COGITO-MIN seismic reflection study in Polvijärvi: Insight into the first results

COGITO-MIN project

The COGITO-MIN project – coordinated by the University of Helsinki – is developing cost-effective geophysical mineral exploration techniques, with main emphasis on seismic methods (Koivisto et al., 2016). Project partners from Poland and Finland, representing both academia and industry, are working together in the project with the aim to develop new data acquisition, processing and interpretation techniques. Locally, the goal is to achieve a better understanding of the subsurface structures in the vicinity of the Kylylahti Cu-Au-Zn mine in Polvijärvi, Eastern Finland. As a part of this project, new 2D reflection seismic data have been acquired.

Field work

The seismic data in the Kylylahti area were acquired along two, almost parallel ca. 6 km long profiles. Geopartner, an industrial partner of the COGITO-MIN project, provided the wireless recording system (Figures 1and 2) and vibroseis sources used in the project (Figure 2). Survey parameters are given in Table 1. Acquisition of the high resolution 2D seismic profiles (Figure 3) was done within two weeks in August-September 2016.

Table 1. Receiver parameters (on the right) and source parameters (below).

Receiver parameters		
Tape format		SEG-Y
Receiver spacing		10 m
No. of active channels in	A	577
	B	574
Profile lengths		~6 km
Sampling interval		1 ms

Source parameters					
Dynamite			Vibroseis		
Source spacing		20 m	Source spacing		20 m
No. of source points in	A	98	No. of source points in	A	121
	B	85		B	152
Depth of explosion		2 m	No. Of sweeps/source point		3
			Sweep frequency		4-220 Hz
			Record length before correlation		22 s

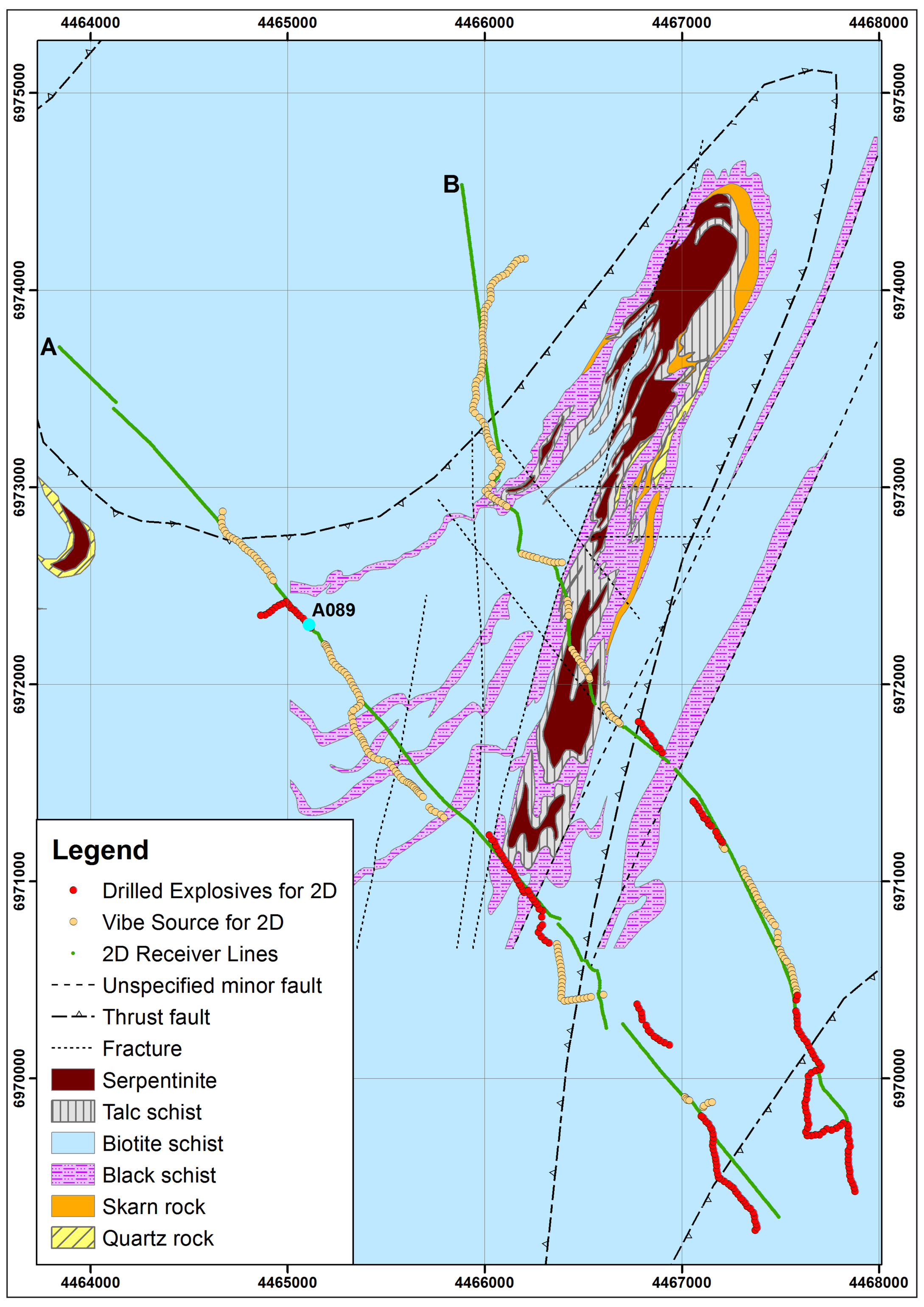
Figure 1. a) Planted wireless receivers for line A. b) Wireless receiver during pick-up after 2 days in the mine area. c) Recording truck with a receiving antenna.

