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Seismic promises a revolution for mineral explorers

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THE use of seismic in mineral exploration is undergoing a revolution, with Perth-based HiSeis at the forefront of a worldwide trend. By David Upton

A HiSeis team at work in Finland

HiSeis was formed two years ago by Curtin University to commercialise the hard rock seismic methodology developed by its geophysicists.

The results are anything but academic, with HiSeis already turning over several million dollars a year and achieving some great results for customers, including Canada's Lundin Mining.

Lundin recently announced a 3D seismic survey of its Neves-Corvo base metal mine in Portugal had clearly imaged a previously unknown southern extension of its 900m deep Semblana deposit.

Subsequent drill testing confirmed its existence, with results including a 5m interval of massive copper sulphides averaging 4.6% copper.

HiSeis executive chairman and geophysicist Don Pridmore said seismic technology for mineral exploration had come a long way, with research at Curtin making a major contribution.

He said HeSeis-Curtin was certainly among the world leaders in the introduction of seismic to mineral exploration, with more papers published, more academics and more students than any other university in the world.

Pridmore said previous attempts to transfer seismic technology to mineral exploration had failed for a number of reasons.

'The major factor was the failure to adapt the design and interpretation of seismic surveys to suit the 3D geometry of mineral deposits," he said.

"In the oil and gas industry, seismic is used in the largely 2D environment of flat sedimentary layers over distances of several kilometres.

"In hard rock exploration, the geometry of deposits is very much 3D and the distances are measured in only hundreds of metres.

"There's also the fact that seismic energy travels two or three times faster in hard rocks compared to sedimentary layers.

"That has very profound ramifications on how you design surveys, how you acquire the data and how you process it.

"For these two reasons, the migration of this technology on which the oil industry spends $10 billion a year to the mining industry has not been that successful."

Pridmore said the oil industry's success with 3D seismic from the early 1990s paved the way for a renewed attempt.

"We've seen a huge increase in success rates with 3D in the oil industry this century," he said.

"There were some sporadic experiments with that in the mining industry and the results showed a lot of promise but it has really taken a concentration of expertise in hard rock seismic in Curtin.

"These guys have tried to understand how to overcome the limitations of simply taking the existing technology from the oil industry and applying it to the mining industry.

"They created the Centre for High Definition Geophysics and did some fantastic pioneering work in

hard rock environments, including work at the Victory gold mine and around the nickel mines of Kambalda."

Curtin's team of geophysicists includes Milovan Urosevic, Anton Kepic and an associate Peter Williams.

The group is continuing to develop hard rock seismic technologies, partly funded by Deep Exploration Technologies Cooperative Research Centre, based in Adelaide.

Urosevic said 3D seismic conducted properly in hard rock environments could provide images of "amazing quality … they look like photos taken underground".

He believes the technology has "the potential to stand above all other geophysical methods in minerals exploration".

He said it was very well-suited to locating small, high-grade orebodies at depths of up to 2km but it could be used in all phases of exploration, even in greenfields campaigns as a series of 2D surveys spaced 10 or even 20km apart.

"The methodology is there, but each situation has its own complexity," Urosevic said.

"You can't take one method and apply it everywhere.

"The survey must be designed to suit the local geology, the composition of the rocks and the velocity contrasts."

HiSeis and other pioneers in hard rock seismic face significant hurdles in convincing miners to take up their new exploration tool, with cost being the primary barrier.

Hard rock seismic surveys cost between $100,000 and $200,000 per square kilometre, depending on the complexity of the target.

With a typical 3D survey extending over an area of 20sq.km, that's a price tag of between $2 million and $4 million.

This cost is even higher per square kilometre than a 3D oil seismic survey because the density of "shots" and receivers in a hard rock survey is about 10 times greater.

Pridmore said hard rock seismic was suited to areas where there was sufficient economic interest to justify the expenditure, in much the same way the oil industry used 3D seismic to get more detail on highly prospective targets of limited area.

"3D seismic in the oil industry faced its own resistance because of the much higher cost compared to 2D," he said.

"But the high success rates with 3D soon showed that the benefits were out of all proportion with the increased cost."

He said the necessity to explore at greater depths, where hard rock seismic provided far superior resolution compared to other geophysical methods, could be a very positive force in the adoption of the new technology.

"When you're at depths of a kilometre or more, it costs about $250,000 per drillhole and that quickly adds up when you are drilling almost at random to discover mineralisation and then get some definition of its geometry," Pridmore said.

"With 3D seismic it is possible to lay out a grid over about 20 square kilometres to form a picture of the resource down to 1.5km or 2km.

"You can characterise that volume with definition down to 15 by 15 by 15 metres and that will cost you $3 or $4 million."

He said a hard rock seismic survey provided a very clear picture of the structures in the target area, which could be put together with the explorer's knowledge of likely mineralisation to better define drilling targets.

"It clearly shows shear zones, which are not picked up by other geophysical methods and can pinpoint the intersection of structures – a primary focus for mineral explorers," he said.

Urosevic said it was even possible with 3D hard rock seismic to see the mineralisation itself,

particularly if it was in the form of massive sulphides because of their sharp velocity contrast with host rocks.

He said seismic was also an incredibly powerful tool for mine development because it could provide a full picture of the extent of mineralisation, without the costs of drilling out the entire resource.

"Infill drilling is justified only where it's needed to support a feasibility study," he said.

"But this means mine developments are often built on top of future reserves, only to be relocated at a later stage.

"With seismic, we can conduct a life-of-mine study that enables better development decisions at the very beginning, creating huge savings over the long term."

While HiSeis has achieved its best results overseas, the company has a growing following in Australia, where it has conducted a number of projects.

Results are not yet in the public domain but are believed to be impressive.

After a number of failed starts over several decades, it looks like hard rock seismic is finally here.

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