

Separation of plume head from its stem: effect of the temperature dependent viscosity on the pinch-off process

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We have conducted laboratory experiments on mantle starting plumes to investigate the effect of temperature dependence of viscosity on the pinch-off process in a thermal starting plume.

Our experiments were carried in a rectangular tank filled with syrup which has a strong temperature dependence of viscosity like Earth's mantle. A thermal starting plume was generated by operating a heater placed at the bottom of the tank. The flow was visualized by using PIV for the velocity and TLCs (Thermochromic Liquid Crystals) method for temperature measurements.

A thermal starting plume was cooled by thermal diffusion and mechanical entrainment of surrounding material as it ascends. The cooling effect of the large plume head and the thin conduit were different. This causes the pinch-off process in a thermal starting plume, that is the plume head and tail are disconnected. Then a new plume head was generated from the tip of the tail.

We will discuss the size and structure of the mantle plume head and tail, and the role of cooling effect and the temperature dependent viscosity on the pinch-off process.