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Panorama Saal EDEKA-Arena Kongress 1 - Tiefe Geothermie

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Panorama Hall EDEKA-Arena congress 1 - Deep Geothermal Energy

Modern seismic reprocessing to cope the demands of geothermal projects

Moderne seismische Datenbearbeitung zur Erfüllung der Anforderungen von Geothermieprojekten

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While seismic imaging is standard in the exploration of oil and gas fields, its significance is growing as the basis for success of geothermal projects. Standard seismic processing strategies work for areas with simple geology, but do not lead to satisfactory results in complex geologic settings. As geothermal projects regularly face such complexity (e.g. the fault systems of the Rhine Graben), the applied standard and often outdated seismic processing techniques do not provide sufficient subsurface imaging. Insufficiencies include the loss of amplitude conversation, resolution, and frequency content. Furthermore, ray-based depth migration techniques such as Kirchhoff or Beam may not be sufficient to solve travel times correctly for the complex velocity models involved in these areas. This leads to horizontally shifted locations of faults in the range of more than 100 m. A knowledge that is crucial for the success of a geothermal project. All these shortcomings cause problems and costs that can be avoided with enhanced seismic data processing strategies.

TEEC's experience from numerous projects in highly complex geologic settings shows that six key steps are crucial for successful imaging: 1. Near surface velocity model and tomo statics, 2. surface wave suppression, 3. increase in signal-to-noise ratio (S/N ratio), 4. stacking/migration velocities & residual statics, 5. data regularization and 6. interval velocity model & Reverse Time Migration.

1) The first step to successful imaging is the near surface velocity model and the associated basic statics solution. In settings with topography and/or highly variable subsurface velocities, standard refraction or elevation statics fail to provide sufficient results as they suggest structures in time domain which are due to velocity variations. Here, tomographic approaches are a key to remove shallow subsurface velocity effects. They can be accompanied by Full Waveform Inversion (FWI) on land data, which was successfully applied by TEEC several times. 2) Modelling noise and subsequent adaptive subtraction from the input data, shows good results especially for near offsets, where shot noise generates high noise levels. 3) For areas with a low S/N ratio, the Common Reflection Surface (CRS) processing technology improves the data quality significantly by analysing dip, depth and curvature of subsurface reflection elements. 4) Stacking velocity analysis, residual statics and migration velocity analysis benefit from all previously described steps with a proper basic static, enhanced denoising and an improved S/N ratio. 5) Data regularization can influence the migration result considerably. Irregularities in receiver/shot locations result in an irregular fold of coverage and data gaps, which possibly lead to migration artefacts. CRS processing along with 5D interpolation are modern regularization techniques with CRS even working in areas where 5D often fails such as low S/N ratio, low fold of coverage and steep dips. 6) Finally, correct positioning of geologic structures is mandatory in seismic depth imaging. As ray-based depth migration techniques, which are standard in processing, fail to solve travel times correctly for complex velocity models, the usage of the Reverse Time Migration (RTM) is favored. The RTM can accommodate for any complexity in the velocity model.

In the talk (in English), we will present data examples (e.g. from seismic re-processing work within EBN's SCAN geothermal project) to show the effects of enhanced seismic data processing strategies in comparison to standard processing.