The Triassic Duobaoshan appinite-granite suite, NE China: implications for a water-fluxed lithospheric mantle and an extensional setting related to the subduction of the Mongol-Okhotsk Ocean

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Abstract

In this study, we present zircon U-Pb ages, Hf-O isotopes, and whole-rock geochemical data for the newly identified Duobaoshan appinite-granite suite in the eastern Central Asian Orogenic Belt (CAOB). Field and petrographic investigations show that this suite of rocks is composed of hornblende gabbro, quartz monzonite, and granite porphyry. The appinites are abnormally hornblende-rich, and contain spectacular hornblende phenocrysts, pegmatitic textures, and miarolitic cavity structures that indicate an anomalous water-rich origin. The quartz monzonite and granite porphyry show intrusive contact relations with the appinites. Secondary ion mass spectrometry (SIMS) zircon dating reveals that the Duobaoshan appinite-granite suite was emplaced in a very short time interval of 224–223 Ma. These samples show typical subduction related arc magmatic geochemical characteristics that are enriched in large-ion lithophile elements (LILEs) and light rare earth elements (REEs), depleted in high field strength elements (HFSEs) and middle and heavy REEs. All samples exhibit comparative total REEs and no significant evolutionary relationships. The appinites show high Sr/Y ratios (reaching ˜100) and positive or zero Eu anomalies, which reveal amphibole fractionation promotion and plagioclase fractionation suppression in a water-rich magma system. The quartz monzonite possesses high Sr/Y and La/Yb ratios that exhibit adakite-like properties and were derived from thickened lower continental crust. The granite porphyry is silica-rich and non-adakitic. All samples have juvenile whole-rock initial $^{87}Sr/^{86}Sr$ ratios (˜0.7038) and $e_{Nd}(t)$ values. Zircons have depleted mantle-like e_{Hf} (t) (to +12.0) and $\delta^{18}O$ (˜+5.65geochemical features with observations of the regional geology and tectonic setting, we propose that the Duobaoshan appinite-granite suite was generated under a Triassic back-arc extensional setting related to the southward subduction of the Mongol-Okhotsk Ocean. The appinites were derived from an unusual water-rich mantle source, which was previously metasomatized by slab-derived fluids. The quartz monzonite and granite porphyry were generated from partial melting of the juvenile lower continental crust triggered by coeval appinitic magma underplating.

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The appinite suite of rocks offers a unique opportunity to reveal the properties of subarc lithospheric mantle, indicate essential crust-mantle interactions, and ascertain critical geodynamic settings. In this study, we present zircon U-Pb ages, Hf-O isotopes, and whole-rock geochemical data for the newly identified Duobaoshan appinite-granite suite in the eastern Central Asian Orogenic Belt (CAOB). Field and petrographic investigations show that this suite of rocks is composed of hornblende gabbro, quartz monzonite, and granite porphyry. The appinites are abnormally hornblende-rich, and contain spectacular hornblende phenocrysts, pegmatitic textures, and miarolitic cavity structures that indicate an anomalous water-rich origin. The quartz monzonite and granite porphyry show intrusive contact relations with the appinites. Secondary ion mass spectrometry (SIMS) zircon dating reveals that the Duobaoshan appinite-granite suite was emplaced in a very short time interval of 224–223 Ma. These samples show typical subduction related arc magmatic geochemical characteristics that are enriched in large-ion lithophile elements (LILEs) and light rare earth elements (REEs), depleted in high field strength elements (HFSEs) and middle and heavy REEs. All samples exhibit comparative total REEs and no significant evolutionary relationships. The appinites show high Sr/Y ratios (reaching ~100) and positive or zero Eu anomalies, which reveal amphibole fractionation promotion and plagioclase fractionation suppression in a water-rich magma system. The quartz monzonite possesses high Sr/Y and La/Yb ratios that exhibit adakite-like properties and were derived from thickened lower continental crust. The granite porphyry is silica-rich and non-adakitic. All samples have juvenile whole-rock initial 87Sr/86Sr ratios (~0.7038) and εNd(t) values. Zircons have depleted mantle-like εHf (t) (to +12.0) and δ18O (~+5.65‰) values. Combining these geochemical features with observations of the regional geology and tectonic setting, we propose that the Duobaoshan appinite-granite suite was generated under a Triassic back-arc extensional setting related to the southward subduction of the Mongol-Okhotsk Ocean. The appinites were derived from an unusual water-rich mantle source, which was previously metasomatized by slab-derived fluids. The quartz monzonite and granite porphyry were generated from partial melting of the juvenile lower continental crust triggered by coeval appinitic magma underplating.