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An Investigation of a Salt Dome Interior using In-Mine Seismic Reflection

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Summary

An in-mine seismic reflection survey was executed at an underground salt mine in Louisiana, USA. In-mine seismic surveys are typically completed to map the inner structures and boundaries of the salt dome, which are near typically vertical geological features. Similarly to surface seismic, reflections are the result of faults and geologic boundaries. In contrast to surface seismic reflection, these reflections may occur anywhere in 3D space. Specific survey parameters and post processing of data are required to account for out-of-plane reflections and map the interior of the salt dome effectively.

Theory / Method / Workflow

The survey consisted of 56 3-component borehole geophones placed in the mine pillars (see Figure 1). 31 of the geophones were placed in a west-east orientation and 25 were placed in a north-south orientation. All channels were live during acquisition.

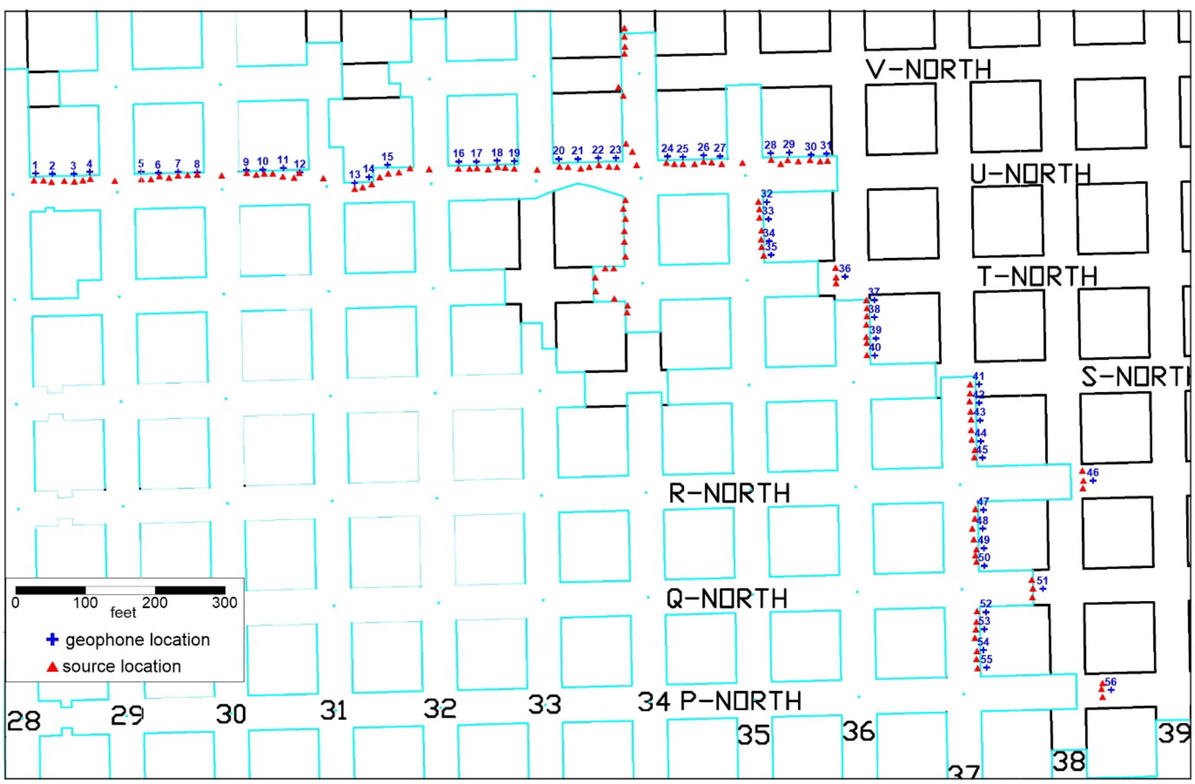

Figure 1: Map of geophone layout in the mine. Blue crosses indicate geophone location. Red triangles indicate the source location.

