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Contemporaneous growth and differentiation of the continental crust in the accretionary orogen: a case study from the Chinese Altai, CAOB

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The Chinese Altai, a key area of the Central Asian Orogenic Belt (CAOB), experienced large scale magmatism, high temperature metamorphism and increase of εHf(t) values of zircons in the Devonian. Geochemical and Sr-Nd-Hf isotopic analyses were conducted on the Devonian metaluminous and strongly peraluminous granitic rocks and mafic rocks to constrain the growth and evolutionary process of the crust in the Chinese Altai. These Devonian mafic rocks show large ranges in initial 87Sr/86Sr ratios (0.7041–0.7082), εNd(t) (-2.5–+8.1) and εHf(t) values (+2.8–+15.6) with variable Ba/La, La/Yb and Th/Yb ratios, which are attributed to the metasomatism of their mantle source by fluid and melt from the subducted sediments. The Devonian metaluminous granites show εNd(t) values ranging from -2.2 to +0.8 and εHf(t) from +3.9 to +12.9 with flatten HREE pattern. The very similar Nd-Hf isotopic decoupling between these metaluminous granites and coeval mafic rocks suggest that these granites were possibly remelting products of these mafic rocks at middle to lower crustal level. The Devonian strongly peraluminous granitic rocks show lower εNd(t) (-4.6 to -0.6) and εHf(t) (+2.1 to +4.3) values than the metaluminous granites. Meanwhile, these samples show higher contents of compatible elements (Cr = 12.4 to 153 ppm; Ni = 11.5 to 51.5) than those metaluminous granites (Cr = 7.10 to 36.2 ppm; Ni = 2.80 to 25.5). We suggest that these strongly peraluminous samples were derived from magma source with some contributions from the early Paleozoic sedimentary rocks (Habahe Group). Our work reveals that large amount of juvenile materials were input into the crust of the Chinese Altai in the Devonian in the form of strongly basaltic underplating. The solidified basaltic magma underwent widespread remelting due to the high thermal gradient in the Devonian, resulting in felsic components emplacing into middle to upper crust and leaving mafic residue in the lower crust. Seismic data illustrates that the thickness of the whole crust and lower crust of the Chinese Altai are about 56 km and 20 km, respectively. Since no large scale magmatism developed after the Middle Paleozoic in the Chinese Altai, the Devonian magmatism should be a major event resulting in formation of current crustal architecture in the Chinese Altai with contemporaneous continental growth and differentiation.