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A Proposed U.S. Resource Classificaton System

by

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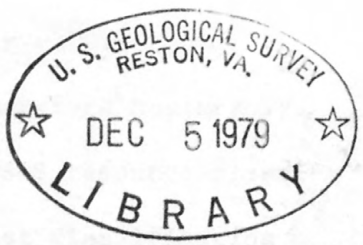

A PROPOSED U.S. RESOURCE CLASSIFICATION SYSTEM by

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ABSTRACT

Energy is a worldwide problem calling for worldwide communication to resolve the many supply and distribution problems. Essential to a communication problem is a definition and comparability of elements being communicated. The U.S. Geological Survey, with the cooperation of the U.S. Bureau of Mines and the U.S. Department of Energy, has devised a classification system for all mineral resources, the principles of which we believe offer the possibility of world communication. At this time several other systems, extant or under development (Potential Gas Committee of the U.S., United Nations Resource Committee, and the American Society of Testing and Materials), are internally consistent and provide easy communication linkage. The system in use by the uranium community in the United States, however, ties resource quantities to Forward-Cost dollar values rendering them inconsistent with other classifications and not therefore comparable. The paper will then develop the rationale for the new USGS resource classification and note its benefits relative to a Forward-Cost classification and its relationship specifically to other extant classifications.

A Proposed U.S. Resource Classification System

The previous speaker, Jack Schanz, and I have spent a lot of time in the past few years discussing the problems of communicating resource information between well-intentioned communicants. The problem is severe even between English speaking people educated in similar cultural and scientific situations. It gets progressively worse as we try to blend the interest and biases of government, industry, different nationalities, laymen, and political interests. But, as I'm sure we all agree here at this symposium, energy is a worldwide problem and we must learn to communicate our ideas about resource quantities in an understandable manner. That the United Nations' group of resource experts was able to reach a consensus is remarkable. That that consensus can be correlated with certain U.S. resource classification systems, as well as with some other nations' classifications, is a great credit to the U.N. study group and to Jack Schanz.

I will not try to show you in detail exactly how the United Nations' system and a proposed U.S. system can be integrated, but in discussing the U.S. classification/nomenclature scheme, which we perceive suits our national needs, I will refer to elements of what Jack Schanz has just discussed. Likewise, as many of you know, I would not be accurate were I to say <u>the</u> U.S. system, because we do not have unanimity in U.S. resource reporting. In particular, significant differences exist in uranium resource reporting between the Department of Energy, uranium subdivision,

(DOE/u) and the Department of the Interior. The former reports tonnage numbers in terms of Forward-Cost categories, whereas the latter imposes only a generalized economic subdivision on the tonnage estimates. In addition, there are definitional differences that do not permit us to equate precisely the resource boundaries drawn on the basis of geologic assurance of existence. Unfortunately, that is true also of the Nuclear Energy Agency/International Atomic Energy Agency (NEA/IAEA) classification, and I'll note where those differences lie.

In this paper, I want to describe to you what we are trying to achieve generally for mineral resource classification in the United States, and specifically for uranium. The specific classification/nomenclature system that I will present to you today is a modification of an earlier system reported in USGS Bulletin 1450-A and one that has recently been agreed to by working groups from the U.S. Geological Survey, U.S. Bureau of Mines, Energy Information Administration of the Department of Energy, and the Securities and Exchange Commission. For purposes of this paper, I will refer to it as the proposed U.S. resource classification system. Though we have not yet achieved final interagency approval for the system, we do have approval in principle and are presently writing the final drafts of the document. Most of you, I'm sure, are familiar with the broad outline of the proposed U.S. resource classification system. The diagrammatic presentation you see here is a variant of the earlier work but it adheres to the same basic principles. That is, the classification is based on a matrix composed of economic subdivisions on the vertical axis and increments of geologic certainty on the horizontal axis. The system allows for the use of all of the subdivisions inherent in the matrix, but aggregations

of appropriate subdivisions are permitted at the discretion of the estimator. I will discuss with you here only some of the principal aspects of this version, noting differences with the earlier version as appropriate. We now have a three-part subdivision of the vertical economic axis instead of a two-part (which I will discuss later), and we have specifically allowed for the recognition of Occurrences of certain low-grade or remotely located materials about which we have no sense of any part of them possibly ever becoming economic as is required in the definition of a Resource. This distinction, therefore, calls for some specific limiting concept to define the bottom of the Total Resource diagram. This limit may be described in economic terms or in terms of grade, thickness, depth, or other physical resource parameters. An identical requirement was called for in the proposed U.N. classification that Schanz just discussed.

The question of a clear separation between Undiscovered Resources and Identified Resources is tied up in the definition accorded the Inferred Reserve. We consider the Inferred Reserve to represent the growth potential of the deposits recognized as making up the Demonstrated Reserve. Because the existence of these Resources is confirmed marginal to the Indicated Reserve, we consider them to be Identified, but they are not as yet satisfactorily delineated by the drill and, in a sense then, are not discovered. On the other hand, Undiscovered Hypothetical Resources bear no physical relation to Indicated Resources and are truly Undiscovered no matter how good the prospect may be. The distinct classification of Inferred as representing growth potential of existing Reserves, which is a significant component part of the Total Resource, clearly separates the Undiscovered Resources from the Identified Resources. The U.N.

classification, discussed by Schanz, recognizes these same boundaries; the U.N.'s R-2 equates to Inferred and R-3 equates to Undiscovered. The DOE/u's category of Probable Potential and the NEA/IAEA's category of Estimated Additional Resources, however, include both the concept of Inferred and some part of Undiscovered Resources; such classifications require the aggregation of numbers with significantly different probabilities of occurrence, which poses serious statistical problems and does not serve to highlight an important, high probability, near-term-available potential Resource--the Inferred Reserve.

