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Sub-/seismic structure and deformation quantification from 3D reflection seismics across different scales

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The evolution of a sedimentary basin is mostly affected by deformation. Large-scale, subsurface deformation is typically identified by seismic data, sub-seismic small-scale fractures by well data. However, faulting at the medium scale plays an important role, e.g. in reservoirs: large individual reservoirs can be disrupted by faults enhancing fluid flow, or producing compartmentalized deposits due to cementation of fractures. Thus, between the methods, we lack a deeper understanding of how deformation scales in the subseismic region.

We analysed a 3D reflection seismic data set in the North German Basin, in order to determine the magnitude and distribution of deformation and its accumulation in space and time. A five-step approach is introduced for quantitative deformation and fracture prediction. An increased resolution of subtle tectonic lineaments is achieved by coherency processing, allowing to unravel the kinematics in the North German Basin from *structural interpretation*. Extensional events during basin initiation and later inversion are evident. *3D retro-deformation* shows major-strain magnitudes between 5-15% up to 1.5 km away from a fault trace, and variable deviations of associated extensional fractures (see also Lohr et al., this volume). Good correlation of FMI data, strain distribution from retro-deformation and from *geostatistic tools* allows the *validation of the results* and makes the prediction of small-scale faults/fractures possible. The temporal component will be gained in the future by *analogue models*.

The suggested workflow is applicable to reflection seismic surveys and yields in great detail both the tectonic history of a region as well as predictions for hydrocarbon plays.