Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

SIT040-P05 Room:コンベンションホール Time: May 26 17:15-18:45

On topographic subsidence and magma bursts at initiation of large igneous provinces

Linda Elkins-Tanton[1*], Ingrid Ukstins Peate[2]

[1]Masschusetts Institute of Technology, [2]University of Iowa

Increasing the density of parts of the lithosphere is an inevitable result of magma conduit formation at the initation of a magmatic province. Sufficient volumes of magma will create dikes wide enough to propagate upward without freezing, but some magma will travel through small dikes or by percolation. Because of the immediate departure of the geotherm from convective to conductive at the bottom of the lithosphere, any small fraction of melt will be exposed to lithospheric temperatures substantially below its solidus within a few kilometers of rise at most. The melt will conductively cool and freeze over timescales that decrease as the dimensions of the melt-filled pore space decrease, and as the deviation from the solidus temperature increases. This freezing magma will create a dense region prone to gravitational instability. A dense unstable lower lithosphere may therefore be an inevitable consequence of flood basalt formation. Here we investigate the topography and magma dynamics that result from a plume rising beneath a lithosphere with a dense, unstable region.

Numerical experiments indicate that dense lithosphere from magma intrusion leads to surface subsidence at the plume axis with compensatory uplift in a surrounding ring. As the dense lithosphere drips and is sheared away, topography at the plume axis rises, lithosphere thins, and the plume can be disrupted by sinking lithospheric instabilities, producing periodic magma bursts. The resulting lava should show both plume and lithospheric compositions.

Field observations support the hypothesis of subsidence upon initiation of melting under a large igneous province. The near-ubiquitous occurrence of mafic volcaniclastic deposits in the basal deposits of flood basaslt provinces indicates a common, initial stage of down-warping and development of water reservoirs in aquifers and fluvio-deltaic, lacustrine, and marine settings; the volcaniclastics are produced by eruption into shallow bodies of water. Here we present evidence from the Emeishan, North Atlantic, Afro-Arabian, and Siberian large igneous provinces. Variations in lateral extent and volume of mafic volcaniclastic deposits may serve as a proxy for assessing plume geotherm and lithospheric conditions which impact lithospheric instabilities and generation of topographic variations.

Keywords: Large igneous province, subsidence, volcanism, lithosphere