Contribution ID: **20** Type: **Oral**

Seismological and geophysical signatures of the deep crustal magma systems of volcanic fields beneath the Eifel, Germany

Tuesday 11 February 2020 09:10 (18 minutes)

The distributed volcanic fields of the West German Eifel region had their last eruptions less than 13,000 years ago. Recently, so-called deep low frequency (DLF) earthquakes were discovered under one of the Quaternary volcanic fields, which gives clear evidence of ongoing magmatic activity in the lower crust. Complementary gas geochemical, petrological and volcanological investigations support models of active magmatic processes at greater depths. Although different geophysical profiles were measured above the active volcanic fields of the Eifel in the early 1980s, these have rarely been interpreted in terms of magmatism and crustal reservoir processes. In this work, seismic wide-angle and steep-angle experiments are compiled, partly reworked and interpreted together with other geophysical data to discuss the type, size and shape of possible magmatic reservoirs in the deeper crust beneath the Eifel volcanic fields.

We review and discuss wide angle seismic data and the evidence of a low velocity zone below the Moho, which extends over a larger region of volcanic fields of the Rhenish Massif. We show that the DLF earthquakes connect the low velocity layer in the upper mantle with the upper crust at a depth of about 8 km directly below one of the youngest phonolitic volcanic centres in the Easteifel, where CO_2 from the mantle is massively outgassing.

Below the Tertiary and Quaternary fields of the Western Eifel, a prominent transparent zone in the lower crust was identified in 1987 in steep angle reflection seismic data. Above this zone a “bright spot” reflection band correlates with a strong magnetic anomaly and was interpreted as a solidified magmatic reservoir. We use reprocessed reflection seismic data to discuss the seismic signature of this reservoir in the middle crust and compare it with ongoing magmatic processes in the Eastern Eifel.

The reprocessed data indicate that the Moho is staggered below the Siegen Thrust System (ST). The ST correlates with the transparent lower crustal wedge in the West Eifel and possibly similar in the Westerwald at a distance of about 120 km and coincides with the velocity anomaly of the upper mantle identified in wide angle refraction data. We speculate whether the distribution of Quaternary and Tertiary volcanic fields in the Rhenish massif is controlled by tectonic features in the crust.

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Session Classification: Subsurface & Surface Processes

Track Classification: Subsurface & Surface Processes