Geophysical Research Abstracts
Vol. 13, EGU2011-7030, 2011
EGU General Assembly 2011

Progress in Melt Induced Weakening Concept Driving Rift Induced Delamination

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Understanding geodynamically the special situation of the Rwenzori Mountains is our research objective. The horst is embedded inside rift segments of the western branch of the East African Rift System. Rift induced delamination (RID) has been proposed as a mechanism explaining the extreme topography, old metamorphic and young volcanic rocks nearby, crustal thickness and structure tectonics and seismicity. The hypothesis implies weak and hot mantle material under the rifts encircles almost completely the cold lithospheric block, decouples it lateral mechanically and triggers, when the lower crust fails, the detachment of mantle lithosphere and the uplift of crust.

To improve the strong ad hoc initial condition of temperature anomalies in our numerical models, we tested melt induced weakening (MIW) as an alternative concept driving RID. First successful models promise a more realistic and self-consistent process with moderate given anomalies.

By MIW we conceive an assemblage of intertwining processes. Additional heating generates incipient melts in the upper asthenosphere. Percolation and accumulation of these partial melts lump to regions with high melt fractions. Above a certain low fraction melt is extracted and transferred energetically to a higher level. For this, we assume short time scale transport mechanisms such as channeling or dyking, which we do not model. After probably repeated emplacement within the mantle lithosphere or even in the lower crust the melt's energy weakens its surrounding. Thus advective heat transport is accelerated using temperature-, pressure- and stress-dependent rheology. Depletion and enrichment associated with phase changes is considered. MIW is a positive feedback of the system and may lead, if strong enough, by reduction of viscosity and strength to RID.

The thermo-mechanical physics of visco-plastic flow is approximated by Finite Difference Method in an Eulerian formulation in 2D. The equations of conservation of mass, momentum and energy are solved for a multi component and two phase system.

RID models are controlled by many parameters like temperature background level and anomaly related to power laws and solidus or density changes due to phase changes related to yield stress. Their sensitivity and plausibility are explored and discussed. We try to test time dependent boundary conditions considering a propagating plume branch serving as additional heat source. Furthermore we are working on a physical or rheological feedback system controlling the hight range of the impact zone of extracted melts in order to replace the given emplacement level by a more self-consistent mechanism.