Horizontal and vertical waves were generated at and in between the geophone locations. Depending on the direction of the wave propagation, different seismic wave types are created. When the direction of particle movement is the same as the direction of wave propagation, P-waves (compression waves) are generated. In cases where the direction of particle movement is orthogonal to the wave propagation, shear waves are generated. Several seismic profiles were generated from a combination of source and receiver pairings (Figures 2 and 3).

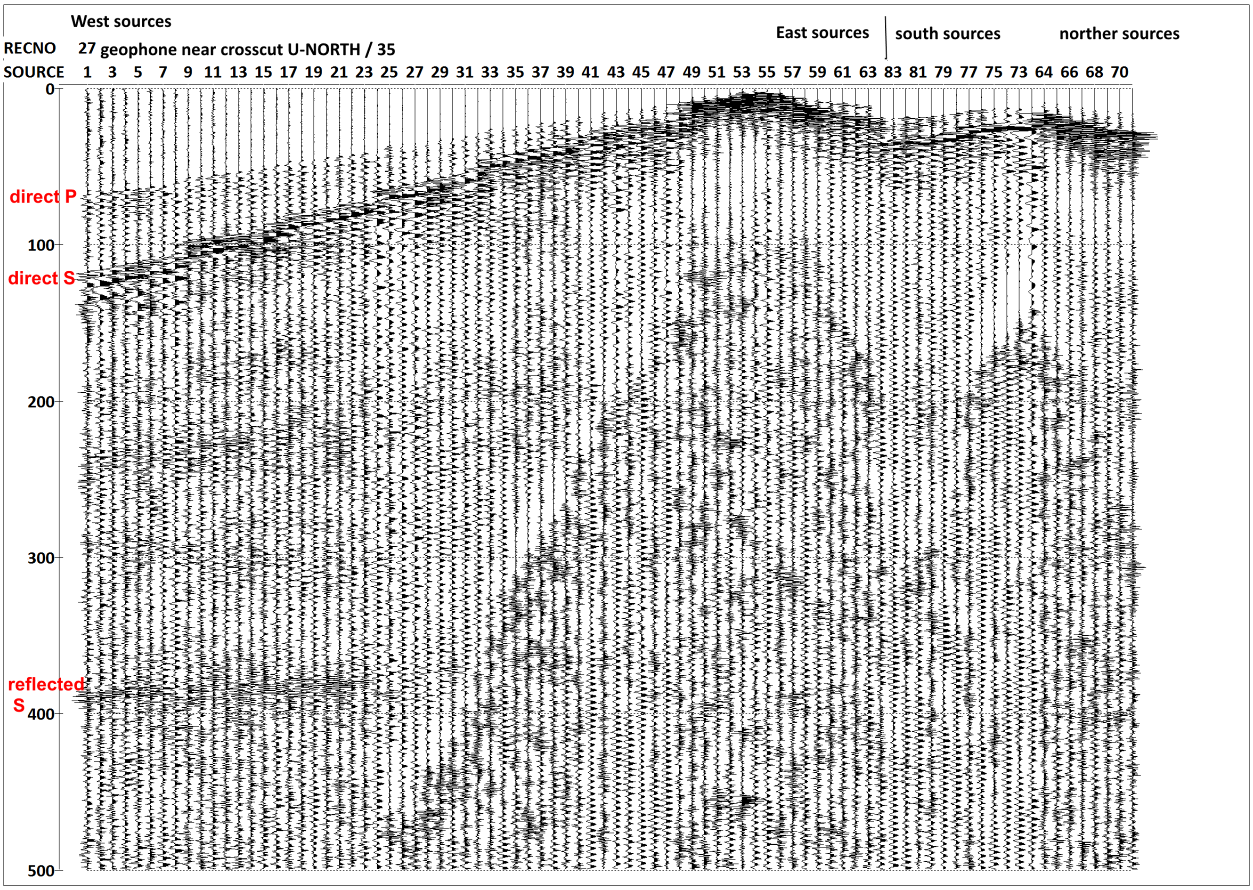

Figure 2: Example of a raw shot examining the vertical component with vertical source.