Figure 2. The Kylylahti seismic reflection data were acquired with wireless recording system (red circles) using the INOVA UniVib 9.5-ton trucks, as a seismic source.

Comparison of vibroseis and explosive sources

The Vibroseis source points were located on the roads while most of the explosive source points were located along small forest paths, resulting in a crooked line geometry presented in Figure 3. Both dynamite and vibroseis shot gathers were collected at six source locations to compare the two source types and also to aid parameter selection in data processing. Figure 4 shows a comparison of the vibroseis and explosive shot records at shot location A089 (indicated in Figure 3). It is apparent from the data that the vibroseis record has a better signal-to-noise (S/N) ratio when compared to the explosive shot gather. This is attributed to the fact that a vibroseis record is actually stack of three records allowing efficient suppression of noise. Both shot gathers show clear first breaks, indicating good quality of the data along the whole length of 6 km geophone spread. The reflections indicated in Figure 4 are encouraging for future processing efforts. Figure 5 shows a spectral comparison between the two shots from Figure 4 where it is apparent that highest power occurs at 40-60 Hz. The power of the dynamite source is around 2 times smaller than the power for the vibroseis source (which, as mentioned before, is stacked three times).

Figure 3 (on the right). Locations of receivers and sources of the two seismic profiles, A and B.



