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Tectonic and erosion-driven uplift for the Gamburtsev Mountains: a preliminary combined landscape analyses and flexural modelling approach

Fausto Ferraccioli (1), Lester Anderson (1), Stewart Jamieson (2), Robin Bell (3), Kathryn Rose (1), Tom Jordan (1), Carol Finn (4), and Detlef Damaske (5)

(1) British Antarctic Survey, Geological Sciences, Cambridge, United Kingdom (ffe@bas.ac.uk), (2) Department of Geography, Durham University, UK, (3) Lamont-Doherty Earth Observatory of Columbia University, USA, (4) USGS, Denver, Colorado, USA, (5) BGR, Hannover, Germany

Mountain building processes in intraplate settings remain relatively poorly understood when compared to ranges formed along plate margins. The most enigmatic intraplate mountain range on Earth is located in the middle of the East Antarctic Craton and is known from geophysical surveys as the Gamburtsev Subglacial Mountains (GSM). During the IPY, the AGAP project acquired 120,000 line km of airborne geophysical data (Bell et al., 2011, Science) and seismological observations (Hansen et al., 2010, EPSL) across central East Antarctica that provide new perspectives on crustal architecture and uplift mechanisms for the enigmatic GSM (Ferraccioli et al., 2011, Nature). The geophysical data define a 2,500-km-long Paleozoic-Mesozoic rift system in East Antarctica surrounding the GSM. A thick high-density lower crustal root is in parts preserved beneath the range and has been interpreted as having formed during Proterozoic assembly of a mosaic of originally separate East Antarctic provinces. Rifting could have triggered phase/density changes at deep crustal levels, effectively restoring some of the latent root buoyancy, as well as causing more classical flexural rift-flank uplift. Permian rifting was followed by Cretaceous strike-slip faulting and transtension associated with Gondwana break-up and this phase may have provided a more recent tectonic trigger for initial uplift of the modern GSM. The Cretaceous rift-flank uplift model for the Gamburtsevs is appealing because it relates the initiation of intraplate mountain-building to larger-scale geodynamic processes and is consistent with several geological and geophysical interpretations in the adjacent Lambert Rift (Ferraccioli et al., 2011). However, a more recent interpretation predicts that major Cretaceous rift-related exhumation in interior East Antarctica is not required to explain detrital thermochrology results from Oligocene-Quaternary sediments in Prydz Bay (Tochlin et al., 2012, G3). This raises the question of whether the modern Gamburtsevs may have been uplifted solely in response to significant changes in Cenozoic erosion patterns during the early stages of East Antarctic ice sheet formation that were superimposed upon an old remnant Permian-age rift flank. To address this question we combine results from: i) analyses of the subglacial landscape of the GSM that includes valley network, hyposometry and geomorphic studies of the fluvial and glacial features identified within the range (Rose et al., 2013 EPSL in review) with; ii) preliminary flexural models of peak uplift caused by the isostatic responses to fluvial and glacial valley incision processes, both within the range and in the adjacent Lambert Glacier region. We also include in our geophysical relief and isostatic model calculations considerations on the major change in erosion rates since Oligocene times and the total amount of incision estimated for the Lambert Glacier system using the values proposed by Tochlin et al. (2012). Our models yield new estimates of peak uplift and regional lowering for continuous and broken-plate approximations that can also be used to assess the range of pre-incision elevation of the “Gamburtsev plateau”. Our modelling outputs were also calibrated against the present-day elevations of up to 1500 m a.s.l of uplifted Oligocene-early Miocene glacial-marine sediments in the Lambert Glacier (Hambrey et al., 2000, Geology).