Profitable mining with the help of radiation technology

By Rodolfo Quevenco

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— Nick Cutmore, Research Programme Director, Commonwealth Scientific and Industrial Research Organisation, Australia

During the boom years of the 2000s, the global mining industry expanded quickly, with many countries and companies investing large amounts of money in efforts to increase production and satisfy a rapidly growing global economy hungry for natural resources. Now, with lower commodity prices, decreasing ore quality and higher production costs, keeping these mines open means streamlining operations and improving productivity. Radiotracers and nucleonic gauges are among the techniques that enable the industry to achieve this increased efficiency.

Aerial view of the Coober Pedy opal mine in Australia.
(Photo: G. Sharp/Flickr.com/CC BY 2.0)

The industry is well aware of these issues. "The big challenge that the mining industry faces today is that there is less water; energy is getting more expensive; and the actual grade of ore is lower and lower," said Nick Cutmore, Research Programme Director at the Commonwealth Scientific and Industrial Research Organisation (CSIRO), a leading scientific agency in Australia that pioneers research and development work on the application of nuclear techniques to the mining industry. "So we need new technology that will enable us to mine material more selectively and not waste water and energy on very low grade ore."

"The bottom line is simple: it's all about keeping the good rocks and getting rid of the bad rocks before you waste energy and water processing them," he said.

In mining operations, it is important to analyse bulk ore — from 1000 to 10 000 tonnes per hour — as it is moved on a conveyor belt. For quick and accurate analysis, engineers need a way of looking into the ore to identify the elements it contains and measure the amounts. Nuclear techniques are "absolutely best suited" for this type of analysis, Cutmore said.

"Neutrons or high energy X-rays or gamma rays are very penetrating and are able to analyse large amounts of material quite accurately where other approaches will fail," he said.

Radiotracers and nucleonic gauges are used by mining industries to improve the quality of products, optimize processes, and save energy and materials, said Patrick Brisset, an industrial technologist at the IAEA. "Today, many mining companies have also recognized the high socio-economic benefits of radioisotope technology."

Nuclear magnifying glass

CSIRO is pioneering development of the use of nuclear-based techniques for, among other things, drilling, mineral sorting and real-time sensing and analysis. It has developed a new analyser that combines X-ray fluorescence and X-ray diffraction to provide rapid characterization of minerals at parts per billion levels. The technique can detect down to a level of about a hundred parts per billion for key elements, measuring valuable metals such as gold, silver, uranium and the platinum group elements, and important contaminants such as lead, mercury and arsenic, at levels of a few grams per tonne or less.

CSIRO has also recently developed a method of gamma activation analysis that uses high energy X-rays to measure ore samples in an automated system without the need for laborious sample preparation or access to a

nuclear reactor to conduct neutron activation analysis. This technique is particularly effective in detecting the gold content of various types of samples (see box).

Cooperation with the IAEA: Sharing technology

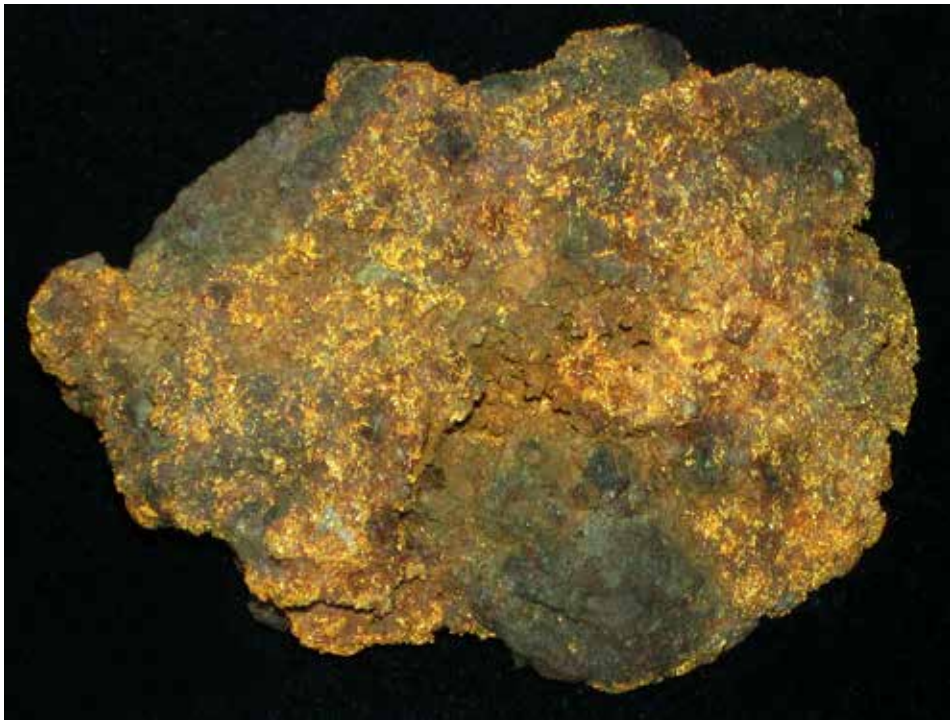
CSIRO is participating in an IAEA coordinated research project on the development of radiometric methods in exploration and mining of minerals and metals — sharing its technology with scientists from around the world.

In fact, Australia's cooperation with the IAEA on the use of neutrons, X-rays and radiotracers dates back to the 1980s when this technology was new.

As one of the top five mining countries in the world, Australia leads in several areas of nuclear applications used by the industry. Many of these applications are quite mature technologies, with a successful history of field and commercial use.

Australia's participation in the IAEA's coordinated research project is mainly focused on the transfer of technology to other countries, Cutmore said.

IAEA coordinated research projects provide a mechanism for bringing researchers from institutions in both developed and developing countries together to collaborate on a specific research topic, and to exchange and transfer knowledge in the use of nuclear techniques for various peaceful applications.



Gold ore in matrix.
(Photo: J. St. John/Flickr.com/CC BY 2.0)

"We want to make other countries aware of the technologies and knowledge we have developed, so that they are fully informed of what is available to the minerals industry in those areas," Cutmore said. "Our desire is to see this technology benefit some other Member States that could in the medium to long term utilize it to better exploit resources for the economic prosperity of their countries."

THE SCIENCE

Extracting every ounce of gold

World production of gold is worth billions of dollars annually, and the high price of gold is mostly a result of the high cost of mining it. Gold is mined commercially at gram-per-tonne levels, and few analytical techniques have the sensitivity to accurately measure metals at these ultra-low levels.

Gamma activation analysis uses high-powered X-rays to excite specific elements in the ore, activating any trace of gold in the sample. The technique applies to gold in any chemical or physical form, and can be used to measure the gold content of solids, slurries or liquids. Combining the latest developments in high power X-ray sources and radiation detectors with advanced computer modelling enables the analyser developed by CSIRO to detect gold at levels nearly ten times lower than is possible using other techniques. It can also detect very low levels in extremely small samples.