Mining tool retrained to seek acids and salts

A nuclear probe developed for minerals exploration and mining may soon be enlisted in the fight against some of our biggest environmental challenges; acid mine drainage and salinity.

The probe is part of the SIROLOG suite of spectrometric borehole logging tools developed by CSIRO Exploration and Mining to evaluate the composition and quality of coal, ore and rock at mine sites. For the past 10 years, mining companies have used the tools to map and measure, for example, the ash content of coal, or the copper or iron content of ore. Now, nuclear physicist, Dr Mihai Borsaru, hopes to adapt the technology to measure sulfur, the element responsible for acid mine drainage.

'Acid drainage resulting from mining activities is one of the biggest environmental issues facing the mining industry,' Borsaru says. 'It occurs when sulfur is oxidised to form sulfuric acid, which then seeps from waste rock stockpiles, tailings impoundments or coal rejects. Once established, it is expensive to monitor and remediate.'

Borsaru says the best way to minimise acid drainage is to recognise the sulfide oxidation potential of the mine site, and then incorporate prevention strategies into the various stages of mine planning, design, operation and closure. Understanding the sulfur content of a site will also prevent the burning of high sulfur coal and the production of acid rain.

To measure sulfur, Borsaru will adapt the 'prompt gamma neutron activation' probe. This probe contains an artificial isotope – californium-252 – which emits neutrons. When the probe is lowered down a borehole (up to 1000 m), the neutrons are captured by the nuclei of atoms that comprise the surrounding coal or ore. The nuclei become excited, but rapidly revert to their relaxed state by ejecting gamma rays. As the nuclei in the atoms of different elements – such as sulfur, iron or zinc – release gamma rays of different energies, the identity of each element can be determined. A scintillation detector relays this information from the probe to a computer at the surface, which then graphs the energy spectra and reveals which elements are present and in what quantities.

Borsaru says adapting the probe to measure sulfur will involve spectral data analysis and calibration of the instrument. Preliminary studies have shown that the tool can determine the percentage of sulfur in boreholes and overburden rock. But further work is needed to develop better techniques for spectral data evaluation and increase the speed of signal processing of the tool.

A similar calibration will be required to measure chlorine, the dominant element associated with salinity. Borsaru says the salinity probe will prove most useful in mapping problem areas in agriculture.

'Mapping salinity is important for a more accurate assessment of the extent of salinity and to better estimate the size of the problem,' he says. 'Salinity is a water balance problem, not just a salt problem and the movement of water in a catchment affects the way salt moves in the catchment. So it will be important to measure salinity *in-situ* and to monitor the change of salinity in boreholes in agricultural areas.'

Wendy Pyper

Dr Mihai Borsaru is developing tools to measure acid mine waste and salinity.

Wendy Pyper

Griffith University student William Schey works with the SIROLOG equipment.

Salinity is measured with equipment that logs conductivity. But Borsaru says many measurements are imprecise when shale – a type of rock formation – is present, as it interferes with conductivity. Many boreholes are also encased in iron, which prevents conductivity measurements, but not prompt gamma neutron activation analysis.

Borsaru has tested the salinity probe in the lab, and will shortly conduct field tests, comparing the readings from the probe with those made by conductivity tools.

Various SIROLOG tools are now used in the mining industries in Egypt, India, Iran, Chile, Columbia, Thailand, Vietnam and Australia, while Japan and China have expressed interest in the new sulfur probe. Borsaru says the next step is to market the technology in Australia and sell it in North America and Europe.

SIROLOG tool development is funded by the Australian Coal Association Research Program and the mining industry. The tools are made and supplied by Scintrex/Auslog and CSIRO.

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