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Archean high δ18O Mg-diorite: crustal-derived melt hybridized with enriched mafic accumulated rocks

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The genesis of Mg-diorite or sanukitoids has significances to understand the crustal growth and tectonic style in Archean. The chemical compositions of minerals and rocks, whole-rock Sm–Nd isotope, zircon SIMS U–Pb ages and Hf–O isotopes of Zhulagou (ZLG) Mg-diorite and their mafic enclaves (Yinshan Block, North China Craton) were studied to place constraints on their sources and genesis, and therefore provide information about dynamic processes. The ~2520 Ma ZLG diorites have intermediate SiO_2 (59.4–65.5 wt.%), high Mg# (49–52), Cr (90.4–438 ppm), Ni (15.0–95.9 ppm), Sr (436–882 ppm) and Ba (237–1206 ppm) contents with fractionated rare earth elements (REE, LaN/YbN = 9.1–40.5) and depleted high field-strength element (HFSE, e.g. Nb, Ta and Ti). These geochemical signatures are similar to those Archean high-Mg diorites and sanukitoids. However, they are sodic with low K2O/Na2O (0.14–0.49) ratios, exhibiting an affinity with Archean trondhjemite–tonalite–granodiorite (TTG). Abundant coeval amphibole-bearing mafic enclaves (~2525 Ma) are enclosed within the ZLG diorites. They display low SiO_2 (46.5–50.3 wt.%) contents but high concentrations of MgO (9.0–14.5 wt.%), Cr (647–1946 ppm) and Ni (197–280 ppm). They are enriched in K2O (0.64–3.43 wt.%) and large ion lithophile element (LILE), depleted in Nb, Ta and Ti. Combined with their concave REE patterns and prominent negative Eu anomaly, we suggest that they are cumulates of the melt which probably derived from subduction-related Archean metasomatized mantle source. Mineral trace element modelling results, similar εNd(t) (+0.6 to +2.3) and δ18O(Zrc) values (~8.6–9.0 ‰ of the diorites and mafic enclaves, strongly reflect that they had experienced intense interaction and hybridization.
Evolved whole-rock Nd isotopes (TDM = 2.80–2.70 Ga), variable zircon εHf (t) (–1.6 to +6.0) and high δ18O (~9.0 ‰ values of the diorites indicate that they most likely originated from melting of an older continental crust ($\geq$ 2.65 Ga). The identified Archean highest δ18O(Zrc) (~9.0 ‰ magmatism further demonstrates that supra-crustal sediments or fluids have been transferred into the lower continental crust. All our observations provide first evidence that Archean high-Mg rocks (sanukitoids) can also form by partial melting of lower crust that hybridized with enriched mafic rocks. The associated mantle-crust interaction, large-scale crustal anatexis and high-grade metamorphism were probably induced by rollback of oceanic slab in a subduction zone in the Yinshan Block of the NCC during 2.52–2.50 Ga.

KEY WORDS: Archean lower crust; mafic cumulates; North China Craton; sanukitoids; zircon oxygen isotope