Geophysical Research Abstracts
Vol. 16, EGU2014-1401, 2014
EGU General Assembly 2014
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Thick- and thin-skinned tectonics of the eastern border of the Leinetal Graben, Lower Saxony, Germany, as deduced from reflection seismics

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The Leinetal Graben in northern Germany is a N–S striking, intra-plate tectonic graben that, according to the youngest sediments within the graben, occurred post-Jurassic, probably late Cretaceous. We show, by interpreting two (1.8 and 3.2 km long), 2D, P-wave, reflection-seismic profiles which cross the eastern border faults of the Leinetal Graben, that the tectonic evolution began much earlier, probably in the Early Triassic.

The profiles show information to a depth of approx. 1 km. Using two deep boreholes to calibrate the seismic, we interpreted the Mesozoic sedimentary layers down to Triassic Zechstein salt and the faults that affect these strata. We recognize two sets of faults: firstly steep, planar faults, that are closely clustered and terminate in the Zechstein salt, and secondly shallow faults that connect between two of the first set of faults and have very variable dip, depending on the lithology they cut at that point. These two systems represent thick- and thin-skinned tectonics, respectively. We envisage the late Triassic pro-Leinetal Graben structure as a salt down-building area or as the result of rafting of sandstone units on the salt layer. The system was later reactivated in the Late Cretaceous during intra-plate N–S compression and E–W extension.

By restoring the deformation caused by the thin-skinned fault, we are able to determine the amount of area change in the hanging-wall caused by the fault, due to its undulating geometry. Area change is heterogeneous, but reaches 3–4% locally. This may well be sufficient to allow fluids to flow in the fault damage zone in these areas. It would also account for the different seismic appearance of the fault in the two profiles if fluids were heterogeneously distributed along it. This method of retro-deformation is entirely appropriate to determine the suitability of a brittle fault for, for instance, geothermal applications.