Crustal-derived granitoids in accretionary orogens: implications for the evolution and differentiation of continental crust

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The location and mechanism of initial mantle extraction generating primitive crust and its transformation into compositionally evolved continental crust remain enigmatic. Accretionary orogens are identified as one of the viable locations, where manufacturing and reworking of the continental crust occurs. Therefore, granitoid magmas emplaced in the accretionary orogens can potentially provide vital evidence for the origin and evolution of continental crust. Here, we present petrology and geochemistry in relation to geochronology of crustal-derived granitoids from southern India and develop a petrogenetic model to identify the source area and petrogenetic processes.

The Kerala Khondalite Belt (KKB) in southern Indian granulite terrain exposes lower-crustal section consisting of metatonalites and metagranites formed during arc-continent collision. The zircon crystallization ages reported for these granitoids show a prolonged time gap of 210 Ma between the formation of metatonalites (ca. 2.1 Ga) and metagranites (ca. 1.89 Ga) indicating multiple stages of melting events in the KKB. The εHf(t) values (−0.4 to +3.1) obtained on zircons from metatonalites point to isotopically heterogeneous protolith and suggest the presence of a depleted mantle component mixed with early formed crust in the source region. Geochemistry of the metatonalites also indicate their origin in relation to partial melting of a thickened oceanic-arc crust composed of Archaean mafic source rocks with a garnet amphibolite residue. The negative εHf(t) values (−6.1 to −9.2) obtained on zircons of the metagranites and whole-rock high Rb/Sr (avg. 1.80) and Ba/Sr (> 6) ratios indicate crustal reworking in their genesis, suggesting remelting of a quartzo-feldspathic (TTG) source. Thus, the multiple tectono-magmatic records of the metagranitoids of KKB suggest building up of an over-thickened oceanic-arc leading to initial mantle extraction forming the primitive crust. Subsequent melting of this primary crust by basaltic underplating and finally by arc-continent collision caused intra-crustal melting and differentiation of the continental crust leading to its compositional evolution.