafic rocks [1] is represented by serpentinized dunites with layers of spinel (Sp) peridotites and subordinate pyroxenites with hornblendites. The rocks show high MgO and Cr_2O_3 contents (30–36 wt.% and 0.15–0.4 wt.%, respectively) and low contents of TiO_2 (up to 0.1 wt.%), FeO (up to 9 wt.%) along with overall depletion by REE (ΣREE = 0,47– 17 ppm). The main minerals of Sp peridotites at the peak are Cr-Sp, Opx with very low Al_2O_3 contents (0.57 wt.%), olivine (Ol_{90}) ± Grt (nearly completely replaced by Cpx–Sp symplectites) ± Cpx, and correspond to at least P = 34 kbar according to the Al-in-Opx contents. Similar to the rocks of Fe-Ti group spinel peridotites, the metamorphic evolution included a prograde stage: peak Ol encloses inclusions of medium-chromium Sp and Opx with higher Al_2O_3 (1.1 wt.%) in comparison to peak Opx. Therefore, the protoliths of the Mg–Cr rocks may have been fragments from different levels of the mantle wedge, buried during subduction to

UHP field. Thus, the AMC represents a tectonic package, consisting of units from different levels buried to different depths during subduction and juxtaposed during exhumation.

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References:

[1] Carswell D et al. (1983) Bull Minéral 106: 727-750