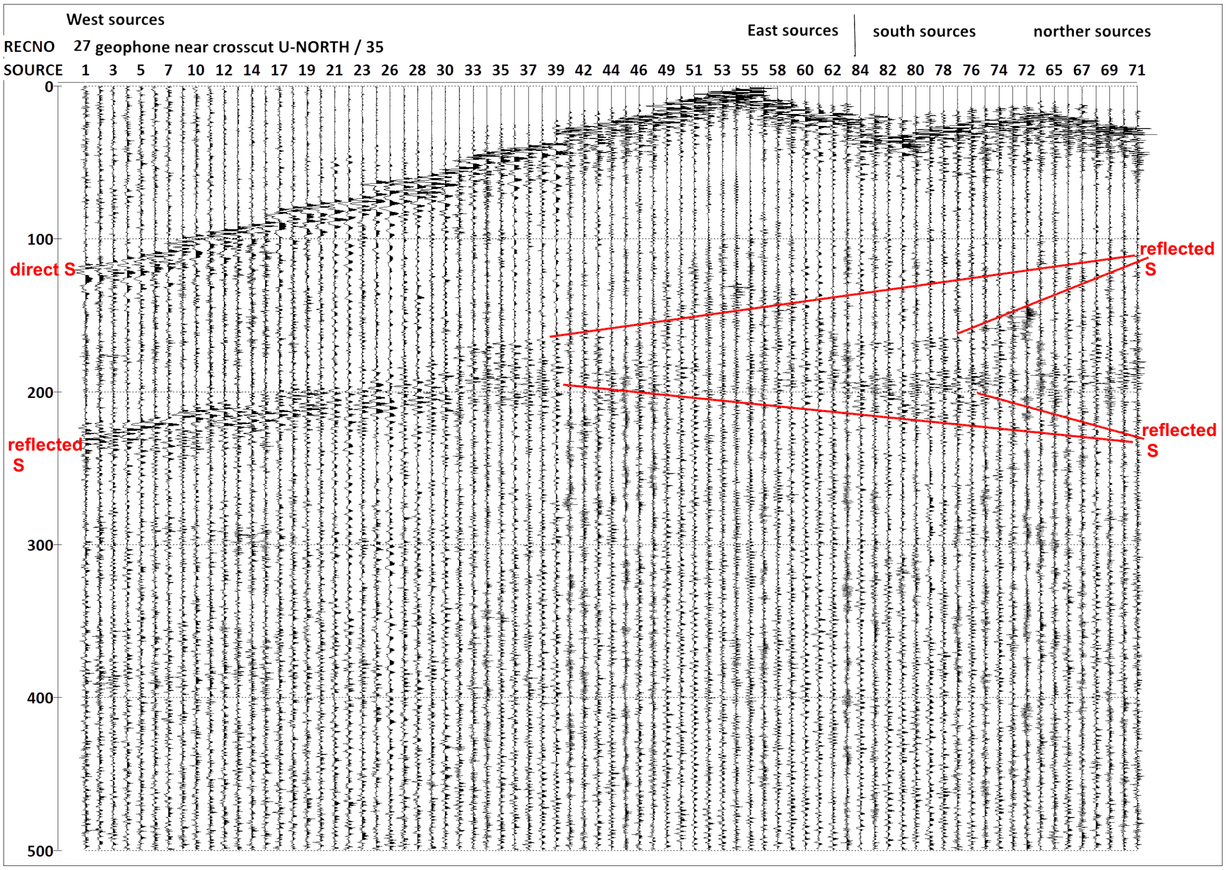

Figure 3: Example of a raw shot examining the horizontal component with horizontal source.

Pre-stack processing was completed prior to stacking. Further processing was completed by a time/depth conversion and migration of the data. Unlike above-ground seismic, reflections may be caused by geological features or faults anywhere in 3D space. The location of the reflectors can be reconstructed by observing several shot-source pairings. The travel times of the reflection, the location of receivers and shot, and the velocity of the seismic wave are needed to determine its location.

