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Multiple Melting Events During an Orogeny and the Role of Water

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In this paper we discuss the role of water fluxing of hot rocks in orogens and how this can lead to several overprinting anatectic events in short succession, without requiring significant temperature fluctuations. On Kangaroo Island, South Australia, we have documented several anatectic events on turbidites of the Kanmantoo Fm. along a narrow coastal strip. These melting events were associated with the 500Ma Delamerian Orogen and are associated with different deformation events. The anatectic rocks have typically 20 to 50% or more neosome volume, rare sillimanite, late-formed randomly oriented muscovite, and lack any other anhydrous peritectic minerals. We interpret these features to result from water fluxing. In this area, we documented four major melting and deformation events overprinting one another. Early anatectic melts solidified and were subsequently overprinted by later anatectic events associated with changes in the nature and orientation of structures.
The oldest and youngest magmatic rocks derived from anatexis were dated by U-Pb SHRIMP (sensitive high-resolution ion microprobe) dating techniques. Both reveal a continuous age spread between ca. 495 and 465 Ma. The age range is interpreted to indicate the duration
of anatexis (order of 30 m.yr.), with the older ages marking onset of monazite growth as the system approached peak metamorphism and younger ages representing final growth close to the solidus during cooling.
Together the evidence suggests that the region remained above the water-saturated solidus for a considerable period and melting occurred during fluxing of water-rich fluids and an increase in water activity. Solidification occurred as water activity decayed, until a new water-fluxing event occurred triggering a new melting event. We suggest that this may be a common process in the deep crust under arcs where magmas are the source of both fluids and heat.