Quantifying Earth's copper: Study puts numbers on nonrenewabilility

February 21 2008

Unlike forests, fisheries and other resources that can be renewed relatively rapidly through natural processes, mineral deposits form so slowly that they're classified as nonrenewable. But just how non-renewable are they, and is it possible to put a number on their nonrenewability?

For one mineral—copper—researchers at the University of Michigan and Syracuse University have done just that. Their results, reported in the March issue of the journal Geology, show that humans use about 18,000 times more copper each year than Earth manages to put into new deposits.

In the past, estimates of the world's mineral resources have relied on two basic approaches: geologic and economic, said U-M professor of geological sciences Stephen Kesler, a co-author on the paper. Geologic estimates compile data on mineral deposits in well-explored areas and extrapolate into less-explored regions. Economic estimates look at how much of a given mineral resource already has been found, assume that's a representative sample and then use statistical methods to figure out what proportion of Earth's total reserves the sample represents.

But for most resources, both of these methods provide estimates to depths of only about a kilometer (0.6 mile), ignoring large parts of Earth's 50-kilometer thick crust that might contain important deposits.

"The new dimension to our work is that we have estimated what's in the

entire crust—all 50 kilometers—because that really is the ultimate resource. It's not just what's in the top kilometer," Kesler said.

He and collaborator Bruce Wilkinson of Syracuse University accomplished this by developing a model that simulates the migration of deposits through Earth's crust over time. To check the accuracy of their model, they compared its estimates for the upper 1 km of crust in the United States to a U.S. Geological Survey estimate of the same area that represented hundreds of person-years of geologic studies. The estimates agreed, "so that made us feel that the model works," Kesler said.

From the model, Kesler and Wilkinson were able to extract a wealth of information. For example, they determined that Earth formed more than 125,000 copper deposits over time in order to produce the 574 deposits known to be at or near the surface today. Of those 125,000 original deposits, more than two-thirds have been eroded away and are being recycled by geological processes.

The researchers also estimated how soon the amount of copper in deposits above 3.3 kilometers—the likely limit of future mining—will be depleted. The answer—5,500 years—may sound like a long time, but to geologists it's alarmingly short, Kesler said.

Next, he and Wilkinson want to use their model to estimate the world's gold and oil deposits.

Source: University of Michigan