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Radially Anisotropic Viscous Root beneath Ontong – Java Plateau: Evidence from SS Waveform Modelling

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We present evidence for a deep viscous mantle root beneath the Ontong-Java Plateau (OJP) which is a massive, stable, buoyant mass of anomalous oceanic lithosphere in the southwest Pacific Ocean. OJP is the largest of the Large Igneous Provinces (LIPs). Bulk of OJP was emplaced due to a catastrophic volcanic event c. 120 Ma years ago and a minor event at c. 90 Ma years ago in a submarine environment. OJP is hypothesised to represent a modern day analogue for continental craton formation due to its anomalously thick crust, stability and buoyancy, which is also suggestive of processes well beyond the ones that explain the evolution of oceanic plates. Though several models have been proposed for the formation of continents and also OJP, their origin remains an enigma since no single model fits all observations constraints. Understanding the lithospheric and mantle structure of the OJP will plausibly provide an insight into the processes that created the cratons towards the end of the Archean. We image seismic discontinuity structure beneath OJP by modelling SS precursor waveforms. We present results beneath the northern OJP where bouncepoint coverage is high, > 500 bounces. We observe a thick (28 $\pm$ 4 km) crust, in agreement with previous active source refraction results. A Mid-Lithospheric Discontinuity (MLD) was detected at a depth of 80 $\pm$ 5 km with a velocity decrease of 6 $\pm$ 4 %. We also detect a velocity decrease of 5 $\pm$ 4 % at a depth of 282 $\pm$ 7 km, base of the mantle root of OJP. This deeper discontinuity (DD") could possibly represent a change in anisotropic structure. MLD is reminiscent of structure that has been recently imaged beneath continental interiors. However, the DD" discontinuity beneath OJP is not imaged beneath continental interiors, suggesting that if OJP is a proto-craton this boundary, plausibly a dehydration boundary formed by the large melting event that created OJP, may be destroyed over billions of years. SS precursor stacks from the Nauru basin and "normal" pacific lithosphere show no seismic signature of DD" discontinuity suggesting that the mantle root is a unique feature beneath the OJP that supports its compensated topography. Comparison to surface wave velocities suggests that the root is viscous and radially anisotropic (VSH > VSV). Presence of a well-defined crust, a MLD and a deep root lends additional support for the notion that OJP represents a modern day analogue for craton formation.