Coherence based seismic imaging in crystalline rock environment: A real data example

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CRS Workflow

It is well acknowledged that 3D seismic reflection studies are challenge to image when in crystalline environment. The reason for this is the small reflectivity and S/N ratio compared to data from sedimentary basins. Contrary to typical reflection data, hard rock data are usually dominated by diffracted events which leads to a criss-cross pattern and numerous conflicting dip features in the stacked sections which make these difficult to interpret. The established CRS based work flow usually includes the CRS stacking, automatic picking of the kinematic wave field attributes and NIP wave tomography and time/depth migration.

We process the 3D seismic reflection data. The seismic experiment was conducted in the area of the city of Schneeberg, Germany. The 3D CRS stack method has advantages for low fold and S/N data and may provide a suitable alternative to image weak events. In a first attempt we will follow a purely data driven approach without considering any prior geological information for processing except the near surface velocity. In this stage coherence weighted stack (CWS) is considered as more valueable information regarding the subsurface structure compared to the stack.

Figure 1 shows the comparison of shot gathers of sedimentary rock and the hard rock which clearly indicates the data quality. The geological map of Schneeberg is in Figure 2 (a) which reflects complex structure. 2 (b) is the cross-section of study block. In 3D CRS, Figure 3 (a) the automatic CMP, (b) shows the 3D CRS stack. In Figure 3 (c) coherence section shows better signal but (d) CWS shows best signal with least noise. In Figure 3 (e), the 3D volume shows steep dipping reflecting event is visible in cross-line 650, Schneeberg body in in-line 369 . These are Kirchhoff post-stack time migrated images with constant velocity. The greatest effort needs to be imposed on the improvement of the pre-stack data quality (Baykulov and Gajewski, 2009; Dell et al., 2012).

