MINERAL RESERVES, RESOURCES, RESOURCE POTENTIAL, AND CERTAINTY

DEFINITIONS OF MINERAL RESERVES, resources, resource potential, and certainty of assessment have been adopted by the Geological Survey and U.S. Bureau of Mines to foster more uniform terminology and more accurate communication. The exact nomenclature used depends on the commodity being described, but the unified terminology can be applied to all commodities.

The terminology of McKelvey (1972) for both discovered and undiscovered mineral resources, modified by Brobst and Pratt (1973, p. 1–8), has been adopted with minor changes for joint use by the U.S. Bureau of Mines and U.S. Geological Survey (1976a, b, 1980). This terminology applies to the description of the mineral endowment of an area. Resource assessment studies evaluate the likelihood of the occurrence of mineral deposits (resources) in terms of levels of mineral resource potential and the certainty of the assessment (Goudarzi, 1984). The likelihood of occurrence is not a measure of the resources themselves; consequently, the McKelvey classification should not be used in assessment studies except for descriptions of identified resources.

RESERVES AND RESOURCES

The total mineral endowment of an area is divided into two major parts: identified resources and undiscovered resources. These, in turn, are subdivided on the basis of the adequacy of knowledge about the deposits and current economic factors (fig. 21). The definitions of reserve and resource terms as follows are quoted or paraphrased from Geological Survey Circular 831 (U.S. Bureau of Mines and U.S. Geological Survey, 1980).

Resource. A concentration of naturally occurring solid, liquid, or gaseous materials in or on the Earth's crust in such form that economic extraction of a commodity is regarded as feasible, either currently or at some future time.

Identified resource. A resource whose location, grade, quality, and quantity are known or can be estimated from specific geologic evidence. Identified resources include economic, marginally economic, and subeconomic resources.

Undiscovered resources. Undiscovered bodies of mineral-bearing material whose existence is surmised from broad (regional) knowledge and theory.

Reserve. That portion of an identified resource from which a usable mineral or energy commodity can be economically and legally extracted at the time of determination. The term "ore" applies to reserves of some kinds of mineral commodities, generally metallic, but for want of another term it is sometimes applied to nonmetallic commodities.

Definitions given here for "measured," "indicated," and "inferred" resources may be applied to both identified economic resources (reserves) and identified subeconomic resources.

Measured. Materials whose quality and quantity have been determined, within a margin of error of less than 20 percent, by quantitative data, including appropriate analyses, from closely spaced and geologically well-known sample sites.

Indicated. Materials whose quality and quantity have been estimated partly from analyses and measurements and partly from reasonable geologic inferences.

Demonstrated. A collective term for the sum of materials in both measured and indicated resources.

Inferred. Materials in identified but unexplored deposits whose quality and quantity have been estimated from geologic projections.

The terms "hypothetical resource" and "speculative resource" apply to undiscovered resources and are useful when estimating resource endowment.

Hypothetical resources. Undiscovered materials that may reasonably be expected to exist in known mining districts under known geologic conditions.

Speculative resources. Undiscovered materials that may occur in known types of deposits in geologic settings where no previous discoveries have been made or in as-yet-unknown types of deposits that remain to be recognized.

The terms "proved," "probable," and "possible" are commonly used by industry for economic evaluations of ore in specific deposits or districts. "Proved"

