High resolution seismic reflection for imaging metamorphic rocks

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Introduction

To optimize the exploitation of ore deposits it is necessary to know the exact geometry of the ore body, as well as the geometry of any barren rock. In the course of this project the principal applicability of high resolution 2D seismic reflection should be tested. For this purpose we have chosen a magnesite quarry where the geology is known from outcrops and deep mining. In the chosen test site we have a succession of magnesite, mylonite, and dolomite. The mylonite zone has an approximate thickness of 10 m (figure 1).

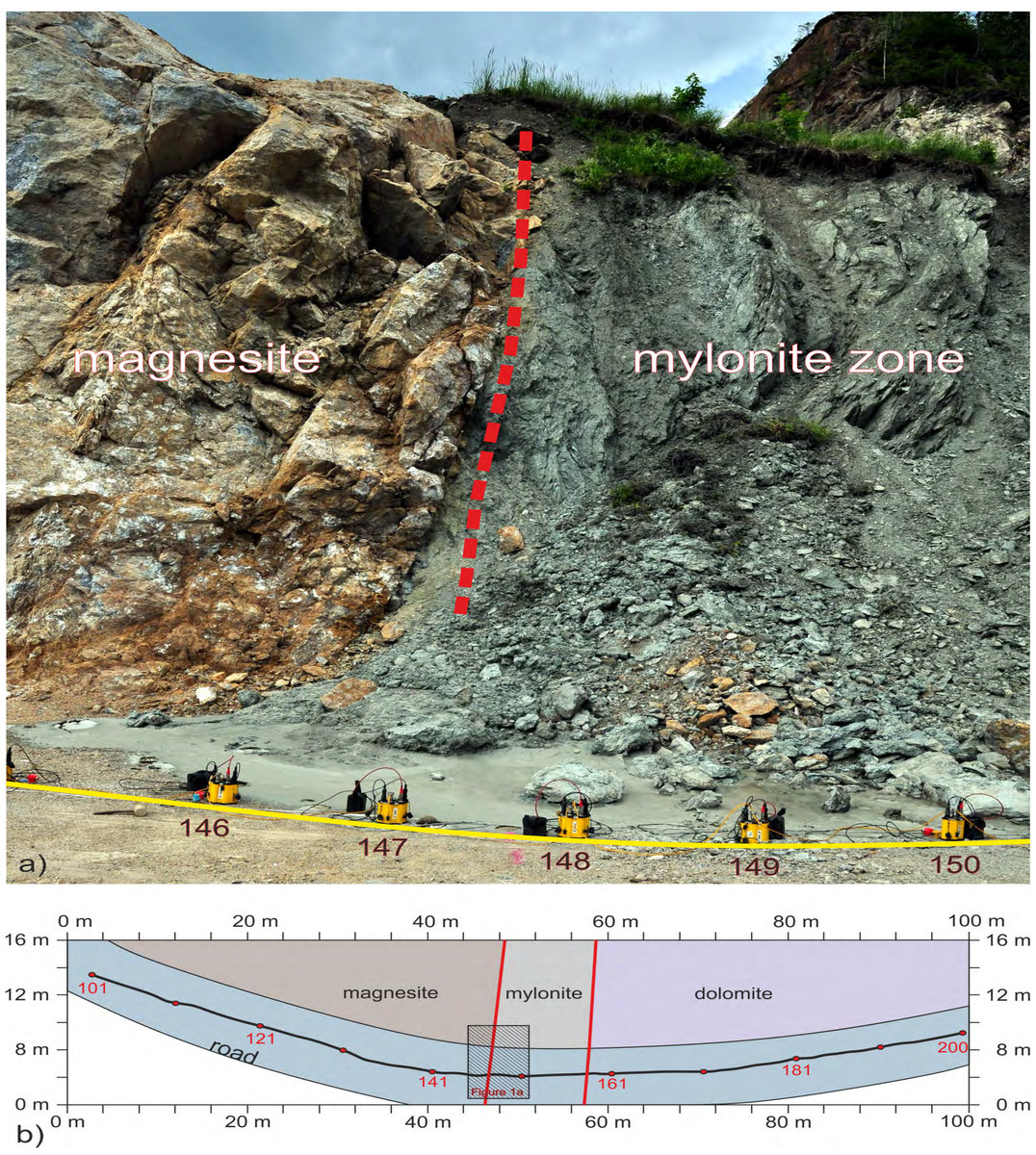

Figure 1: In (a) the transition between magnesite and mylonite is shown together with a small part of the seismic acquisition line. In (b) a map of the acquisition geometry and location of transition between magnesite and mylonite zone, respectively mylonite zone and dolomite is shown.

