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Ductile extrusion of the weak mid-crust during transpression in the Neoproterozoic East African Orogen

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Hot Proterozoic collisional orogens such as the East African Orogen are commonly characterized by widespread granulite facies metamorphism and magmatism synchronous with deformation. The deeply exhumed southern East African Orogen represents a window into the weak mid-crust of a Himalayan style collisional belt and could thus provide a better understanding of the processes responsible for coeval melt generation, lateral flow and ductile extrusion of the middle crust. However, the complex thermal history of the granulites that are so widespread in East Africa and Southern Madagascar, involving consecutive HT-HP and HT-LP granulite events at $\sim$630 Ma and $\sim$545 Ma, hinders such progress. We therefore focused on Central Madagascar, which is dominated by $\sim$545 Ma amphibolite facies tectonism; this phase produced syn-tectonic migmatites and late-tectonic granites that are exposed in a 2-5 km wide and $>$100 km long shear zone that marks the upper boundary of the mid-crust. Thus, we were able to study the actual contact between a rigidly deformed upper plate and a weak, subhorizontal mid-crustal section dominated by syn-collisional melts. In order to provide absolute age constraints on the time(scale) of peak-metamorphism, deformation, melt generation and late HT fluid metasomatism across the contact, detailed meso- and microstructural studies were integrated with SHRIMP U-Pb dating on igneous and metamorphic zircon from granitoids, metasediments, migmatites and basement gneisses.

The rigid upper plate contains the Paleoproterozoic supracrustal rocks of the Itremo

Group and is dominated by steep structures; our data indicate that the youngest of these (D4 & D5) are very partitioned and define a regional sinistral transpressive event around 545 Ma. Large, discordant granite plutons cut the transpressive shortening structures of the upper plate and have an average age of 533 $\pm$ 6 Ma. In contrast, granites in the middle crust are sheeted and concordant within low angle shear zones. The granite margins have weak, subhorizontal tectonic fabrics and lineations. These monzogranites have an average age of 541 $\pm$ 6 Ma, overlapping within error with the upper plate granites. However, the youngest structures are formed by vertical strike-slip shear zones that, in the middle crust, contain weakly deformed granitoids dated at 521 $\pm$ 3 Ma. Geochemistry indicates these youngest, hottest melts are sourced from deeper levels. These data suggest that the sheeted melts in the mid-crustal layer are locally up to $\sim$10 Ma younger than the plutons of the upper plate. In summary, this mid-crustal shear zone contains a crustal scale network of low angle ductile shear zones and vertical strike slip faults that acted as melt pathways during transpressional deformation from 545 Ma to 520 Ma, plumbing progressively deeper levels. In structural terms, the shear zone marks the transition from partitioned deformation in the upper plate to penetrative ductile flow in the middle crust.

The talk will thus address whether transpression due to oblique convergence could be a possible driving mechanism behind ductile extrusion of the weak mid-crust in this hot, large scale, collisional Neoproterozoic orogen.