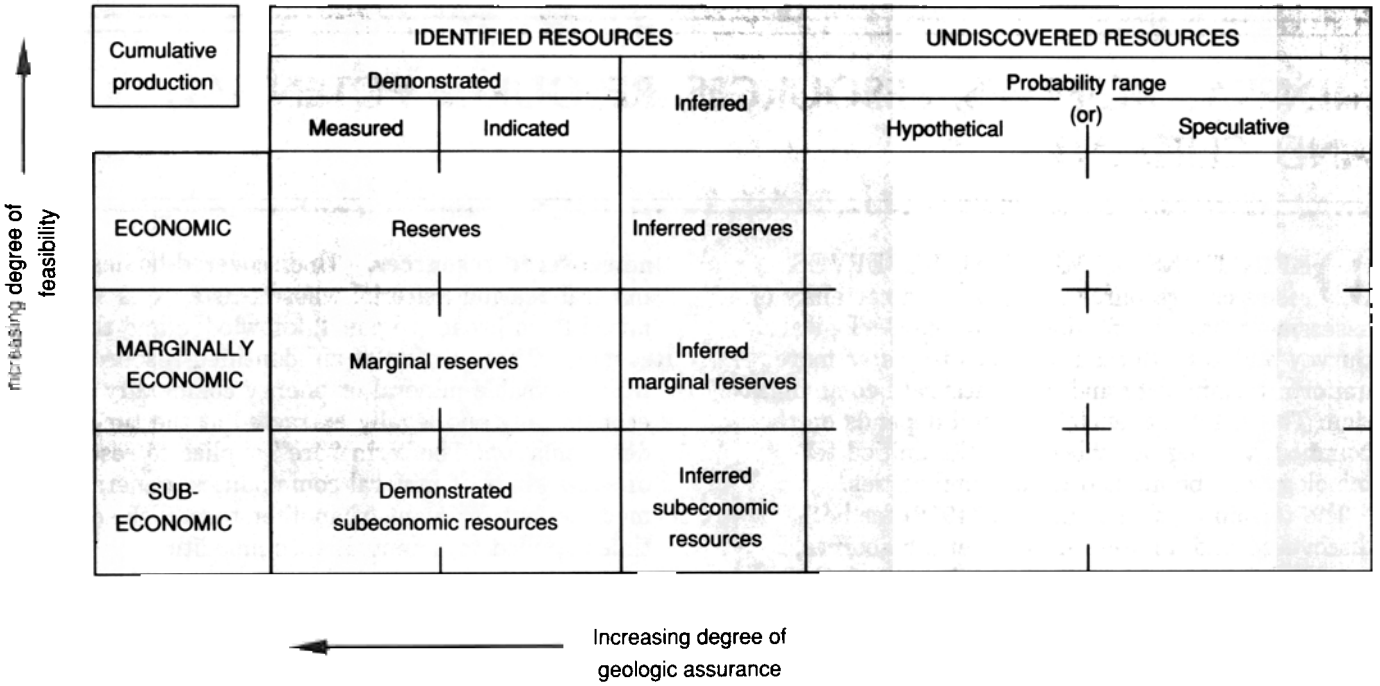

Figure 21. Classification of mineral resources (from U.S. Bureau of Mines and U.S. Geological Survey, 1980, p. 5)

corresponds closely to "measured." "Probable" and "possible" usually describe estimates of partly sampled deposits; both fall within the meaning of the term "indicated" as here defined.

The Survey author's estimate of reserves and resources for a district or area should nearly always be presented in such a way as to conceal figures for individual properties. Quotation of published estimates is permissible so long as they are properly ascribed.

Mineral Resource Potential and Certainty

Mineral-assessment reports use a dual scheme based on two ratings, "resource potential" and "certainty" (fig. 22). The general format for the scheme was suggested by Voelker and others (1979). As shown by figure 22, the level of resource potential expresses the favorability of the area for a given resource; the level of certainty indicates the confidence with which the level of resource potential was assigned (Goudarzi, 1984).

Levels of Mineral Resource Potential

The definition of mineral resource potential and of the several levels of resource potential follow the suggestions of Taylor and Steven (1983) for use in joint U.S. Geological Survey and U.S. Bureau of Mines assessment reports (Goudarzi, 1984).

Mineral resource potential is the likelihood for the occurrence of undiscovered mineral resources in a defined area; it is closely related to mineral-resource favorability. The term "resource potential" is preferred for the description of an area; "resource favorability" is preferred for description of a specific rock mass or geologic environment.

Low potential is assigned to areas where geologic, geochemical, and geophysical characteristics define environments in which the existence of resources is unlikely. This broad category embraces areas that have dispersed but insignificantly mineralized rock, as well as areas that have few or no indications of having been mineralized.

