Geophysical Research Abstracts
Vol. 13, EGU2011-5529, 2011
EGU General Assembly 2011

Thermal plumes in complex fluids: constraints on lithosphere breakup

Anne Davaille and Anna Massmeyer
FAST (CNRS / UPMC / Univ. P-Sud), FAST, ORSAY, France (davaille@fast.u-psud.fr, 33 1 69 15 80 60)

We present new laboratory experiments on the development of thermal plumes out of a localized heat source in complex rheology fluids. In the first set of experiments, Carbopol, a yield-stress and shear-thinning fluid is used. Depending on the Yield number Y_0, which compares the thermally-induced stress to the yield stress, three different regims obtain. For low Y_0, no convection develops; while for intermediate values, a small-scale convection cell appears and remains confined around the heater. For high Y_0, thermal plumes develop. Their morphology differs from the musrhoom-shape typically encountered in newtonian fluids. Combined temperature and velocity field measurements show that a plug flow develops within the plume thermal anomaly, therefore producing a rising finger-shape. Moreover, light scattering highlights the development of a damaged zone ahead of the plume as it rises. In a second set of experiments, colloids are used and the upper surface is kept at a constant low humidity. As humidity decreases, the fluid rheology goes from newtonian, to shear thinning and yield-stress, to brittle, and therefore a skin develops on top of the fluid layer. In that case, thermal plumes develop first with a mushroom-shape, but when they hit the skin, the latter breaks up along star-shaped cracks. These laboratory experiments bring a new light on lithosphere break up, and especially on the importance of the transition from ductile to brittle behaviour.