Geophysical Research Abstracts
Vol. 18, EGU2016-13727-1, 2016
EGU General Assembly 2016

Hunting for the Tristan plume - An upper mantle tomography around the volcanic island Tristan da Cunha

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Tristan da Cunha is a volcanic island in the South Atlantic close to the Mid-Atlantic Ridge. It is part of an area consisting of widely scattered seamounts and small islands at the western and youngest end of the aseismic Walvis Ridge. Tristan da Cunha together with the Walvis Ridge represents the classical example of a mantle plume track, because of the connection to the Cretaceous Etendeka flood basalt province in NW Namibia. The genesis of the island has so far remained enigmatic. It is hotly debated, if Tristan da Cunha sits actually above a deep mantle plume or if it is only originated by upwelling material from weak (leaky) fracture zones. It also has to be clarified if there are any indications for a plume-ridge interaction. Geochemical investigations have shown complex compositions of magmatic samples from Tristan da Cunha, which could be interpreted as a mixing of plume-derived melts and depleted upper mantle sources.
To improve our understanding about the origin of Tristan and to test the mantle plume hypothesis, we deployed 24 broadband ocean-bottom seismometers and 2 seismological land stations around and on the island during an expedition in January 2012 with the German research vessel Maria S. Merian. After acquiring continuous seismological data for almost one year, the seismometers were recovered in early January 2013.

We cross-correlated the arrival times of teleseismic P and PKP phases to perform a finite-frequency tomography of the upper mantle beneath the study area.
Here we show the 3D mantle structure in terms of velocity variations: We do not image a “classical” plume-like structure directly beneath Tristan da Cunha, but we observe regions of low velocities at the edges of our array that we relate to local mantle upwelling from potentially deeper sources.
Additionally we discuss local seismicity within the Tristan da Cunha region, which show processes along the nearby mid-ocean ridge and transform faults. Furthermore, the local seismicity indicates spots of recent magmatic activity in close vicinity to the islands.