Failed plumes? Catalog of thermochemical plumes for seismic imaging in the deep mantle

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Dynamics of thermochemical plumes from the deepest part of the mantle plays an important role in the style of convection and evolution of the mantle. We have conducted series of laboratory experiments on plume formation in density stratified layered system(Kurita & Kumagai 2004) and reported various types of thermochemical plume formed depending on the relative density contrast between the layers. The experimental set-up is as follows; at the base of the column of viscous fluid(sugar syrup) a denser fluid layer of sugar syrup having variable thickness, viscosity and density-contrast is inserted. A concentrated heat source(a resistance type heater with a diameter of 5-8cm)heats up the fluid system from below. Subsequent formation of thermochemical plume is analysed by the temperature field visualized by TLC and the compositional field by LIF(laser induced fluorescence). When the density contrast is high enough or the thickness of the bottom layer is large enough, the bottom fluid can not be entrained into the plume head and the rising plume is purely thermal. When they are in the intermediate value once-rising plume is observed to disintegrate into two parts; a rising thermal plume and a sinking chemical plume. This disintegration is caused by deficiency of the thermal buoyancy against the chemical one by the entrainment of the bottom layer. The sinking plume is characterized as high temperature and high concentration of the heavy fluid. We reconstruct expected images of seismic velocity structure by using suitable thermal/seismic parameters based on the experimental images of this thermochemical plume. The interesting feature is that this failed holds strong low velocity nature in the seismic velocity while it is sinking