Electric Seismic Source with broadband frequency (E-Vib)

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Can you tell us about yourself and your company?
I am the CEO of Seismic Mechatronics. The company originated from a collaboration between TU Delft, Magnetic Innovations and MI-Partners in the Netherlands. The project has developed the Electric Seismic Source, E-Vib. In 2016, Seismic Mechatronics decided to further commercialize the E-Vib technology and operate worldwide. Our expertise lies in direct drive motor development and mechanical/electrical engineering.

What is your main task in the Smart Exploration?
We are one of the technology providers within the Smart Exploration project. Our task was to bring E-Vib to a higher Technology Readiness Level (TRL) and for hard rock seismic applications by improving its operational capabilities. Smart Exploration enabled us to do extensive testing and fine-tuning while raising awareness in the seismic acquisition industry concerning the advantages that E-Vib brings. For the prototype, the lead time for the development from concept, order, building and testing took approximately 12 months.

The mechanical/electrical development of the E-Vib has been done solely by Seismic Mechatronics. However, other project partners such as TU Delft, Uppsala University, Lundin Mining/Somincor and Nordic Iron Ore played critical roles in testing and validation. The collaboration with the Smart Exploration project has been fantastic, resulting in shorter time-to-market for the E-Vib than we earlier envisaged.

What was the motive to develop such a system?
The mineral exploration industry is challenged to supply critical raw materials for the long term and also to come. To improve this supply, cost-effective, sustainable, zero-carbon emission innovations are necessary. A key aspect is finding these critical raw materials using seismic methods that have a great resolution at depth. As a result, Seismic Mechatronics develops electric seismic sources to radically impact seismic data acquisition by doing it sustainably with higher quality and lower costs in comparison with the other hydraulic systems available in the market and for an exploration depth generally economically minable worldwide (e.g., 500-2500 m).

Can you please elaborate on the prototype?
Instead of conventional ways of generating seismic signal for data acquisition, such as explosives and hydraulic vibrators, the E-Vib uses electric motors. One of the main technologies in the E-Vib is the linear synchronous motor. The design of the motor is based on a frictionless or contact-free movement. As a result, we are able to generate signal with low distortion, high controllability and repeatability as well as high forces at the low frequencies. This in turn results in higher seismic data quality at lower costs. Moreover, the frictionless design and high forces at the low frequencies also enable us to the build compact electric sources, while achieving a great depth of penetration. Finally, acquiring the seismic data is done much safer and is more environmentally friendly compared to conventional seismic sources.

Since the E-Vib does not use any fluids, is high pressure and is based on a frictionless design, there are no environmental risks or danger to human life. In Australia, our Lightning E-Vib was granted a ‘non-environmental impact’ status, implying its use does not require environmental permits, which saves time and money.

Figure 1 E-Vib validation at a geologically and geophysically known site in the Netherlands (December, 2018).
Has the prototype been proven to work successfully as expected?

The prototype was tested at three different set-ups and environments in the Netherlands, Portugal and Sweden.

In the Netherlands (Figure 1) and Sweden, the prototype (branded as Storm seismic source) was tested at the surface level against known geological structures and existing seismic data. Results proved to be promising and helped to image key geological units down to even 2000 m depth at the Dutch site (Brodic et al., 2019) and 1500 m in the Swedish site (Pertuz et al., 2020).

In Portugal, the E-Vib was tested inside the Neves-Corvo exploration tunnels. Figure 2 shows an example shot gather after cross-correlation and vertical stacking of three repeated shot records. The data quality is reasonable given the noisy condition of the mine with clear first arrivals on both tunnel and surface profiles but also possible reflections as marked. Time synchronization between the tunnel and surface recorders was done using the GPS-time system developed also in the project. After finishing the survey, we realized that conventional seismic sources, such as vibrators, would probably not have been permitted in such a mine as they do not meet standards assigned for permitted vehicles in an underground mine. While the conditions inside the tunnels (at 650 m depth) were extreme due to high temperatures and humidity, which greatly affect the electronics, the source performed well and clear reflections were imaged in the raw shot gathers, opening up possibilities for similar surveys inside mining tunnels (Malehmir et al., 2019).

Thanks to the robust design of the machine, we were able to conduct all three test surveys successfully and the interpretation of collected data against legacy data has proved that E-Vib adds value to seismic data acquisition.

What does the future hold for E-Vib technology?

The E-Vib has been proven to be effective for mineral exploration purposes. It can operate safely and effectively in the mine tunnels at greater depths with high-resolution results, where any other commercial seismic sources could not operate to the best of our knowledge. Even though this prototype has been designed specifically for mineral exploration, the E-Vib technology can be used in all industries requiring an onshore seismic source.

We aim to bring a range of E-Vibs to the market for different purposes and for this reason we have started the Full Force Geophysical joint venture with industry partners to enable an efficient time-to-market. The E-Vibs can be both hired and bought and we also offer the total seismic service package from acquisition to processing to interpretation.

References

