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Deformation prediction across different scales between 1D well data and 3D reflection seismics

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In addition to seismically observed faulting, faulting at the medium sub-seismic scale plays an important role, e.g. in reservoirs which can be disrupted by faults enhancing fluid flow. Thus, between seismic and well data scale, we lack a deeper understanding of the sub-seismic region. To tackle this problem, a 3D reflection seismic data set in the North German Basin was analysed with respect to structure and faults in great detail, calibrated by well data. This led to the determination of magnitude and distribution of deformation and its accumulation in space and time on the seismic scale. The structural interpretation unravels the kinematics in the North German Basin with extensional events during basin initiation and later inversion. For further quantitative deformation and fracture prediction on the sub-seismic scale, two different approaches are introduced. Coherency processing yields together with geostatistic tools the distribution of low- and high-strain zones in the region. Independently, geometrical 3D retro-deformation predicts the distribution and quantification of the strain magnitude from identified structures. For the fault structure analysed, it shows major-strain magnitudes between 5-15 percent up to 1.5 km away from a fault trace, and variable deviations orientation of associated extensional fractures. The small scale is represented by FMI data from borehole measurements, showing main fault directions and densities. These well data allow the validation of our sub-seismic deformation analyses. In summary, the good correlation of results across the different scales makes the prediction of small-scale faults/fractures possible. The suggested geomechanical workflow is applicable to reflection seismic data, but requires the 3D coverage of a region as basic principle. It yields in great detail both the tectonic history of a region as well as

predictions for the genesis of structures below the resolution of reflection seismics.