Geophysical Research Abstracts
Vol. 12, EGU2010-10565, 2010
EGU General Assembly 2010

Extreme uplift of basement blocks within continental rifts, joint effort of an ancient fold and thrust belt, crustal bending, lithospheric weakening and erosion

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In this contribution we will explain how extreme uplift of a basement block within an extending continental rift is possible. As an example we will use the Rwenzori mountains that lie within the northern part of the western branch of the East African Rift System. This spectacular basement block was uplifted up to heights exceeding 5000m above sea level (4000m relative to its surroundings), with equatorial glaciers around the major peaks.
We identified three principal mechanisms, which contribute to the Rwenzori uplift.

In order to understand how the block is captured by rifts and how it is successively uplifted we developed a numerical model. Our model shows that the stretched crust is bending upwards due to a strain gradient that develops from the brittle upper crust downwards into the viscous lower crust. This bending results in a large-scale dome with a basement block in the centre that is uplifted up to 2000m.

Petrological and Geophysical evidence shows that the lower lithospheric mantle in the Rwenzori area and below the rifts changes its properties being heated and weakened. These effects lead to an additional uplift component due to expansion, necking and isostatic forces. Due to the partial detachment from the surrounding crust, the component of mantle related uplift of the Rwenzori horst is strong. This can amount to an additional uplift of 1500 to 2000m.

A final component can be induced by selective erosion that leads to peak uplift. This process is controlled by the basement geology, since the central peaks consist of a steeply dipping frontal thrust sheet of a Paleoproterozoic belt with weathering-resistant amphibolite. Peak uplift in the Rwenzori mountains is the third component that leads to the overall uplift.

If we sum up all components we conclude that the extreme Rwenzori uplift in an extensional environment can be explained as a joint effort of three principal mechanisms.