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Supra-subduction igneous formations of the Char ophiolite belt, East Kazakhstan

Inna Safonova^{a,b,c}, Tsuyoshi Komiya^d, Rolf L. Romer^e, Vladimir Simonov^{a,b}, Reimar Seltnann^f,
Sergey Rudnev^a, Shinji Yamamoto^g, Min Sun^h

^a Institute of Geology and Mineralogy, SB RAS, Koptyuga ave. 3, Novosibirsk 630090, Russia

^b Novosibirsk State University, Pirogova St. 2, Novosibirsk, 630090, Russia

^c School of Earth Sciences and Engineering, Nanjing University, 210023 Nanjing, China

^d Department of Earth Science and Astronomy, University of Tokyo, Tokyo 153-8902, Japan

^e GFZ German Research Centre for Geosciences, Telegrafenberg, D-14473, Potsdam, Germany

^f Natural History Museum, Centre for Russian and Central EurAsian Mineral Studies (CERCAMS), London, SW7 5BD, UK

^g Yokohama National University, 79-1 Tokiwadai, Hodogaya-ku, Yokohama 240-8501, Japan

^h Department of Earth Sciences, the University of Hong Kong, Pokfulam, Road, Hong Kong, China

There is a wide range of controversial tectonic concepts for the final development of the Paleo-Asian Ocean (PAO) in the western Central Asian Orogenic Belt (CAOB), largely due to scarcity of geochronological and geochemical data. Our paper presents first results of U-Pb zircon dating and detailed geochemical studies (major and trace elements, Sr, Nd and Pb isotopes) of subduction-related mafic to felsic igneous rocks of the Char ophiolite belt (East Kazakhstan). The new data shed light on the final stage of the PAO in this region. The igneous assemblages comprise mafic to felsic volcanic rocks and their plutonic varieties. The rocks yield Devonian and early Carboniferous U-Pb zircon ages, which match the previously reported micropaleontological ages of sedimentary rocks of oceanic origin. According to major element composition, the rocks belong to the tholeiitic and tholeiitic to calc-alkaline transitional igneous series. They are characterized by low TiO₂ (0.7 wt.% in average) and moderately enriched light rare-earth element (LREE) to flat chondrite normalized REE patterns (La_n = 3.5 - 34.6, La/Sm_n = 0.8 - 4.6, La/Yb_n = 0.6 - 9.1). Primitive mantle normalized multi-element spectra show distinct troughs at Nb (Nb/La_{pm} = 0.1-0.38; Nb/Th_{pm} = 0.04-0.6). Most of the samples have positive εNd_t values ranging from +2.9 to +8.8 and ²⁰⁶Pb/²⁰⁴Pb ratios ranging from ~18.0 to ~19.7. The trace element and isotope data and the results of geochemical modeling in the Nb-Yb system suggest high degrees of melting of a strongly depleted mantle source in the spinel stability field. Clinopyroxene (cpx) monomineral thermometry and the calculations based on the composition of cpx hosted melt inclusions suggest that the melts from which the younger samples were derived crystallized at lower temperatures (below 1170°C) at depths of 12, 6-3 km and in subsurface conditions, while the older samples derived at higher temperatures (up to 1193°C) crystallized at a depth from 6 to 3 km. Our new data show that the Char ophiolite belt hosts fragments of at least two intra-oceanic arcs, middle Devonian and Early Carboniferous, which existed in the Irtysh-Zaisan branch of the Paleo-Asian Ocean, at the active margin of the Kazakhstan continent.

Key words: Central Asian Orogenic Belt; Paleo-Asian Ocean; U-Pb zircon ages; whole-rock geochemistry and Sr-Nd-Pb isotopes; intra-oceanic arcs; petrology

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