CALC-ALKALINE I-TYPE GRANITOID PRODUCTION BY PARTIAL MELTING OF THICKENED CRUST DURING EARLY CONTINENTAL COLLISION IN THE ARAÇUAÍ OROGEN

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ABSTRACT: The Araçuaí orogen in southeastern Brazil formed during the amalgamation of West Gondwana in the late Neoproterozoic upon which voluminous amounts of granitoids were produced from ca. 630 to 490 Ma. The central domain of its interior part exposes batholiths with calc-alkaline, metaluminous I-type affinities that are hosted by mafic to intermediate Paleoproterozoic basement rocks and supracrustal metasedimentary rocks. The tonalitic to granodioritic batholiths of the central domain have been interpreted as a magmatic arc that formed in response to subduction processes, which was based on geochemical signatures, inferred ophiolitic remnants as well as abundant microgranular mafic enclaves (MME). It is generally accepted that isotopic compositions of the calc-alkaline granitoids indicate involvement of Paleoproterozoic basement rocks. Small mafic intrusions and MMEs have been interpreted, however, to indicate involvement of mantle melts.Here we present zircon U-Pb-Hf isotope data of granitoid, gabbro as well as basement samples and discuss that partial melting of the lower crust alone can explain the features of the magmatic arc. Single plutonic bodies record a large range of zircon crystallisation ages from 620 to 580 Ma with subchondritic Hf isotopic compositions consistent with reworking of crustal rocks. Small gabbroic intrusions are contemporaneous to more felsic plutons of the arc characterised by a similar range in age. Paleoproterozoic basement samples with crystallisation ages between 2.1 and 2.0 Ga indeed show superchondritic Hf isotopic compositions that fall on a crustal evolution line together with the Neoproterozoic granitoids further validating them as potential source. This observation is consistent with melting experiments which indicate that fluid-absent partial melting of mafic to intermediate source rocks can produce calc-alkaline, I-type granitoids. The arc-setting chemical signature of the Neoproterozoic granitoids could thus be a feature inherited from the source. MMEs are characterised by similar mineral assemblages, contiguous chemical compositions and identical isotopic compositions to their host granitoids. Zircon Hf isotopic compositions of the gabbroic intrusion will help to constrain if the MMEs represent synplutonic injections of mafic magmas. Their chemical and isotopic compositions are, however, consistent with crystallisation from a coeval magma that gave rise to the host granitoids. Thus, mantle-derived melts might only have acted as heat source for lower crustal melting.An alternative source for heat causing crustal anatexis is the increased contribution from the decay of radiogenic elements in areas of thickened crust. Potassium, U and Th are enriched in the basement rocks of the Araçuaí orogen. Stacking of these rocks during continental collision can result in significant steepening of geotherms inducing dehydration melting at lower crustal levels. Zircons of host metasedimentary rocks indicate onset of collision as early as 630 Ma and P-T modelling is consistent with burial to mid crustal levels before final emplacement of the granitoids. Thus Paleoproterozoic basement rocks should have been buried to lower crustal levels by that time. We propose that calc-alkaline metaluminous granitoids of the Araçuaí orogen might have been produced by lower crustal melting as a consequence of high radiogenic heat production without subduction processes or mantle melts being involved.

KEYWORDS: ARAÇUAÍ OROGEN; CALC-ALKALINE METALUMINOUS GRANITOIDS; LOWER CRUSTAL MELTING