Geophysical Research Abstracts
Vol. 18, EGU2016-15366-2, 2016
EGU General Assembly 2016

Imaging the lithosphere of rifted passive margins using waveform tomography: North Atlantic, South Atlantic and beyond

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Lateral variations in seismic velocities in the upper mantle reflect variations in the temperature of the rocks at depth. Seismic tomography thus provides a proxy for lateral changes in the temperature and thickness of the lithosphere. It can map the deep boundaries between tectonic blocks with different properties and age of the lithosphere.

Our 3D tomographic models of the upper mantle and the crust at the Atlantic and global scales are constrained by an unprecedentedly large global dataset of broadband waveform fits (over one million seismograms) and provide improved resolution of the lithosphere, compared to other available models. The most prominent high-velocity anomalies, seen down to 150-200 km depths, indicate the cold, thick, stable mantle lithosphere beneath Precambrian cratons, including those in North America, Greenland, northern and eastern Europe, Africa and South America. The dominant, large-scale, low-velocity feature is the global system of mid-ocean ridges, with broader low-velocity regions near hotspots, including Iceland. Currently active continental rifts show highly variable expression in the upper mantle, from pronounced low velocities to weak anomalies; this correlates with the amount of magmatism within the rift zone. Rifted passive margins have typically undergone cooling since the rifting and show more subtle variations in their seismic-velocity structure. Their thermal structure and evolution, however, are also shaped by 3D geodynamic processes since their formation, including cooling by the adjacent cratonic blocks inland and heating by warm oceanic asthenosphere.