Small-scale convection tomographically imaged beneath the Pacific plate using a dense OBS array

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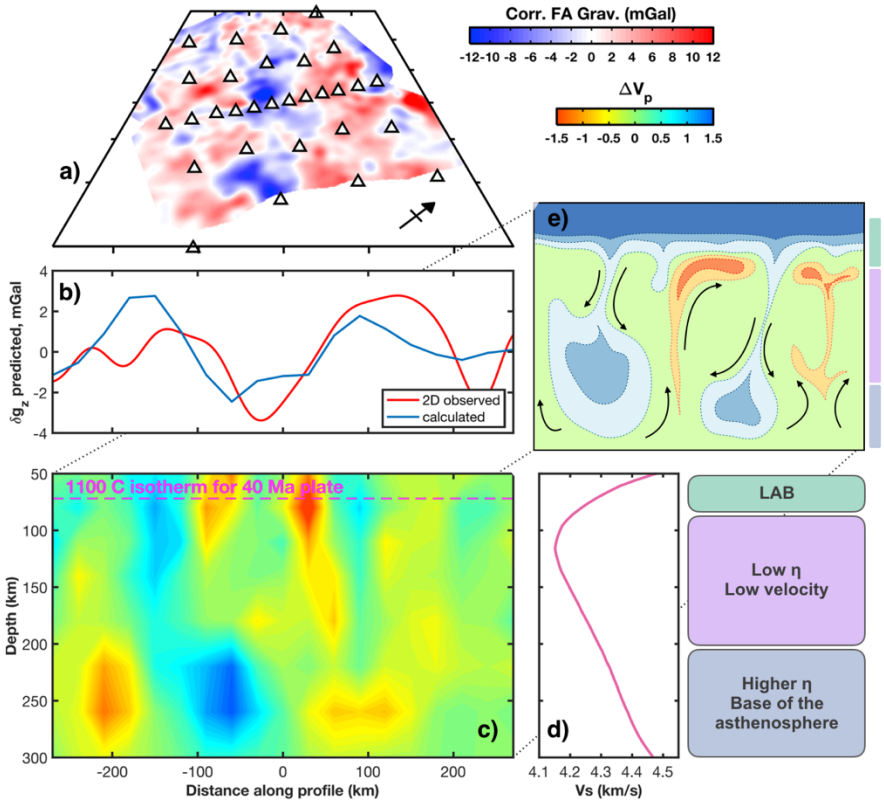
Small-scale convection beneath the oceanic plates is one among several mechanisms invoked to explain off-axis non-plume volcanism, systematic departure from simple seafloor depth-age relationships, and intraplate gravity lineations. Previously, insufficient tomographic resolution of the uppermost mantle in the central oceans has precluded direct testing for the presence of this process. The Pacific OBS Research into Convecting Asthenosphere (Pacific ORCA) experiment was designed to address this imaging gap. Thirty broadband OBS stations were deployed for 13 months in a 500x500 km^2 array on ~40 Ma seafloor northeast of the Marquesas Islands in a region notable for elongated gravity anomalies observed from satellite altimetry. We have conducted *P*-wave differential travel time tomography of 3-D wave speed structure to 300 km beneath the seafloor. We find alternating velocity anomalies in the upper mantle on the order of ±2% in elongated bands orientated parallel to the gravity lineations and local absolute plate motion. These features, which correspond to 300-500 ˚K lateral temperature contrast, and possible hydrous or carbonatitic partial melt, are strongest between 150 and 260 km depth and have a horizontal wavelength of ≤ 300 km. Modelled structure predicts gravity anomalies that qualitatively match the gravity lineations and indicates rapid vertical motions through a low-viscosity asthenospheric channel. New analysis of the gravity and bathymetry substantiates the presence of linear temperature anomalies in the uppermost mantle. Taken together, this suite of observations represents the first direct evidence for small-scale convective rolls beneath the oceanic plates.



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