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Upper mantle seismic structure beneath southwest Africa from finite-frequency P- and S-wave tomography

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We present a 3D high-resolution seismic model of the southwestern Africa region from teleseismic tomographic inversion of the P- and S- wave data recorded by the amphibious WALPASS network. We used 40 temporary stations in southwestern Africa with records for a period of 2 years (the OBS operated for 1 year), between November 2010 and November 2012. The array covers a surface area of approximately 600 by 1200 km and is located at the intersection of the Walvis Ridge, the continental margin of northern Namibia, and extends into the Congo craton.

Major questions that need to be understood are related to the impact of asthenosphere-lithosphere interaction, (plume-related features), on the continental areas and the evolution of the continent-ocean transition that followed the break-up of Gondwana. This process is supposed to leave its imprint as distinct seismic signature in the upper mantle.

Utilizing 3D sensitivity kernels, we invert traveltime residuals to image velocity perturbations in the upper mantle down to 1000 km depth. To test the robustness of our tomographic image we employed various resolution tests which allow us to evaluate the extent of smearing effects and help defining the optimum inversion parameters (i.e. damping and smoothness) used during the regularization of inversion process. Resolution assessment procedure includes also a detailed investigation of the effect of the crustal corrections on the final images, which strongly influenced the resolution for the mantle structures.

We present detailed tomographic images of the oceanic and continental lithosphere beneath the study area. The fast lithospheric keel of the Congo Craton reaches a depth of ∼250 km. Relatively low velocity perturbations have been imaged within the orogenic Damara Belt down to a depth of ∼150 km, probably related to surficial suture zones and the presence of fertile material. A shallower depth extent of the lithospheric plate of ∼100 km was observed beneath the ocean, consistent with plate-cooling models. In addition to tomographic images, the seismic anisotropy measurements within the upper mantle inferred from teleseismic shear waves indicate a predominant NE-SW orientation for most of the land stations. Current results indicate no evidence for a consistent signature of fossil plume.