Geophysical Research Abstracts, Vol. 7, 03076, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03076

A new tool for deciphering plume-lithosphere interactions beneath continents: results from east Africa and Europe

L. Guillou-Frottier (1), E. Burov (2), P. Nehlig (1), and R. Wyns (1)

1. BRGM, Orléans, France (l.guillou-frottier@brgm.fr / Fax: +33 238-643652, p.nehlig@brgm.fr , r.wyns@brgm.fr), (2) Université P. & M. Curie, Paris, France (evgenii.burov@lgs.jussieu.fr)

When a mantle plume rises and impinges on the base of the lithosphere, variations in surface topography can be expected. Depending on plume ascent rate and lithosphere parameters, surface deformation can exhibit simple or complex signatures. In the case of a slow ascent through a Newtonian fluid and beneath an elastic layer, surface uplift with a single wavelength signature is expected. However, when realistic mantle rheology is considered, i.e. a non-Newtonian power-law viscosity, plume ascent rates can reach hundreds of metres per year, in which case the arrival of the plume head at the base of the lithosphere can be considered as an ‘impact’. In contrast to the oceanic lithosphere, which behaves as a single mechanical layer, the continental lithosphere is composed of mechanically decoupled layers including the upper, intermediate and lower crust, and the mantle part. The deformation of such contrasting layers may correlate, miscorrelate or destructively interfere with each other, resulting in multi-harmonic or even chaotic surface deformation. New numerical experiments of plume-lithosphere interactions (Burov and Guillou-Frottier, 2005) take into consideration (1) a free surface boundary condition, (2) realistic plume and mantle rheologies, and (3) the stratified structure of the continental lithosphere. Moreover, evolution of plume-induced surface topography can be computed during the experiment, from the plume-rising to spreading phases. Spectral analyses of the resulting surface topography show that certain topographic wavelengths (at 300-400 km and 60-100 km) are predominantly observed during interaction between the plume head and the continental lithosphere. These dominant wavelengths can be related to mechanical structure of the continental lithosphere. A series of topographic profiles from east Africa, perpen-

dicular to the african rift system, have been analysed to decipher possible dominant topographic wavelengths that may be related to underlying mantle plume(s). In the Main Ethiopian Rift area, three distinct topographic wavelengths (330, 70 and 50 km) clearly came out from the spectrum, whereas the signatures are more diluted around the Tanzania area where lithosphere structure differs considerably from north to south. The spatial and temporal evolution of uplift and subsidence phases, as described by field studies, are also identified by the numerical results. The evolution of the European rift system has also been partly related to mantle upwellings, including the Massif Central and Eifel plumes, even if compressional stresses exerted by the Alps and Pyrenees caused lithospheric deformation. Long-wavelength topographic signatures as well as small-scale topographic undulations identified in Europe are described in a context of plume-lithosphere interactions, and recent models invoking complex three-dimensional shapes of mantle upwellings are discussed.

Burov, E., and Guillou-Frottier, L., The plume head – continental lithosphere interaction using a tectonically realistic formulation for the lithosphere, Geophys. J. Int., in press, 2005.