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Hot granulite nappes - tectonic styles and thermal evolution of the Proterozoic Granulite Belt in East Africa

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The Neoproterozoic orgogen of Tanzania and South Kenya exposes vast areas of granulite nappes that record relatively uniform peak metamorphic conditions of 770-850˚C / 1-1.3GPa and metamorphic ages clustering around 640 Ma. These granulites are subdivided into the (1) Eastern Granulites with a metamagmatic basement and a metasedimentary cover thrusted onto the (2) Western Granulites, a mixed metasedimentary / metamagmatic belt. Both granulite terranes are thrusted westward onto the Archean Tanzania Craton (Fritz et al. 2005). Hot fold nappes root at the mantle / crust boundary and are transported along an upwards climbing basal decollement to the mid crustal levels. Fragments of cold and stiff Paleoproterozoic and Archean crust are increasingly incorporated in the west. The variation of rock strengths from a stiff western foreland to an extremely weak eastern hinterland is supported by a study on rheology of rock forming minerals that display an eastward trend from grain boundary migration mechanisms over diffusion to melt assistant deformation. This goes along with variation in flow geometry derived from lattice preferred orientation pattern of quartz that indicate increase of bulk kinematic vorticity with increase of syntectonic temperatures and crustal weakness. Remarkable differences in pressure – temperature paths between Eastern Granulite hinterland units and Western Granulite foreland units are correlated with the flow path during thrusting. Pronounced isobaric cooling textures (IBC) within the Eastern Granulites correspond to horizontal westward flow in a subhorizontal melt weakened channel. Isothermal decompression textures (ITD) within

the Western Granulites are attributed to motion over westward climbing ramps and exhumation of rocks to mid-crustal levels. Besides this W-E variation the structural styles changes also vertically with crustal depth. Whereas W-E coaxial stretch dominates the Eastern Granulites basement, the structural style in the Eastern Granulites sedimentary cover is characterized by W-E compressional structures. Fold interference pattern seen in marbles display polyphase folding with dominance of upright folds with vertical, N-S striking axial planes.

A consistent model which explains the formation of large granulite nappes in Tanzania has to take into account (1) a large horizontal decollement at the crustal base in the orogens root and thrusts climbing to mid-crustal levels in the foreland, (2) W-E variation in flow geometry (simple vs. pure shear), (3) W-E variation in P-T evolutionary path (IBC vs. ITD) and (4) vertical variation in shortening direction (i.e., W-E stretch in deep crust vs. W-E compression in the mid-crust). An adopted model proposed by Beaumont et al. (2006) describes the observed tectonic style where channel flow evolves in melt weakened internal portions of hot orogens and hot fold nappes evolve when successively stiff foreland portions are incorporated into the orogen.

Beaumont et al. 2006, Geological Society Special Publications 268, 91-145.

Fritz et al. 2005, Tectonics 24, TC6013, doi:10.1029/2005TC001796.