Undiscovered Deposits of Gold, Silver, Copper, Lead, and Zinc in the Conterminous United States

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The USGS has completed a 2-year effort to assess the undiscovered deposits of gold, silver, copper, lead, and zinc in the conterminous United States. It is the first time that probabilistic estimates of undiscovered mineral resources have been provided on a national scale. Such estimates are essential for ensuring that all domestic mineral resources will be considered in planning the optimum use of the Nation's public lands and for securing long-term mineral supplies from national and international sources.

Introduction

The assessment of undiscovered deposits of gold, silver, copper, lead, and zinc, which was conducted by regional assessment teams of scientists from the USGS, was based on the concepts of permissive tracts and mineral deposit models. For the assessment, the conterminous United States was divided into 12 geographic regions—Adirondack Mountains, Northern Rocky Mountains, Central and Southern Rocky Mountains, Colorado Plateau, East Central, Great Basin, Great Plains, Lake Superior, Northern Appalachians, Pacific Coast, Southern Appalachians, and Southern Basin and Range. Permissive tracts are discrete areas of the United States for which estimates of numbers of undiscovered deposits of a particular deposit type were made. A permissive tract is defined by its geographic boundaries such that the probability of deposits of the type delineated occurring outside the boundary is negligible. Mineral deposit models are sets of data in a convenient form that describe a group of deposits that have similar characteristics. They are based on a compilation of worldwide literature and on observation, and they contain information on the common geologic attributes of the deposits and the geologic environments in which they are found.

Within each geographic region, the assessment teams delineated permissive tracts for those mineral deposit models that were judged to be appropriate. Where the amount of information warranted, the number of undiscovered deposits was estimated at the 90th, 50th, 10th, 5th, and 1st percentiles. The nth percentile is the estimated number of deposits that exceeds the stated probability expressed as a percentage. A Monte Carlo simulation computer program was used to combine the probability distribution of the number of undiscovered deposits with the grade and tonnage data sets associated with each mineral deposit model. This computer program constructs the probability distribution of the contained metal in the undiscovered deposits. The steps involved in the quantitative estimation of undiscovered mineral resources are shown in figure 1. The probability distributions of undiscovered metal were combined to generate national estimates. A total of 46 deposit models were used to delineate 281 permissive tracts in the conterminous United States.

Assessment Results

The greatest amount of undiscovered copper is estimated to occur in undiscovered porphyry copper deposits in the Southern Basin and Range region of the country. Porphyry copper deposits are deposits of copper in which the copper-bearing minerals occur in disseminated grains or in veinlets through a large volume of rock. Although this part of the country has been extensively explored, the amount of undiscovered copper that is estimated to exist suggests that a greater effort be devoted to improving exploration technologies and to developing a better understanding of the occurrence of this type of deposit.

The greatest amount of undiscovered gold is estimated to occur in the Great Basin region of the country in principally two deposit types—hot-spring gold-silver and sediment-hosted gold.

Hot-spring gold-silver deposits are deposits in which native gold and silver-bearing minerals occur as disseminated grains or in veinlets in fine-grained rocks of silica and quartz. Sediment-hosted gold deposits are deposits in which very fine grained gold occurs in disseminated grains in carbonaceous calcareous rocks and associated jasperoids. Of the two types, hot-spring gold-silver is expected to contain the greater amount of gold. This deposit type warrants a greater effort in data gathering, particularly for those tracts that were delineated as being permissive for this type of deposit, but for which quantitative estimates were not made.

The greatest amount of undiscovered silver is anticipated to occur in sediment-hosted (red-bed) copper deposits mostly in the Northern Rocky Mountains region of the country. Sediment-hosted (red-bed) copper deposits are deposits of copper in which the copper-bearing minerals occur as disseminated grains in red-bed sequences of sandstone, siltstone, and shale. There were tracts in this region that were not assessed quantitatively; more detailed information is needed for assessing those areas judged permissive for this deposit type. The large areas of these tracts also suggest that the recognition criteria for this type of deposit need to be improved.

