When hot thermochemical instabilities trigger subduction and continental growth

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Cratons generation often starts with massive mafic-ultramafic volcanism, to climax about 30 m.y. later with intrusion of voluminous granitoids. In terms of mantle dynamics, the first episode could be created by a mantle plume, while the second corresponds to subduction. To understand this sequence of events, we have studied the circulations induced by the onset of thermochemical hot instabilities at the bottom of the mantle, using laboratory experiments. A strongly temperature-dependent viscosity fluid, glucose syrup, was used. Initially a thin layer of syrup, made denser by the addition of salt , was at the bottom of the tank. Then the tank was heated from below and cooled from above. The temperature and velocity fields were measured in situ using thermochromic liquid crystals and PIV. The experiments were run for low buoyancy numbers, in the regime where episodic hot thermochemical doming occurs. The presence of denser material at the bottom of the tank delays the onset of hot instabilities, and convection usually starts by cold downwellings. Then hot domes develop from the hot chemically denser layer, with a morphology of cavity plumes since they are less viscous. When they hit and spread under the top surface, they peel off the cold thermal boundary layer there. This triggers a ring of enhanced cold instabilities around each thermochemical dome. The velocity of the cold downwellings is significantly increased compared to its value in absence of domes. Scalings laws derived from the experimental data suggest that this sequence of events is similar to what was observed on Earth in the archean. Moreover, such a mechanism could explain geophysical observations around the Ontong-Java and Caribbean plateaus.