On the hunt for a Gondwanan suture zone in South India

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The Southern Granulite Terrane (SGT) of India is located at the apex of the Indian subcontinent and is a Proterozoic mobile belt that was involved in the amalgamation of the Gondwana supercontinent. The tectonic evolution and geochemical characterization of individual crustal domains within the SGT is rendered difficult due to the intensity of metamorphism (ultra-high-temperature conditions) associated with the ca. 550–500 Ma collision between Neoproterozoic India and the African continents.

Here, we use Sm–Nd isotopes, U–Pb zircon geochronology and whole-rock geochemistry of the basement rocks combined with the Lu–Hf and U–Pb isotopic systems in detrital zircons from the overlying Neoproterozoic sequences to define Indian versus African affinities of the rock packages. The results are used to place constrains on the spatial distribution of individual crustal domains during the Proterozoic. Our results show that the metasedimentary rock packages north of the proposed suture zone (Palghat Cauvery Shear Zone) have Palaeoproterozoic maximum depositional ages and detrital signatures typical of Indian basement rocks, while those to the south have Neoproterozoic maximum depostional ages and probable African sources.

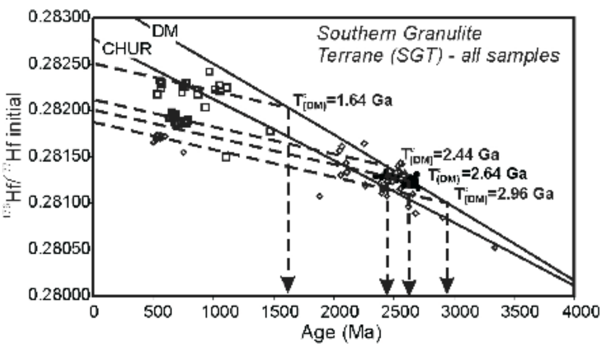

Figure 1: Initial $^{176}Hf/^{177}Hf$ vs. Age (Ma) evolution plot of detrital zircons from arcoss the SGT.

Self-organizing reactive porosity waves allow large-scale fluid escape from subducting oceanic lithosphere

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At subduction zones seawater-altered oceanic lithosphere is returned to the Earth's mantle, where increasing temperatures and pressures results in the progressive destabilization of the hydrous minerals to release large amounts of aqueous fluids. This cycling of volatiles is one of the most distinctive features of subduction zones and has fundamental consequences for Earth's geodynamics and chemical cycles. Fluids released from the subducting slab trigger sub-arc mantle melting leading to explosive volcanism and induce petrophysical changes during dehydration that are thought to be the principal source of intermediate-depth intra-slab earthquakes. In all these cases large-scale transport systems need to form where fluids can escape from the subducting slab to either migrate up-dip along the plate interface or into the overlying mantle wedge. However, permeability is minimal at the depths and confining pressures relevant to subduction settings, thus insufficient to allow for pervasive fluid flow with high enough fluxes to efficiently drain the subducting oceanic plate. Evidence of the volatile cycle indicates that a fluid extraction mechanism is required that can keep pace with the slab descent velocity of cm/year to avoid the fluid being lost to the mantle. The tendency of fluid flow to occur channelized in space and time, illustrated in nearly all high-pressure terrains as vein networks, points to a potential mechanism. Channelized fluid flow would enable efficient fluid release rates with high local fluid fluxes over long distances. However, how a dehydrating system with an initially low, pervasive fluid production develops into channelized fluid extraction network is largely unknown. By using an interdisciplinary approach of field observations, reaction microstructures and numerical modeling we investigate the most prominent devolatilization reaction for the deep volatile cycle, the breakdown of serpentine phases within the subducting oceanic mantle. Based on our findings we formulate a fully consistent mechanistic model of metamorphic fluid escape during mineral dehydration.

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