The greatest amounts of undiscovered lead and zinc are estimated to occur in the East Central and the Great Plains regions of the country, principally in replacement- type deposits exemplified by the Mississippi Valley type. Mississippi Valley type lead-zinc deposits are deposits in which lead- and zinc-bearing minerals occur as fillings in open-spaced calcareous rocks. The large areas of these tracts suggest that greater efforts be made to improve recognition criteria so as to delineate better the areas of permissiveness for this type of deposit.
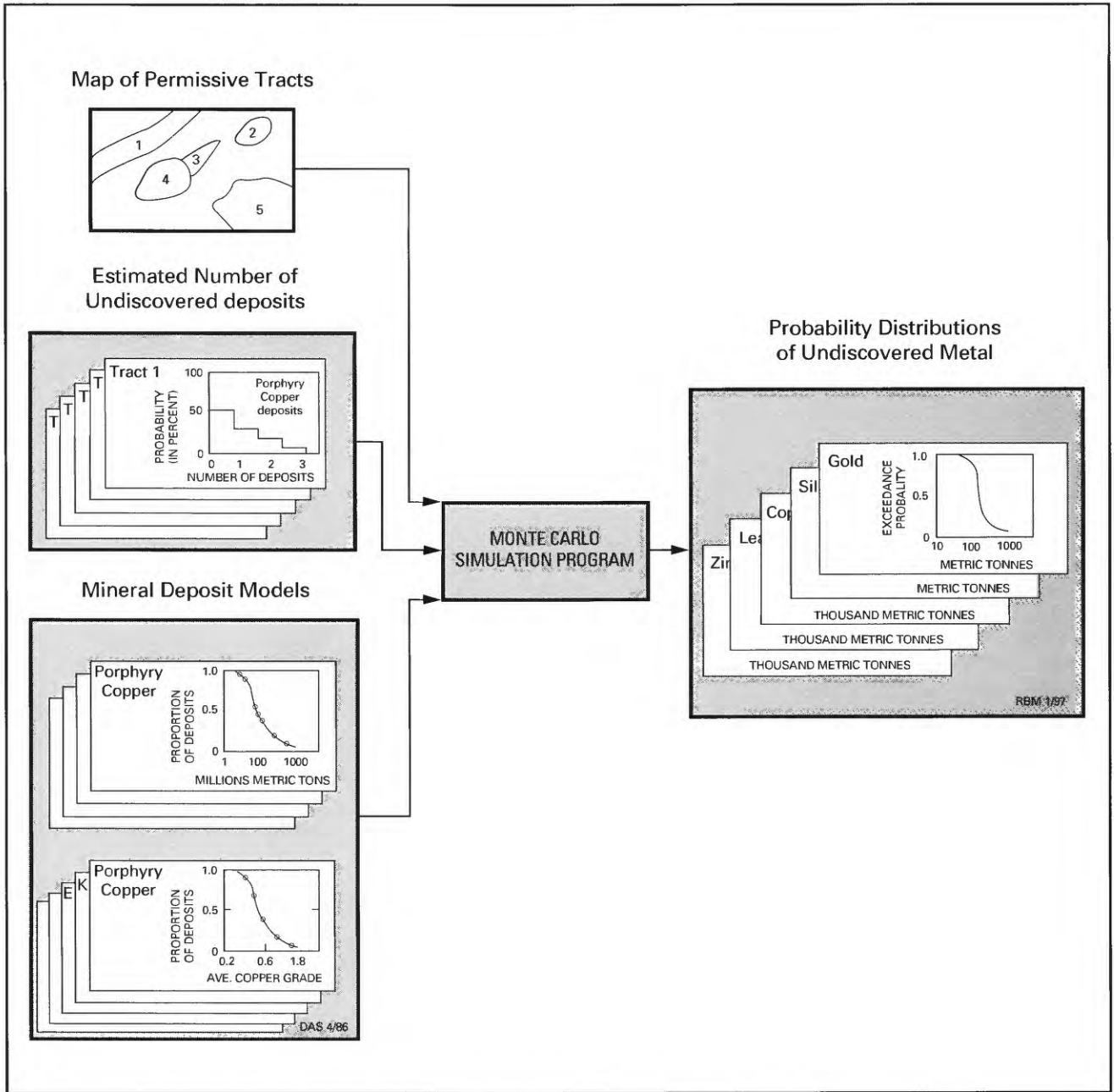
Figure 1. The steps involved in the quantative estimation of undiscovered mineral resources.
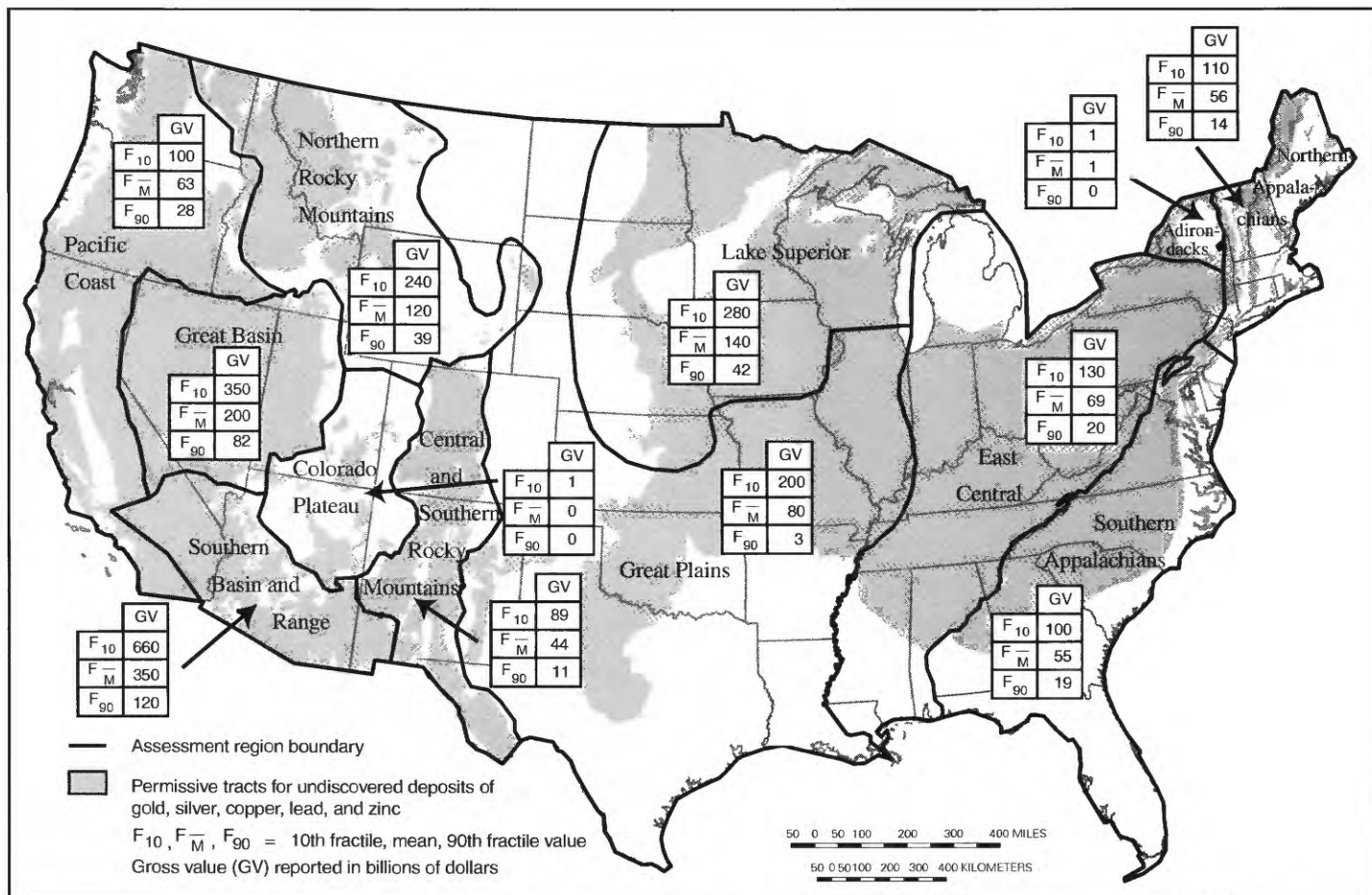
Figure 2. Combined permissive tracts for the conterminous United States and estimates of the gross value of the contained metal at today's prices for gold, silver, copper, lead, and zinc in undiscovered deposits in each of the 12 regions of the country.

