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Interaction of Mantle Plumes with Lithospheric Steps

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The theory of plate tectonics successfully explains the large-scale motions of Earth's lithosphere, the rigid outermost shell of our planet. It also accounts for the locations of most volcanoes: they occur at plate boundaries. However, a significant class of volcanism occurs within plates or across plate boundaries. This so called intra-plate, or hotspot volcanism, is usually associated with mantle plumes, but several intra-plate volcanic provinces display characteristics that are inconsistent with the mantle plume hypothesis. As a result, alternative mechanisms have been proposed, including edge-driven convection and shear-driven upwelling, which are controlled by regional lithospheric structure. Interestingly, in some regions, such as Eastern Australia and Africa, volcanism displays certain characteristics that are consistent with both deep-rooted (plume) and shallow (lithosphere driven) processes, hinting at an interaction between both processes. To quantify the nature and surface expression of these interactions, we have performed three-dimensional numerical models of the upper-mantle, using the Fluidity computational modelling framework, which account for both a plume and the shallow flow regimes induced by lithospheric structure. Under certain conditions, the models predict complex and transient volcanic trends at the surface. Preliminary results will be presented, with particular relevance to volcanism in Eastern Australia.