Shot Gathers

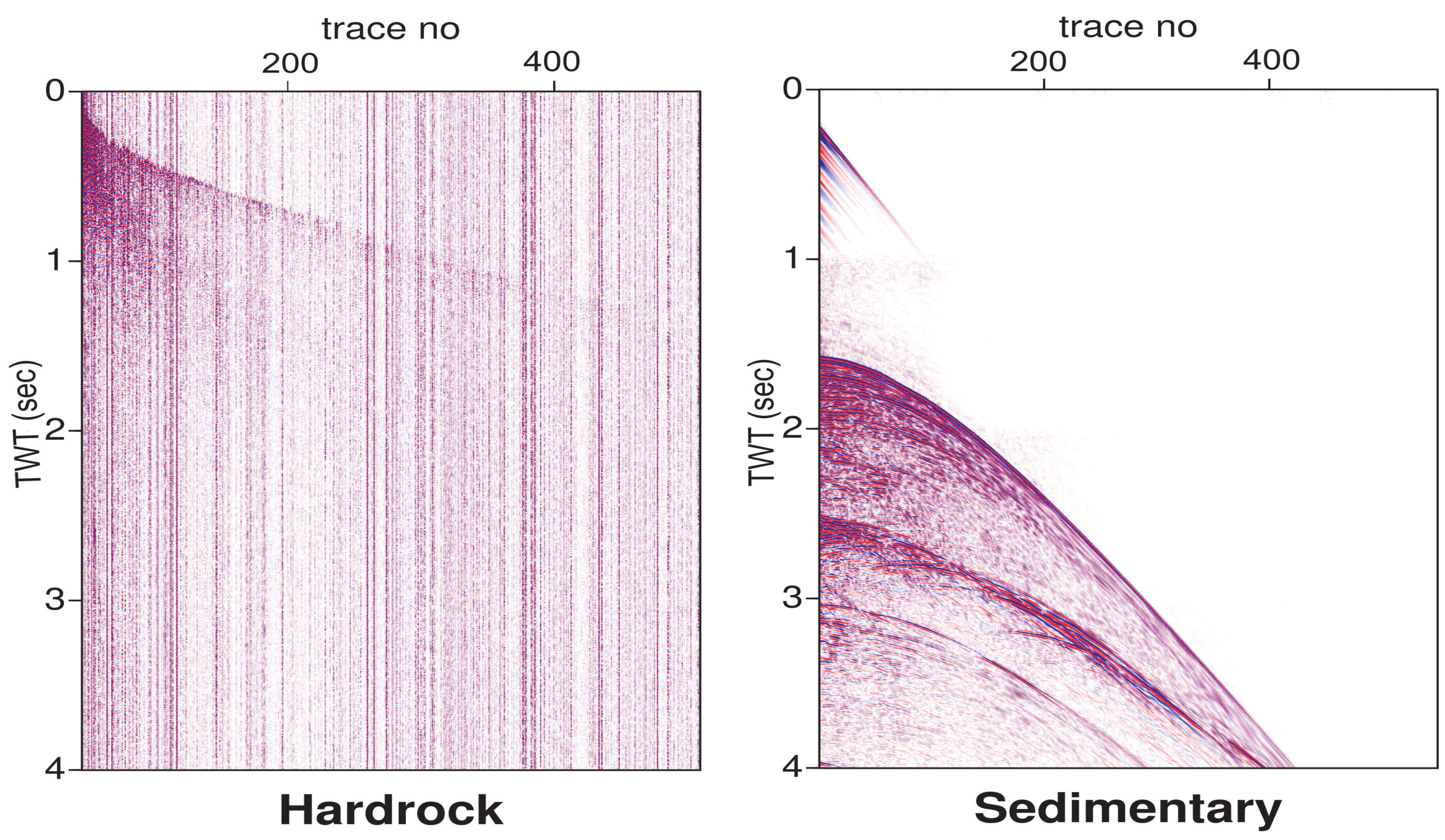

Figure 1: Comparison of seismic data (hard rock and sedimentary rock).

Geological Map and Profile of Schneeberg

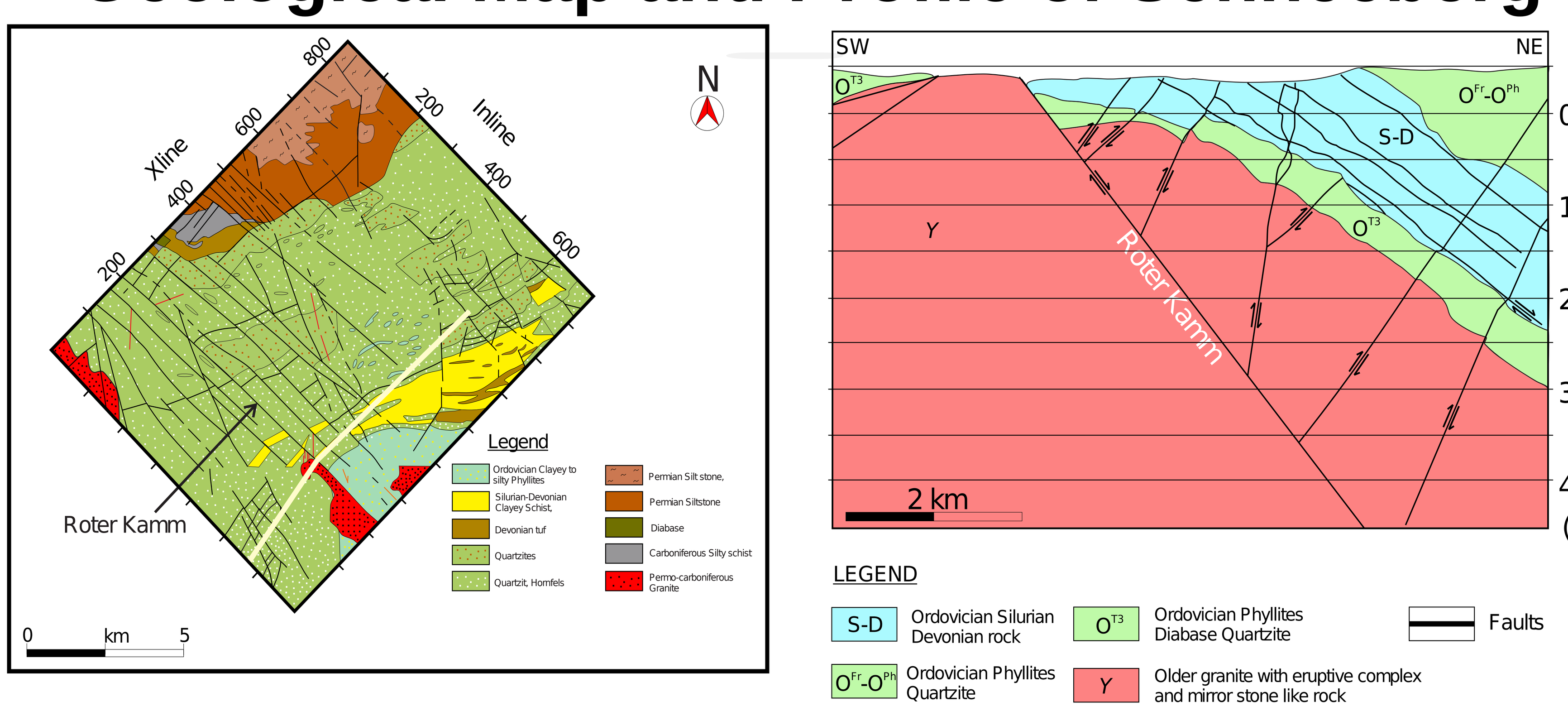

Figure 2. Geological map (left) and profile (right) of the Schneeberg.

