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Growth and mixing dynamics of mantle wedge plumes

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Recent work suggests that hydrated partially molten thermal-chemical plumes that originate from subducted slab as a consequence of Rayliegh-Taylor instability are responsible for the heterogeneous composition of the mantle wedge. We use a 2-D ultra-high resolution numerical simulation with 10 billion active markers to anticipate the evolution of the internal structure of natural plumes beneath volcanic arcs in intra-oceanic subduction settings. The plumes consist of partially molten hydrated peridotite, dry solid mantle and subducted oceanic crust, which may comprise up to 12% of the plume. As plumes grow and mature these materials mix chaotically resulting in attenuation and duplication of the original layering on scales of 1–1000 m. Comparison of numerical results with geological observations from the Horoman ultramafic complex in Japan suggests that mixing and differentiation processes related to development of partially molten plumes above slabs may be responsible for strongly layered lithologically mixed (marble cake) structure of asthenospheric mantle wedges.