Lithospheric mantle downwelling beneath the Southeast Carpathians

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The South Carpathian Project, a major seismological experiment carried out during 2009-2011 by the University of Leeds, the National Institute of Earth Physics in Bucharest, the Eötvös Loránd Geophysical Institute in Budapest, and the Seismological Survey of Serbia in Belgrade, has resulted in the most detailed tomographic images yet obtained of the upper mantle structure beneath the Pannonian – Carpathian region [1]. These images shed new light on the unique geological structure which is responsible for the damaging earthquakes that occur in the upper mantle beneath the Vrancea Zone of the South-east Carpathians. A sub-vertical high-velocity body extending down to the top of the Mantle Transition Zone is interpreted as downwelling mantle lithosphere. The main mass of fast (presumably dense) material is located directly beneath the seismic activity. The earthquakes are caused by vertical stretching at strain-rates which imply that the mantle at 200 km is moving downward at about 20 mm/yr relative to the surface.

Three-dimensional numerical experiments assuming viscous flow support the interpretation that the drip-like structure that we image may be a natural consequence of a Rayleigh-Taylor instability developing from an unstable stratification of mantle lithosphere above asthenosphere, and triggered by recent convergence of Adria and Europe. The depth distribution of seismic-moment release rate is most easily explained if this high velocity structure is produced by a Rayleigh-Taylor instability. The present high rate of tectonic activity in this region is probably short-lived on a geological scale (< 1 Myr) but is likely to increase in energy before it is abates. The circumstances of this tectonic activity support the idea that Rayleigh-Taylor instability of the mantle lithosphere requires relatively dense mantle lithosphere activated by local plate convergence.

[1] Ren, Y., Stuart, G., Houseman, G., *et al* (2002), *Earth Planet. Sci. Lett.*, 349-350, 139-152.

Newly measured enthalpies of K-Na mixing for low albite - microcline crystalline solutions

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Earlier studies [1,2] on the thermodynamic mixing properties of the low albite - microcline system reported enthalpies of K-Na mixing that were nearly symmetric with regard to composition, despite a solvus [3] and Gibbs free energies of mixing [4,5] that require compositionally asymmetric relationships. To refine earlier results, new data have been collected at a particularly large number (21) of compositions across this series. Duplicate solution calorimetric experiments on each of these samples at 50 °C in 20.1 wt% HF have produced highly precise calorimetric data having an average standard deviation per sample of just 0.06% of the heats of solution. The new study, which reveals a maximum 8.7 kJ/mol enthalpy of mixing (H_{ex}) at $N_{Or} = 0.39$, demonstrates that detail in data at the sodic end of the series is crucial to definition of asymmetry in H_{ex}. The greater mixing magnitudes for this series relative to those for analbite - sanidine solutions (newly investigated via a 20-sample series) correlate well with the comparatively higher critical temperature of the low albite - microcline solvus [3] relative to that for analbite - sanidine [e.g., 6]. Entropies of K-Na mixing have been calculated by combining the new enthalpy data with Gibbs free energies of mixing derived from phase equilibrium studies [4,5]; these may be compared with entropy data based on the recent heat capacity measurements of Benisek and others [7].

[1] Waldbaum & Robie, 1971, *Z. Krist.* [2] Hovis, 1988, *J. Petrol.* [3] Bachinski & Müller, 1971, *J. Petrol.* [4] Delbove, 1975, *Amer. Mineral.* [5] Hovis, Delbove, & Roll, 1991, *Amer. Mineral.* [6] Smith & Parsons, 1974, *Mineral. Mag.* [7] personal communication.

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