Figure 2 shows the combined permissive tracts for the conterminous United States and estimates of the gross value of the contained metal at today's prices for gold, silver, copper, lead, and zinc in undiscovered deposits in each of the 12 regions of the country. For each region, the 10th fractile, the 90th fractile, and the mean estimate of the gross value is given. The nth fractile is the estimate of the gross value that exceeds the stated probability expressed as a fraction. At today's prices, the gross value of gold, silver, copper, lead, and zinc in undiscovered deposits is estimated to be $1.2 trillion. This can be compared with the gross value at today's prices of the discovered (past production plus remaining reserves) gold, silver, copper, lead, and zinc, which is calculated to be $1.4 trillion. Thus, for conventional-type deposits in the conterminous 48 States, about as much is left to be discovered as has already been discovered, excluding discovered materials that have not been produced and are not currently classified as reserves.

Use of Assessments

The uses of national assessments in long-range planning are primarily threefold. First and foremost is a look to the future. Current mineral inventories are necessarily finite and tied directly to current technologies. To meet future demands, new sources of raw materials must be found, and new technologies must be developed to accommodate the processing of materials (for the most part at progressively lower grades) or new materials that provide a property needed by society.

Second is an ability to identify emerging issues. As a nation's economy evolves, greater attention needs to be paid to land use and the state of the environment. National assessments provide the framework for addressing these issues at the regional and local levels. Important considerations are to know where future resources may be located, how much metal such resources may contain, and what environmental impacts may result from the extraction of such resources.

Third is the role of national assessments in risk management. At issue are risks associated with resource adequacy, economic security, and environment degradation. National assessments are critical tools for making prudent decisions for the future.

Access to the Data Base

The data base consists of a series of computer files in Microsoft Excel, Microsoft Word, and Adobe Illustrator formats. These can be used to generate tables, text files, maps, and graphs, along with an executable Adobe Acrobat file that can be used with the following operating systems: Macintosh OS™, MS-DOS™, WINDOWS 3.1™, WINDOWS 95™, and UNIX.

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For More Information

Copies of Open-File Report 96–96, *Data Base for a National Mineral-Resource Assessment of Undiscovered Deposits of Gold, Silver, Copper, Lead, and Zinc in the Conterminous United States* on CD-ROM can be obtained from the:

USGS Information Services
Box 25286, Denver Federal Center,
Denver CO 80225-0046

Tel: 303-202-4210; Fax 303-202-4695. The price of the CD-ROM is $32.

—*Richard B. McCammon*