Space radar to improve miners' safety

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Advanced ground penetration radar, originally developed to investigate the soil structure on the Moon and other planets on ESA planetary missions, is now being used in Canadian mines to spot hidden cracks and weaknesses in mine roofs.

Using space technology developed for ESA for the special ground penetration radar GINGER (Guidance and Into-the-Ground Exploration Radar) that will be mounted on a Moon or Mars rover to investigate those planets' soil structure, the German-Swiss company RST has designed and developed two radars to detect invisible separations in the roofs and walls of mines: the Crack Identification System (CRIS) for hard rock mines and the Potash Roof Inspection System (PRIS) for potash mines.

ESA's Technology Transfer Programme Office (TTPO) helped fund the adaptation of the space radar technology and thus facilitated the transfer.

"CRIS and PRIS are based directly on the GINGER radar technology which we started to develop with ESA in 1994. We have changed the operating frequencies to target what we search for in mine drifts, that is cracks and structural weakness," explains Yvonne Krellmann, RST Project Manager.

"During test campaigns with our two radars CRIS and PRIS in Canada, we have verified that this technology is very successful in spotting horizontal cracks in the roofs of mine drifts; cracks which are difficult to identify with the human eye and which, in time, could cause a roof to

fall down."

Ground penetration radars and GINGER

Ground penetration radar is a geophysical, non-destructive technique, which employs radio waves to determine structures and objects buried in the ground. The main application is the study of the very shallow subsurface at construction and archaeological sites, where typically the radar operates at the frequency range 1 to 1000 MHz.

In principle, a ground-penetration radar works in the same way as a radar to detect aircraft; it sends out an impulse of radio waves and receives the reflected energy. The radio waves are reflected on any boundary where the dielectric properties of the materials change.

In the case of aircraft radar this is when the waves hit a plane; for ground-penetration radar used in mineshafts it is when the waves meet a separation in material or a clay seam in a wall or roof, thus reducing its strength. To calculate the exact distance or depth to the detected boundary, the travel time of the waves is measured.

GINGER uses two frequencies to cover two independent functions. Firstly, it acts as the 'eye' of a planetary rover, as it makes the surface in front of the rover visible through medium resolution imaging, helps to steer the rover. At the same time, it not only maps but also penetrates the surfaces it drives over, exploring the structure of the ground layers beneath.

Spotting weaknesses in mine roofs

A radar system based on this so-called 'stepped frequency radar technology', the ground-penetrating radar CRIS, was developed to identify cracks in hard rock environments. It was successful tested in

several mines in Ontario, Canada, as well as in several potash mines commenced. Those mines are especially vulnerable to cracks, as they are located about one kilometre under ground. The immense pressure of the rock's weight combined with certain properties of salt incorporated in the rock can cause those mine rooms to deform and consequently to crack.

This technology was developed further and resulted in PRIS II, a stepped frequency radar device which can be mounted on a jeep or a mining machine and is operated by slowly driving through mine shafts, thus reducing inspection time.

"As the stepped frequency radar technology becomes more robust to handle harsh environmental conditions and results are further refined to be more understandable by mining engineers and other personal not familiar with radars, we are getting more enquiries from interested mining companies," says Hans Martin Braun, RST Manager and shareholder.

"Efforts to improve mine safety could, in the near future, include equipping mining machines with ground penetration radars, which are faster and more efficient at detecting weakness in mineshaft walls than visual inspection."

Technology requests from street and tunnel inspection market

This technology can be transferred to many other applications. TTPO just recently got several requests, the most promising of which came from a German-Swiss inspection firm that is interested in transferring the technology to the street and tunnel maintenance business. Bearing in mind that Switzerland alone has 1600 km of tunnels, with 500 more under construction, this sector represents a considerable market to explore.

Source: European Space Agency

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