Using an industrial 3D seismic dataset from the central part of the Vienna Basin (Austria), we investigate fault growth by studying marker horizons within the hanging wall and footwall of the Markgrafneusiedl fault, a large-scale normal fault. The fault geometry and throw distribution of individual horizons show a remarkable variability, both along strike and along dip of the fault. Quantification of this large-scale fault drag allows identification of linked individual fault segments constraining the fault evolution.

Near-fault deformations are common phenomena that frequently occur in both extensional and compressional tectonic systems. Two fundamentally different explanations for the origin of fault drag in extensional regimes have been proposed. One very popular model explains the development of rollover anticlines by the existence of a listric normal fault (e.g., McClay & Scott 1991), which connects a steep upper part of a fault to a low angle detachment horizon at depth. Alternatively, the occurrence of reverse fault drag, comprising an anticlinal structure in the hanging wall and a synform in the footwall of a planar normal fault, has been explained by the decrease of displacement from the center to the tips of the fault surface both laterally and vertically (Grasemann et al. 2005). The latter model, which we favor for the interpretation of structures along the Markgrafneusiedl fault, additionally offers a solution to the observation of „compressional“ structures, i.e. folds surrounding fault planes with normal displacement, which in conventional tectonic models require for a regional compressional phase and basin inversion.

The investigated Markgrafneusiedl fault, crosscutting the clastic Miocene sedimentary pile deposited from Carpathian up to the Pannonian age, represents the southeastern border of the Matzen oilfield. At depth, the fault displaces seismic horizons up to the decollement level, with a maximum throw of ~400 m.

In order to document marker horizons for the analysis of fault drag, several most distinctive seismic reflectors were mapped throughout the entire 3D time-migrated seismic cube. In addition to the two well-documented stratigraphic markers, the chronostratigraphic framework was constrained at the basis of seismic calibration with numerous deep exploration boreholes. After seismic amplitudes were mapped in TWT by using a Landmark/ Geographix software, a depth conversion applying a generalized equation assuming an exponential increase of seismic velocity with depth was calculated in the 3D modeling software Gocad (Paradigm). This conversion ensured a better geometric representation of the fault drag geometries, additionally enabling a 3D displacement measurement in meters.

The additional documentation of fault drag permits a more detailed identification of individual fault segments, which cannot be so accurately achieved by using conventional parameters, such as fault dip, azimuth and throw. Moreover, using a complex 3D attributes derived from a 3D surfaces, we identified that the two scale-dependant generations of a fault drag correspond to a similar number of fault segment orders. Thereby, it is possible to constrain the relative timing of faulting with respect to coalescence of individual initial fault segments. Therefore, a study of a fault drag around complex mature fault surfaces can help to identify pre- and post-coalescence time of differently sized fault segments, and to distinguish fault drag along normal faults from folding due to tectonic inversion.

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Frontier seismic exploration in the North Atlantic

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The North Atlantic continental margin was formed by continental break-up in the early Tertiary, which led to stretching and thinning of the continental lithosphere, accompanied by massive magmatism, producing flood basalts which covered pre-existing sediments and extensive igneous intrusion. Industry and university goals coincide in the North Atlantic region where low frequency seismic energy, together with high-density, long-offset, single-sensor recordings, are used to penetrate volcanic overburdens and illuminate both the deep structure of magmatic margins and potential hydrocarbon-bearing sub-basalt sediments.

This paper briefly summarizes the seismic results of the iSIMM project (integrated seismic imaging of magmatic margins). The industry-university collaboration aimed to develop a structural model from seabed to Moho to image the stretched crust and the extruded, intruded and underplated igneous material, and sediment structures in this area within and overlain by the basaltic sequences of stacked flows up to several kilometers thick.

The present paper further highlights the implications of basalt-tuned acquisition and processing techniques for OMV, which is successfully exploring the remote region of the North Atlantic margin. Examples illustrate developments in intra- and sub-basalt seismic acquisition (e.g., over-under shooting) and consequences for processing such target-focused seismic data sets (e.g., LF-processing).

Marine Isotope Stage 3 recorded in palaeolake sediments in the Eastern Alps

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