Moderate potential is assigned to areas (1) where geologic, geochemical, and geophysical characteristics indicate environments favorable for resource occurrence, (2) where interpretations of data indicate a reasonable likelihood of resource accumulation, and (3) where application of knowledge of types of mineral deposits indicates favorable ground for specific types of deposits.

High potential is assigned to areas (1) where geologic, geochemical, and geophysical characteristics indicate environments favorable for resource occurrence, (2) where interpretations of data indicate a

high degree of likelihood for resource accumulation, (3) where knowledge of types of mineral deposits supports determinations of the presence of resources, and (4) where data indicate that minerals have concentrated in at least a part of the area. Resources or deposits need not be identified for an area to have high resource potential.

Unknown potential is assigned to areas where information is inadequate to assign low, moderate, or high levels of potential; this category is generally used for areas that have covering rock units and have inadequate geophysical and geochemical data.

The phrase **"no potential"** should be applied only to a specific kind of resource in a carefully defined area; it should not be used as a summary rating for all commodities in any area.

Levels of Certainty

The level of certainty applied to a rating of resource potential indicates the degree of confidence with which the rating was assigned. The level of certainty should reflect (1) the adequacy of the geologic, geochemical, and geophysical data available at the time of evaluation, and (2) how well the specific deposit type being evaluated is understood. Generally, the attributes of a mineral-deposit type are determined first, specific requirements for assignment of high, moderate, and low potential are determined next, and the nature and amount of data required for assignment of level of certainty are determined last.

Level A. Available information is not adequate to determine the level of mineral resource potential; this level of certainty is assigned when the area is assigned unknown resource potential for a specific commodity.

Level B. Available information suggests the level of resource potential; level B is assigned where the general geologic environment is known but key evidence is lacking on such aspects as rock units, structure, activity of resource-forming processes, or expectable types of mineral deposits.

Level C. Available information gives a good indication of the level of mineral resource potential; level C is used where geologic environments are clearly defined but where specific evidence is inadequate to evaluate past activity of resource-forming processes (mineralization).

Level D. Available information clearly defines the level of mineral resource potential; generally level D is used where geologic environments are clearly defined, activity or lack of activity of resource-forming processes can be ascertained, and data on expectable mineral-deposit types are well understood.

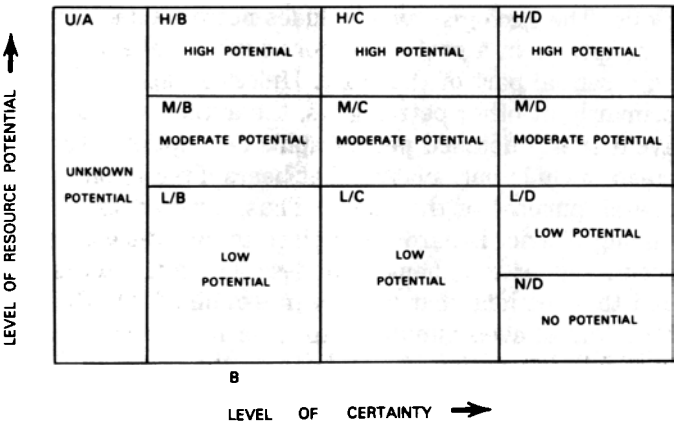

Figure 22. Mineral-assessment classification based on level of resource potential versus level of certainty (based on Voelker and others, 1979).

The approach to resource evaluation should be aggressive and basically optimistic—even imaginative and daring. Undiscovered resources will remain undiscovered as long as investigations are limited to an inventory of known deposits or as long as investigators fail to use carefully reasoned geologic predictions to suggest the likelihood of resource occurrences. Conclusions must be based solidly on evidence, the criteria for conclusions must be stated clearly, and an account of the logic used in the analysis must be provided. The assessment should state the date of the assessment: although the rocks change very slowly, our understanding of them may change rapidly.