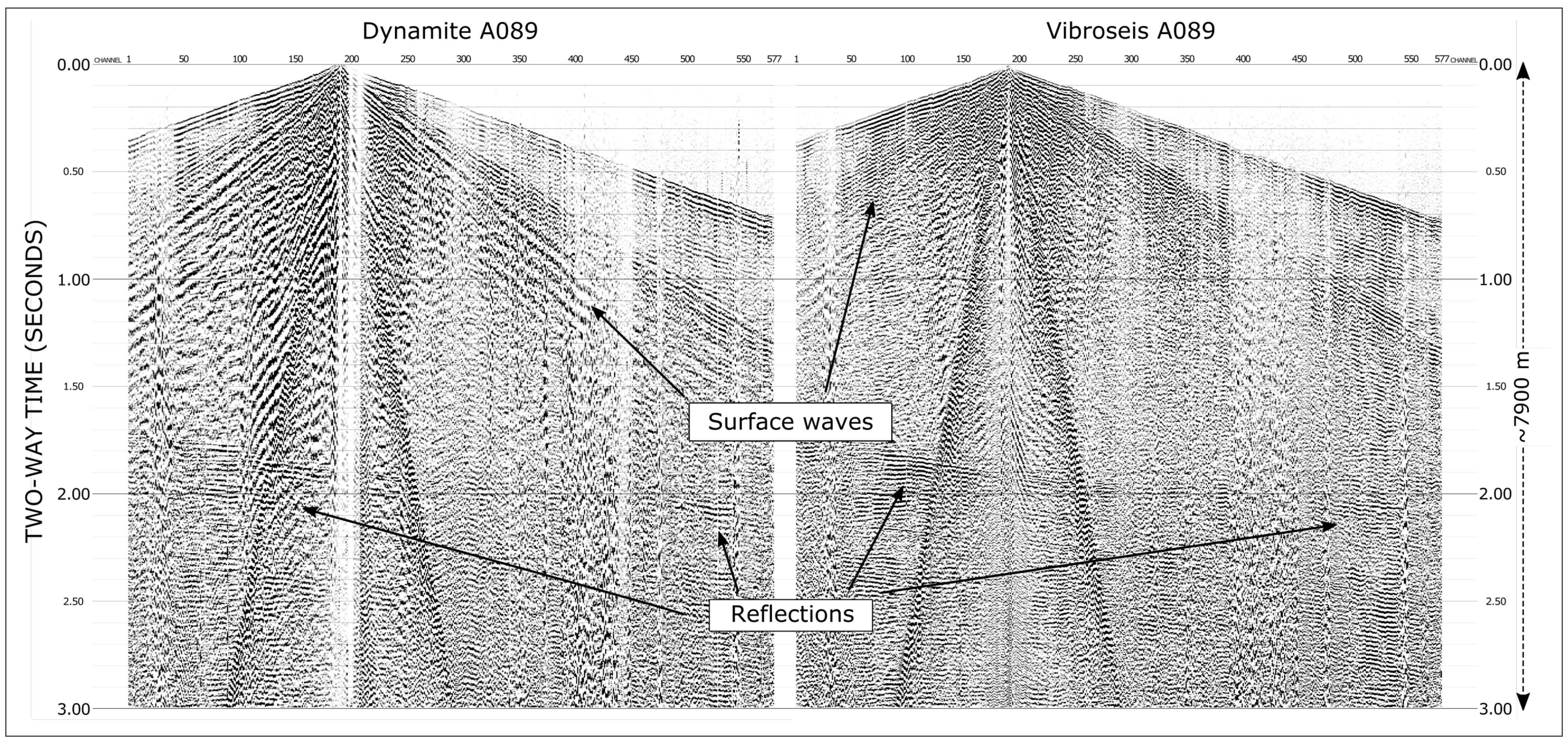


Figure 4. Comparison of vibroseis and dynamite source shot gathers of point A089 (location shown in Figure 3). Depth was estimated using a velocity of 5250 m/s.

Conclusions

The energy from both dynamite and vibroseis sources penetrates down to depths of several kilometres. Comparison between dynamite and vibroseis shot gathers shows that the vibroseis shot gather has a better S/N ratio than the dynamite shot gather. Reflections observed in the unprocessed seismic data are encouraging for future processing efforts.

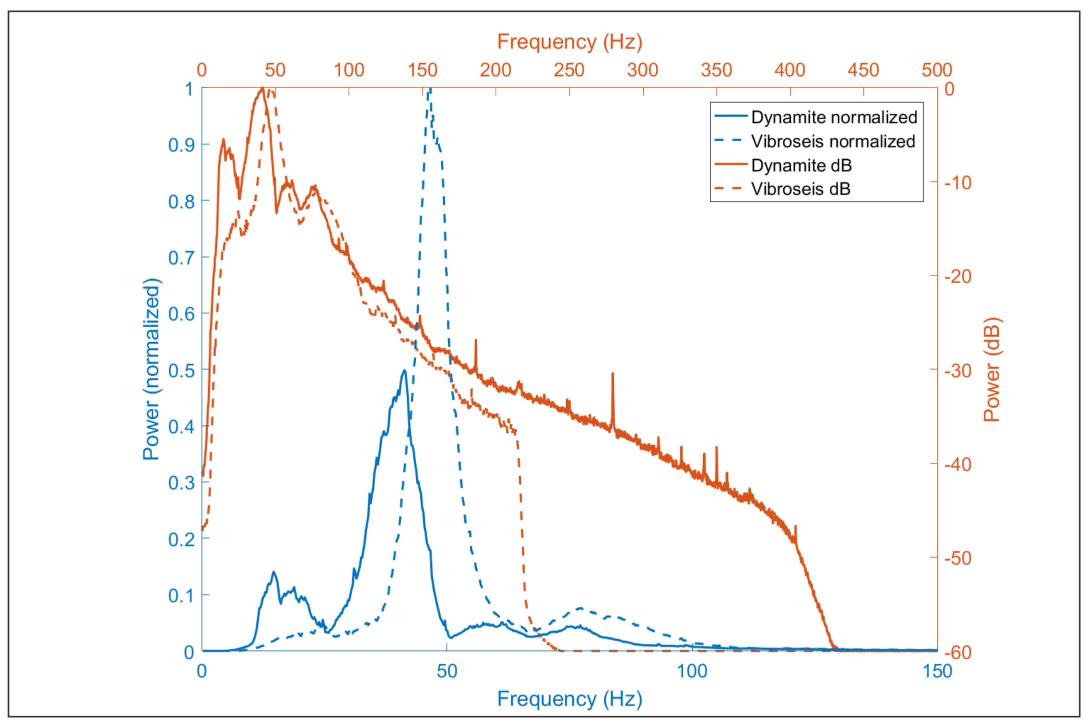


Figure 5. Spectral power comparison of vibroseis and dynamite source shot gathers from figure 4.

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