More gold -- and other minerals -- in them thar hills?

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Though technology has taken much of the guesswork out of mining, mountain ranges are still notoriously difficult environments in which to hunt for valuable minerals. Various methods used to draw a picture of the underground environment, including the measurement of gravitational and magnetic fields, are easily thrown off by factors such as changes in topography height, surrounding temperature, and barometric pressure.

Now Prof. Lev Eppelbaum of Tel Aviv University's Department of Geophysics and Planetary Sciences has developed a new method for processing and analysing complex environments in the face of these challenges. Combining new physical-mathematical approaches with their own advanced software — which brings together all available analysis in the same three-dimensional image — the researchers were able to overcome the difficulties posed by mountainous regions, successfully uncovering new mineral reserves.

Prof. Eppelbaum began working on his methodology with the late Prof. Boris Khesin of Ben Gurion University. Presented at the European Geosciences Conference in Vienna in April 2012 and in their book Geophysical Studies in the Caucasus, the method has already uncovered a previously unknown polymetallic reserve on the southern slope of the Caucasus, part of a vast mountain range between Europe and Asia that stretches from the Black to the Caspian Seas. The reserves include copper, zinc, lead, aluminium, and a mixture of gold and silver, Prof. Eppelbaum says.

A mountain range in three dimensions

In the hunt for underground metals or other resources like oil, gas, or water, geophysical fields such as gravity, magnetics, temperature, polarization, and electromagnetism play crucial roles. For example, the density of polymetallic ore —which consists of more than one metal — exceeds that of the surrounding rocks, creating a gravity anomaly. Although a 3D gravity analysis may then be used to decode these environmental cues, reserves do not reveal themselves that easily.

"After the environmental analysis, you must calculate the different types of background 'noise,' "Prof. Eppelbaum observes, such as the complexity of the topography, environmental characteristics, and more. Mountain ranges present particularly difficult terrain for this kind of calculation.

In order to circumvent these issues, Profs. Eppelbaum and Khesin improved current methods of geophysical analysis. They developed new mathematical approaches to process the information gathered from already-existing technology and from their own specially-designed software which allows the user to interpret all the information in a cohesive 3D image. "This 3D combined modelling software, which we programmed ourselves, enables scientists to see the buried targets more clearly," says Prof. Eppelbaum.

Prof. Eppelbaum believes they have discovered more than 500,000 tons of previously undiscovered polymetallic ore in the Caucasus mountainside in a single ore deposit. Other zones that could contain ore reserves have also been identified by the new methodology.

Caucasus and beyond

An expert in the Caucasus Mountains, Prof. Eppelbaum says that this technique can be applied to any region of the world, but most effectively in mountainous regions such as the Appalachian Mountains in the US and Canada or the Alps in Europe. Dr. Eppelbaum plans to develop collaborations with international geophysicists in an effort to discover new reserves around the world. "These reserves are very valuable resources for countries to discover," he says.

Provided by Tel Aviv University