Geophysical Research Abstracts,
Vol. 11, EGU2009-10315-1, 2009
EGU General Assembly 2009

Granulite microfabrics and rheology of the Madagascar lower crust

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Madagascar Island displays rocks equilibrated under granulite facies metamorphism over a widespread area. Major high - temperature metamorphic event is developed during late Panafrican-Cambrian and East-West shortening associated with the development of vertical transpressive shear zones (SZ). The studied "Ankaramena - Ihosy – Satrokala" granulitic area (200 * 200 km) constitutes an exceptional site to constrain the strength evolution of the lower crust during orogenic processes. Satellite, aeromagnetic, spectrometric data and field mapping were used to constrain with a regional scale the geometry of the anastomosed lithospheric shear zone network. Major North – South SZ (Ihosy SZ, Zazafotsy SZ, 5-15 km * >350 km) and minors SZ (1-3 km * <140 km) are localized predominantly in the quartzo – feldspathic rocks. The microstructural evolution of quartzo – feldspathic rocks with increasing strain associated with the Zazafotsy shear zone was studied using: major and trace element analyses, back scattered imaging, electron back scattered diffraction (EBSD) and quantitative microstructral analysis involving crystal size distribution, grain boundary statistics and grain shapes analyses. The evolutionary stages, of melt-absent to charnockitic quartzo- feldspathic rocks, display relative constant granitic composition through the whole deformation gradient and constant P-T condition (800°C -6 kbar). The matrix is formed by elongate feldspar grains, with well oriented wide (annealed) perthitic flames. The large single quartz grains with exceptionally strong LPO are forming elongate inclusions in feldspars matrix (500 microns). The microstructural profile across the shear zone show almost stable grain size and lack of variations in strong LPO for both feldspars and quartz. The rock is marked by originally strong aggregate distribution of feldspars and weak aggregate distribution for quartz, that evolves in regular distribution of both phases with increasing amount of interstitial phases. This microstructure is characteristic for chemically induced grain boundary migration, strong crystal plasticity and possible contribution of intergranular melt promoting extreme weakness of felsic lower crust. The similar elongation of K-Feldspars, plagioclases and quartz grains indicates convergence of their rheologies at high temperature. This evolution is markedly developed in zones where partial melting occurs suggesting that under such thermo-mechanical conditions neither geometrical nor grain size reduction softening is responsible for strain localisation and it is a partial melting that triggers development of Madagascar shear zones.