Interaction of a mantle plume and a moving plate: insights from numerical modeling

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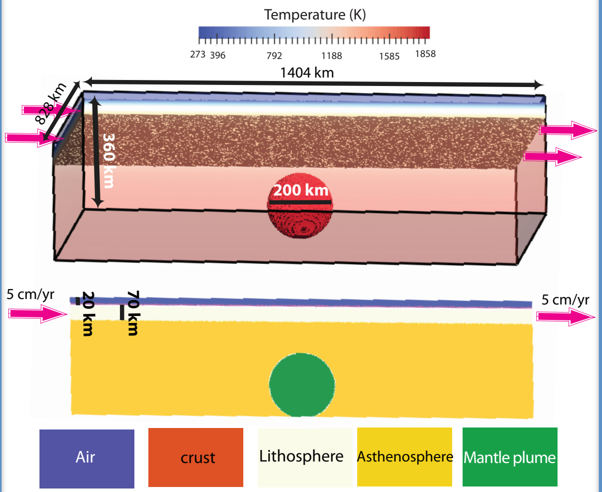
1) Introduction

The impingement of a hot buoyant mantle plume onto the lithosphere can result in either breaking of the lithosphere, which might results in subduction initiation or in under-plating of the plume beneath the lithosphere. In previous studies the interaction of a buoyant mantle plume with lithosphere was investigated either for the case of stationary lithosphere or for moving lithosphere but ignoring the effect of magmatic weakening of the lithosphere above the plume head. ***The aim here is to investigate the response of a moving lithosphere to the arrival of a stationary mantle plume including the effect of magmatic lithospheric weakening.***

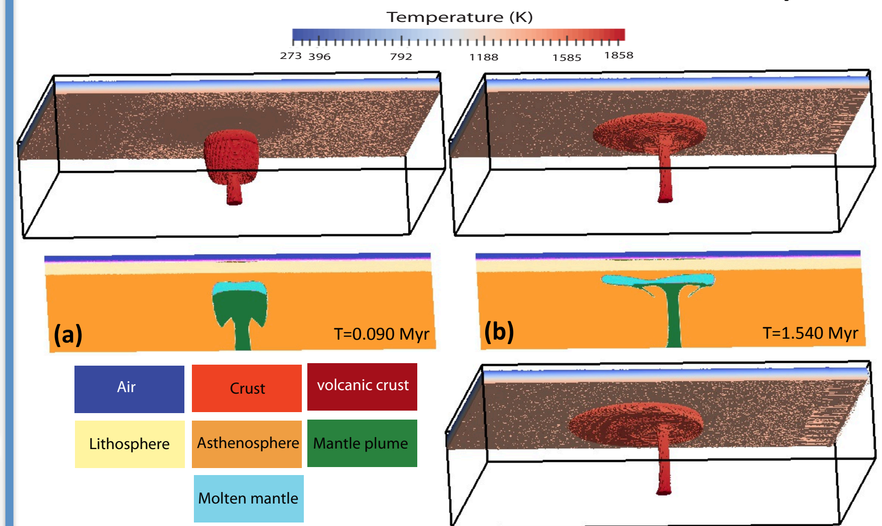
2) Initial model setup

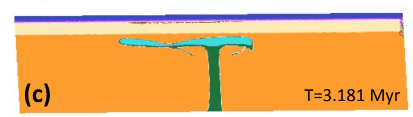
We use the code I3ELVIS to setup 3-d visco-plastic thermo-mechanical experiments. The model consists of an oceanic lithosphere, asthenosphere and a mantle plume. The surface deformation is simulated by considering a thin air layer (20 km) in the top layer of the model. We apply a kinematic boundary condition on the first 70 km of the left and right side boundaries (pink arrows in the figure). Plume has a spherical shape with a cylindrical tail. In the initial model setup the plume tail is outside of model and it is formed as plume rises upwards.



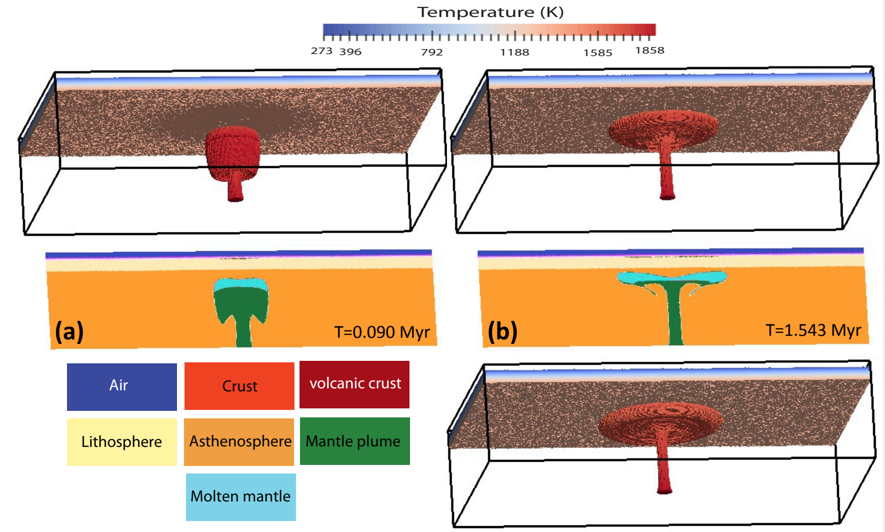
In all figures of this poster, the upper and lower panels show thermal and compositional fields, respectively.