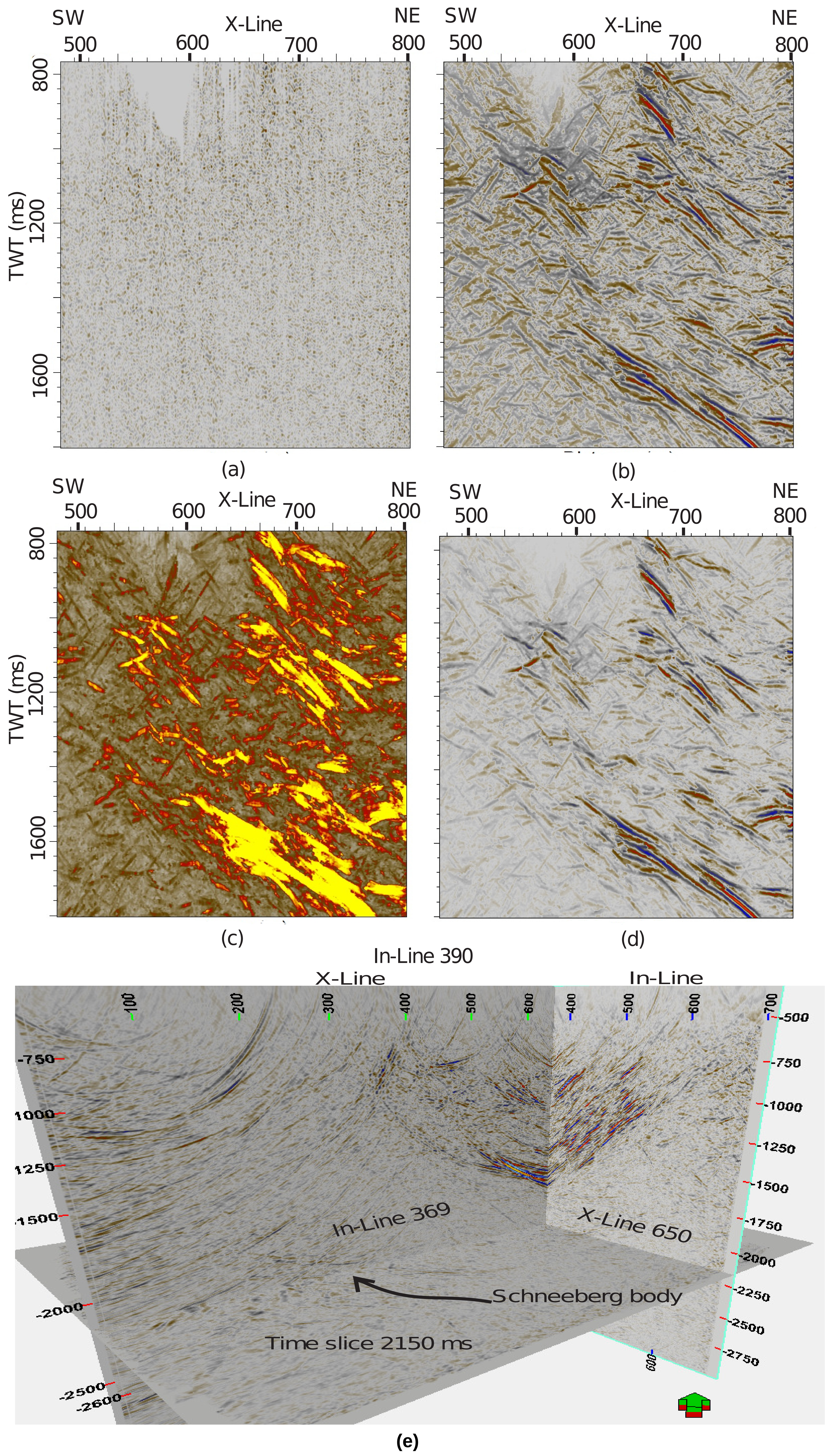

Figure 3: Image (a) 3D automatic CMP stack, (b) 3D CRS stack, (c) Coherence, (d) coherence weighted stack and (e) 3D volume of Schneeberg.

Conclusions

We have presented an application of the CRS-based workflow to the Schneeberg hard rock seismic data. Our results show CRS operator, specially coherence provide a better image compared to conventional CMP stacking. Steeply dipping plane reflectors are visible in the migrated coherence weighted stack (CWS) volume.

References

Baykulov, M., Dümmong, S., and Gajewski, D. (2011). From time to depth with CRS attributes. Geophysics, 76(4):S151–S155
Dell, S., Gajewski, D. and Vanelle, C. [2012] Prestack time migration by common-migrated-reflector-element stacking. Geophysics, 77(3), S73–S82.

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