Method

In hard rock imaging 3D seismic acquisition might be problematic due to topography (e.g. Nedimovic and West, 2003; Milereit et al., 1996). We measured a 99 m long high resolution seismic reflection profile with a source and receiver distance of 1 m. As source a sledge hammer with 8 kg was used. As receivers we used 10 Hz and 40 Hz geophones. The frequency response of the 40 Hz geophones was in comparison to the 10 Hz geophones much higher after preprocessing steps were applied onto the data. Therefore, for further processing only the data from the 40 Hz geophones was taken. For the processing a standard processing sequence with additional F-K filter was used.

In the processed seismic section clearly a set of more or less vertical faults can be seen. Seismic facies is similar over the whole section. Therefore, it is not possible to make any interpretation about lithology changes simply from seismic data. With the help of the outcrop it is possible to locate the boundaries between the different zones and project them onto the seismic section. At approximately receiver stations 146 and 157 the boundaries of the mylonite zone are located. At these positions clearly faults can be seen.

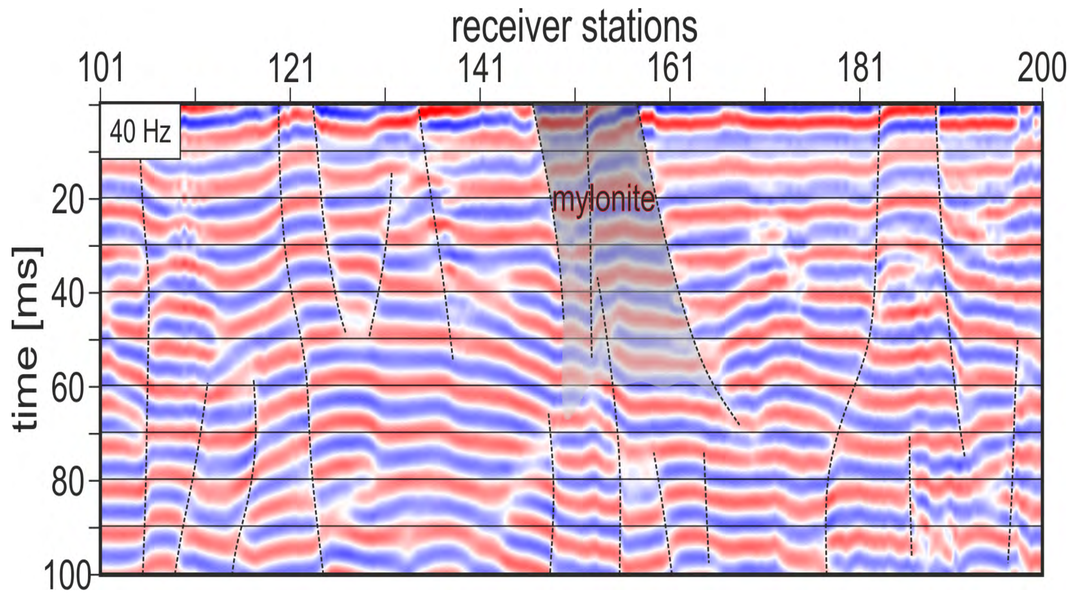

Figure 2: Seismic section with fault interpretation. In the area of the seismic line the subsurface is obviously heavily faulted/fractured. It is not possible to directly distinguish the mylonite zone from seismic facies. But, with the help of the outcrop it is possible to detect mylonite boundaries as faults.

Conclusion

Hard rock seismic reflection has the capability to especially highlight fault and fracture zones. Under the given circumstances it is not possible to distinguish between magnesite, mylonite, and dolomite. The seismic character is similar over the whole seismic section. But, with the help of the outcrop it is possible to determine the boundaries between the different lithologies as fault zones.

Acknowledgement

We thank RHI for the allowance to measure the seismic reflection line in their quarry and for the permission to publish the results. A special thanks goes to Christoph Eichkitz for supporting this project

References:
Nedimovic, M.R., West, G.F. [2003] Crooked-line 2D seismic reflection imaging in crystalline terrains: Part 1, data processing. Geophysics, 66(1), 274-285.
Milkereit, B., Eaton, D., Wu, J., Perron, G., Salisbury, M., Berrer, E., Morrison, G. [1996] Seismic imaging of massive sulfide deposits, part 2: reflection seismic profiling, Economic Geology, 91, 829-834.