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Necking of Plume Conduits and Severing of Plumeheads due to Non-Monotonic Plume Structure and Density Structure

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Many causes can induce a non-monotonic viscosity radial profile in the Earth's mantle, such as the recently discovered properties of the high to low spin transition of Fe++ or the presence of a layer of slab graveyard in the mid- lower mantle, or in the upper-mantle above the transition zone from water filtration. We investigate the change in the plume conduit morphology, when mantle plume crosses a viscous jump or a density decrease between two mantle layers. Using a systematic parameter study performed with the recently developed algorithm, the Multi-pole-Accelerated Boundary Element Method, with an ultra-high spatial resolution of nearly one km in the vertical direction ,we find: (i) a density change between two mantle layers, causes a change in plume rise speed and its associated modified plume's head but it does not influence the conduit morphology and (ii) a systematic jump in the viscosity in the mid lower-mantle, on the contrary, induces a respective intensification of the conduit necking, allowing us to predict plume detachment in a layer with 200 km thickness and viscosity of 10 times higher than the surrounding mantle. These prediction are finally compared with the natural observation of a the volcano spacings between islands in the central Pacific, allowing to establish new links between the mantle radial viscosity profile and seafloor observations.