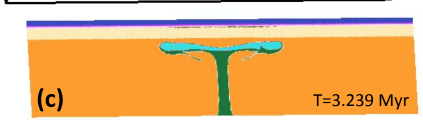
3) Plume under-plating





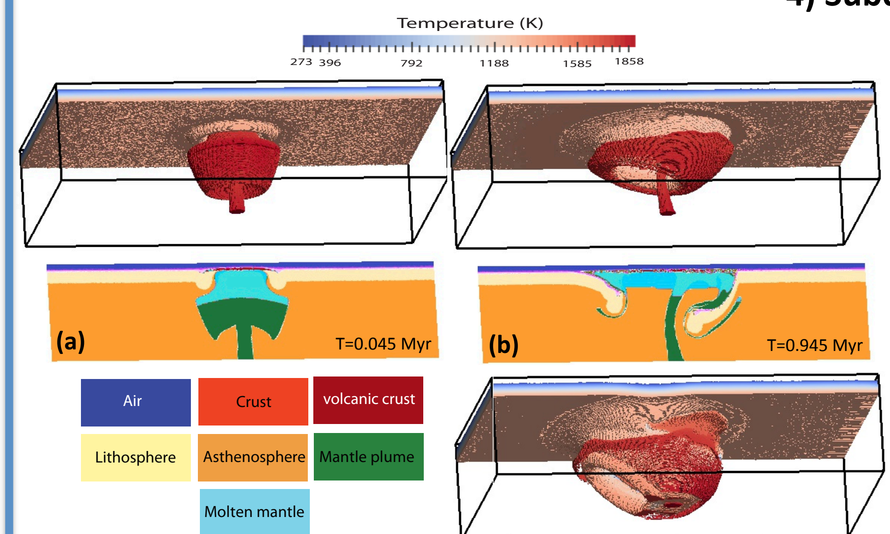
Moving plate:
Plume radius:100 km and plate motion: 5 cm/yr

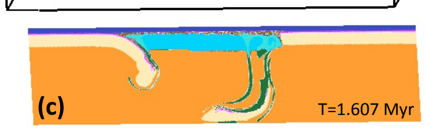




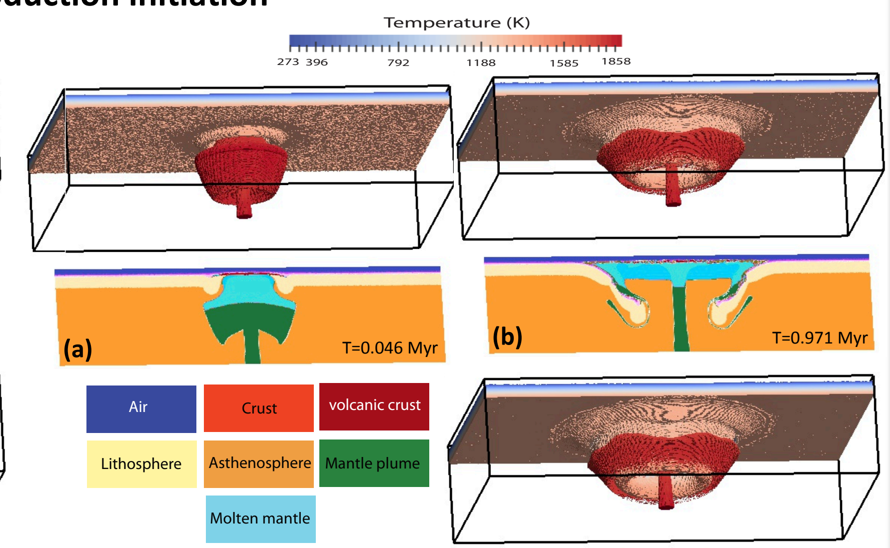
Stationary plate:
Plume radius:100 km and plate motion: 0 cm/yr

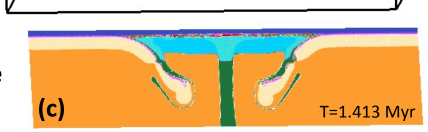
4) Subduction initiation





Moving plate:
Plume radius:150 km and plate motion: 5 cm/yr





Stationary plate:
Plume radius:150 km and plate motion: 0 cm/yr