Do continental processes within the global rock cycle evolve to a state of Maximum Entropy Production?

AXEL KLEIDON*, SUSANNE ARENS, JAMES DYKE, FABIAN GANS, LEE MILLER AND STAN SCHYMANSKI

Max-Planck-Institut für Biogeochemie, Hans-Knöll-Str. 10, 07745 Jena, Germany, (*correspondence: akleidon@bgc-jena.mpg.de)

Many processes within the Earth system operate in a state far from thermodynamic equilibrium. This is for instance reflected in the Earth's unique thermodynamic state of its atmosphere with 21% reactive oxygen and the strong cycling of matter at the planetary scale. For such non-isolated thermodynamic systems it has been suggested that these adapt steady states at which their rates of entropy production is maximized (proposed principle of Maximum Entropy Production, MEP [1, 2, 3]). MEP implies maximum irreversibility of Earth system processes, maximum dissipation of free energy, and the emergence of a steady state that is as far away from thermodynamic equilibrium as possible.

Non-equilibrium thermodynamics also applies to the global rock cycle with its irreversible transformations between sedimentary, igneous and metamorphic rock. Processes on land, particularly physical and chemical weathering of rocks, the formation and development of soils, erosion, sediment and cation transport to sea are the key processes that convert uplifted rock to ocean sediments.

Here we investigate the irreversibility of these processes, estimate their rates of entropy production, and analyze their sensitivity to climate system processes, specifically the strength of the hydrologic cycle, and biotic activity. The application of MEP to these processes would suggest maximum export of weathered rock material from land to ocean given the constraints of the system. We then relate this perspective to the question whether there is a unique topographic signature of life [4] and what the role of life is in the rise of continents [5].

[1] Ozawa *et al*. (2003) *Rev Geophys* **41**: 1018. [2] Kleidon & Schymanski (2008) *Geophys Res Lett* **35**: L20404. [3] Kleidon (2009) *Naturwissenschaften*, in press. [4] Dietrich & Perron (2006) *Nature* **439**: 411-418. [5] Rosing *et al*. (2006) *Palaeogeogr Palaeoclimatol Palaeoecol* **232**: 99-113.

Pan-African granitoid magmatism in central Dronning Maud Land: Comparison of two contrasting emplacement models

ILKA C. KLEINHANNS[1], JOACHIM JACOBS[1] AND NORBERT W. ROLAND[2]

[1]Institutt for geovitenskap, Universitetet i Bergen, Allégaten 41, NO-5007 Bergen (ilka.schoenberg@geo.uib.no)
[2]BGR, Arbeitsbereich Polargebiete, Stilleweg 2, D-30655 Hannover

Central Dronning Maud Land represents the southern end of the East African-Antarctic orogen (EAAO) that was constructed during the collision of parts of East- and West-Gondwana. The orogen spans more than 8000 km from the northern part in present Egypt-Arabia down to present Mozambique-Antarctica. It shows a strong lateral variation in orogenic styles separated by the E-W-trending Lurio belt in Mozambique with accretion in its northern part and continent-continent collision in the southern part. In addition, numerous Pan-African granitoids are observed in the southern part that are virtually absent in the northern part. The petrogenesis of these granitoids is explained by two contrasting models: (i) SE-directed thrusting of nappes from the combined Damara-Zambesi mobile belt towards Dronning Maud Land [1] thereby explaining the granitoid magmatism by crustal thickening; (ii) extensional tectonics with delamination of the orogenic root [2] thereby explaining the granitoid mgmatism by upwelling of hot asthenosphere under a thinned continental crust. Major and trace element signatures of these granitoids show a subalkaline ferroan character with the exception of the granitoids of the Petermann-Ketten that are alkaline. In general, all granitoids show an A_2-type signature. This points towards an extensional regime for the evolution of granitoid melts. Further, they show rather elevated Ce/Pb and Th/U ratios that indicate either crustal origin or high amounts of assimilation during ascent. No older components in these rocks have been found via U/Pb zircon age determination sofar, i.e. no older Mesoproterozoic zircon cores have been observed yet. Discrimination between these models should be possible with the help of Nd-Sr isotope characteristics of these rocks, that is planned as next step in this study.

[1] e.g. Grantham *et al*. (2007) In: Cooper *et al*. USGS Open-File Report, 2007-1047, Ext. Abstract. [2] Jacobs *et al*. (2008) In: Satish-Kumar *et al*. *Geol. Society, London, Spec. Pub.* **308**, 69-90