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The timing of migmatization in the northern Arabian-Nubian Shield: Evidence for a juvenile sedimentary component in collision-related batholiths

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Collision-related granitoid batholiths, like those of the Hercynian and Himalayan orogens, are mostly fed by magma derived from metasedimentary sources. However, sedimentary contribution to the late Neoproterozoic calc-alkaline batholiths of the Arabian Nubian Shield (ANS) is obscured by its juvenile characteristics and scarcity of migmatites. Nonetheless, U-Pb ages and REE contents of monazite, zircon, xenotime, and apatite demonstrate the direct linkage between peraluminous granites and migmatites. A single prolonged period of monazite growth between 640 to 600 Ma is associated with prograde, peak, and retrograde metamorphism. The distribution of monazite dates and zircon ages in migmatites suggest that peak thermal conditions and partial melting prevailed for ~10 m.y., from 620 to 610 Ma. Similar monazite ages (~620 Ma) of amphibolite facies schists indicate that migmatites of the northernmost ANS are the result of widespread regional, rather than local contact metamorphism. Xenotime and apatite dates group around 600-580 Ma and record retrogression to greenschist facies conditions as garnet continues to destabilize. REE patterns of monazite are well correlated with age, recording garnet growth and garnet breakdown in association with the prograde and retrograde stages of the melting reactions, respectively. Phase equilibrium modeling and mineral thermobarometry illustrate that melting occurred either by dehydration of muscovite or by water-fluxed melting at ~650-680 °C and 5-7 kbar. The expected melt production is 8-10%, allowing melt connectivity network to form and eventually melt extraction, segregation, and accumulation into batholiths. The crystallization of peritectic melt retained in dia- and metatexites coincides with the emplacement of a vast calc-alkaline granitic flux throughout the northern ANS, representing the climax of East African orogenesis.