Results, Observations, Conclusions

Three separate sections were created by examining specific portions of the live line; an east-west section, a northwest-southeast section, and north-south section (Figure 4). The north, east and northeast the edge of the salt dome was identified in the seismic reflection data. Reflections from the roof and potential faults were also identified.

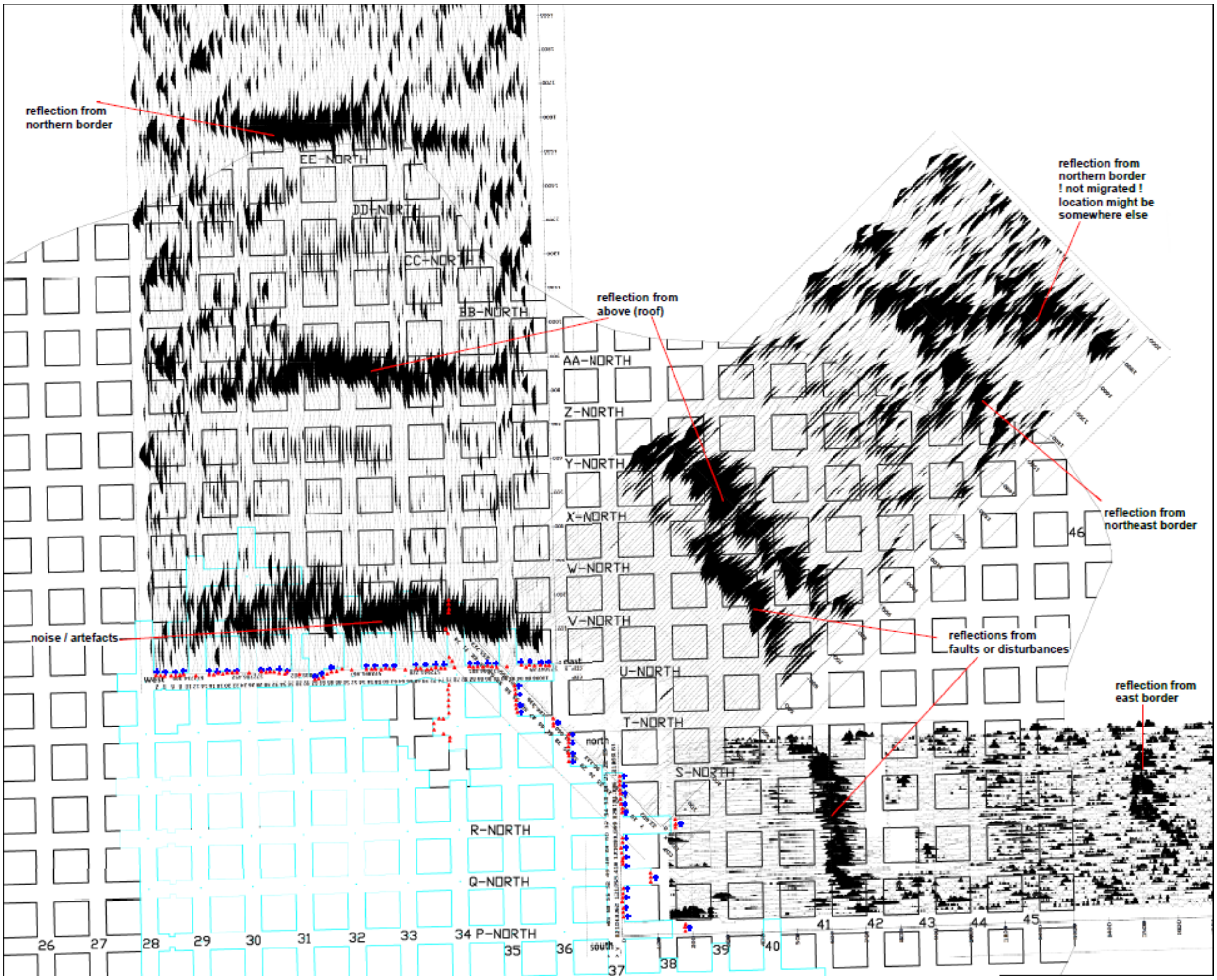

Figure 4:

Acknowledgements

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