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South Pacific hotspot swells dynamically supported by mantle flows

Claudia Adam (1,2), Masaki Yoshida (2), Takehi Isse (3), Daisuke Suetsugu (2), Yoshio Fukao (2), and Guilhem Barruol (4)

(1) Centro de Geofísica, Universidade de Évora, Evora, Portugal, (2) Institute for Research on Earth Evolution, Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan, (3) Earthquake Research Institute, 1-1-1 Yayoi, Bunkyoku, Tokyo, 113-0032, Japan., (4) Université de Montpellier II, 34095 Montpellier Cedex 5, France

The dynamics of mantle plumes and the origin of their associated swells remain some of the most controversial topics in geodynamics. According to the plume theory, originally proposed by Morgan, the hotspot volcanoes are created by jets of hot material (plumes) rising from the deep mantle. With later studies, troubling inconsistencies began to emerge and other phenomena are invoked to explain intraplate volcanism, thus tending to nail the plume coffin. However, the problems encountered may simply be "the maturing of a valid theory to deal with the complexity of the real planet". This alternative is tested here by studying the dynamics of the South Pacific plumes through a new numerical model of mantle flow based on a highly-resolved seismic tomography model. We show here, for the first time, that a direct link exists between the surface observations and the mantle flow. We find indeed outstanding correlations between the observed and the modelled swells and between the modelled flow pattern and the active volcanism. This shows that at a first order, the morphology of the volcanic chains and their associated swells is controlled by the mantle flows. The excellent correlation we find between the buoyancy fluxes obtained from our numerical model and the ones deduced from the swells morphology has even broader implications. It implies indeed that we can accurately evaluate the heat transported by mantle plumes from a careful estimation of the swell morphology. We show that the heat transported by the South Pacific plumes accounts for 13% of the total plume heat flux.