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Proterozoic Eastern Sayan ophiolites (Central Asian Orogenic Belt) record subduction initiation in vicinity of continental block

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Geochemical study of cumulate and volcanic rocks from $\sim$ 1020 Ma Eastern Sayan ophiolites[1] (Siberia, Russia) is used to provide a correlation between two ophiolitic belts and link them to subduction initiation setting. Studied areas include Ospin and Ilchir massifs to the East and Dunzhugur to the West of Early Precambrian Gargan block. Ophiolitic cumulates represent peridotite-pyroxenite-gabbro-norite suite with crystallization orders of Cr-Sp – Ol – Cpx – Opx – Plag, and Cr-Sp – Ol – Opx – Amph – (Cpx) – Plag. Clinopyroxene is augite-diopside with Mg# 85-95, low Al_2O_3 (1-2.5%) and TiO_2 (0.05-0.2%). Amph is Mg-hornblende to edenite (Mg# 84-86, 5-8% Al_2O_3, 0.3-0.6% TiO_2). Cr-Sp has Cr# 65-83 and 0.05-0.3% TiO_2 in cumulates with high Opx proportion, while in Cpx-dominating pyroxenites chemistry of Cr-Sp is variable (Cr# 40-75, 0.05-0.5% TiO_2). Due to alteration, Ol and Opx chemistry is available only for some samples (Ol: Mg# 88, 0.2-0.3% NiO; Opx: Mg# 89, 1.6% Al_2O_3). Whole-rock MgO ranges 9 to 38%. Amph-free pyroxenites and gabbro-norites show flat to slightly depleted REE pattern with negative HFSE anomalies. Amph-pyroxenites have fractionated trace-element pattern with LREE enrichment, Nb-Ti minima at slightly higher HFSE abundances. In-situ LA-ICP-MS analysis of Cpx in Amph-free pyroxenites and gabbro-norites revealed moderately depleted to flat REE and Nb-Zr-Hf-Ti depletion, with low trace element abundances (La/SmPM = 0.14-0.9, Zr 0.6-2.3, Nd = 0.2-1.1, Yb = 0.2-0.7 ppm). Melts calculated to be in equilibrium with Cpx using distribution coefficients[2] are REE-flat to slightly LREE-enriched (La/SmPM = 1-4) at low HREE abundances (0.5-1.5 ppm Yb). Overall, crystallization orders, mineral and whole-rock chemistry suggest origin of ophiolitic cumulates from low-Ca boninites or primitive andesites (higher Opx or Amph proportion) to high-Ca boninites or primitive island arc tholeiites (Cpx-dominating, Amph-free associations with subordinate Opx).

Ophiolitic volcanics and dikes are low-Ca and intermediate-Ca boninites, andesite-basalts, andesites, dacites of calc-alkaline (CA) affinity with rare evolved island-arc tholeiitic (IAT) andesite-basalts. They resemble appropriate rocks of intraoceanic island arcs, forearcs, and ophiolites. Boninites and CA-andesites are LREE-enriched (La/SmPM 1.2-3.8) at low HREE (0.5-1.6 ppm Yb) contents while evolved IAT show flat REE (La/SmPM = 1.1) and higher abundances (2.4-2.8 ppm Yb), and both have negative Nb anomalies.

Nd-isotopic data expressed as epsilon Nd(1020Ma) values are -2.3 to +4.1 in cumulates, -2.8 to +0.4 in boninites and andesites, and +2.3 to +2.7 in IAT (compared to epsilon Nd(1020Ma) +7.8 in depleted mantle). The ophiolites obducted on the Gargan continental block, which contains Archean gneisses with epsilon Nd(1020) = -20 to -28[1]. Subduction and recycling of sediments derived from these gneisses could explain enriched Nd isotopic characteristics of the studied ophiolitic rocks.

The boninite-andesite-IAT association is usually found in subduction initiation settings recorded by modern forearc regions and forearc ophiolites. The difference of the Eastern Sayan ophiolites is their supposed formation close to ancient continental block which supplied recycled material into newly formed subduction zone.

1. Sklyarov et al (2016) Russ Geol Geophys **57**, 127-140

2. Sobolev et al (1996) Petrology **3**, 326-336.