In the area of Undiscovered Resources, the proposed U.S. resource classification allows for single-point-estimate reporting of Hypothetical and Speculative Resources or it permits a range of values to be shown reflecting probabilities of occurrence. I favor the reporting of a probabilistic range of estimates, both to give a visual portrayal of uncertainty as well as to leave room out beyond perhaps a 5 percent or a 1 percent probability assessment for those resources that might be there but are at the moment unconceived. This nicety helps to make the classification system truly inclusive, and that is very important, both theoretically and for purposes of long-term planning. Having said that, I am nonetheless well aware that most analysts will use the mean and ignore the extremes; but I still believe, as did the U.N. people, that we should encourage the expression of a range of uncertainty in the calculations and reporting of Undiscovered Resource potential.

As noted before, in the proposed U.S. resource classification, the Undiscovered category is equivalent to the U.N. R-3 subdivision. The

R-3 subdivision, however, does not allow for an estimate of the portion of that in-place Resource that might be economic, and hence recoverable. We believe that is an important subdivision estimate to make in order that the analyst can more readily compare present with future resource well-being and not be lulled into a false sense of security by a definitional bias to the high side caused by reporting recoverable numbers on the one hand and in-place numbers on the other. We would recommend that the U.N. consider the option of subdividing R-3 just as they have R-1 and R-2. The argument that we can't know future economics, technology, and unknown geologic conditions can be accommodated by remembering that we are only dealing with estimates.

The Measured and Indicated subdivisions of Identified Resources simply provide two levels of detail in Reserve calculations. We have offered the option of a combined reporting under the title Demonstrated and that quantity would equate with the U.N.'s R-1, with DOE/u's Reserves, and with NEA/IAEA's Reasonably Assurred.

Now let's look at the economic subdivisions on the vertical scale. Previously, we recommended the subdivisions of Economic and Subeconomic but have since concluded that there is a genuine need for a gray area in the middle which we call Marginal. If you will recall, the U.N. also recognized this need and provided the suffix M for identification. In our definition of Marginal, we note that the economic conditions required to permit recovery must be specified. This would permit us, for example, to identify a block of uranium resources as being Marginal Reserves at say $50-$75/lb instead of having to present the remainder of the Total Resource beyond Reserves as being Subeconomic. We could also make such a division

based on economically related parameters like ore grade.

Considering the three economic subdivisions in aggregate, we can report an in-place number which would be equivalent to the U.N.'s R category. We recognize that there will be some materials included in the in-place tonnage estimates that may never be recovered but believe that it is important to retain them in the bookkeeping, because, certainly, more than once, entrepeneurs have reentered abandoned mines in search of the unrecovered as a result of changed economic or technologic conditions. Our definition of Resource accommodates this total in-place inclusion by noting that "a Resource is an aggregate of valuable minerals from which an economic commodity may be withdrawn."

With respect to bookkeeping, I should emphasize that while the most common presentation of the DOI classification system has been in this format (Fig. 1), this is not the only authorized format. Tabular formats with additional detail may be appropriate in some circumstances; certainly, for keeping track of abandoned deposits with potential for future extraction, one needs a detailed bookkeeping system, all the components of which are not necessarily shown on this diagram.

The next slide shows a variant on the system that allows for recognizing an in-place component of the Identified Resource without making an economic subdivision; we call this the Reserve Base. It is the in-place Resource perceived by the investigator to be worthy of detailed engineering study for purposes of determining an Economic Reserve. One may include all of the in-place Demonstrated Resources or just that part analyzed for whatever special purposes. As a result of the calculations, some part of that Reserve Base will be defined as an Economic Reserve; another portion

may be delineated as a Marginally Economic Reserve, given specific conditions; and, of course, a remainder will be rendered Subeconomic as a result of the mining methods or the specific mining plan adopted. With respect to the U.N. classification, the Demonstrated Reserve Base would equate to a part or all of R-1, and the Demonstrated Economic Reserve derived from the calculation would be R-1-E. For purposes of National Resource reporting, the boundaries of the Reserve Base will be explicitly defined.

Theoretically, I believe the proposed U.S. resource classification is workable for all minerals and does, in fact, include the universe--i.e., all possible resources of a mineral are potentially included in the system. However, so far we have developed only a conceptual model for all minerals; the data for each mineral or class of minerals must be tailored to fit the framework. Operational classifications for coal and petroleum have been developed, and we have done some preliminary work on defining the boundaries for uranium. For uranium, and for purposes of national resource reporting, one might utilize a Total Resource minimum average grade of .01% U_3O_8. This is well below the average for currently mined Reserves and is richer than the .007% U_3O_8 grade for the best of the Chattanooga Shale, which possibly should not be considered at this time to be a Resource. Rather, in this system, with the above defined recorded limits, estimates of U_3O_8 tonnage in the Chattanooga would be recorded in the block labeled Occurrences. It is well to note too that uranium from the Chattanooga is probably only economic as a by-product and should be recognized separately from other conventional Resources, or at least clearly delineated quantitatively within the Total Resource and specifically assigned a recovery rate according to the annual recovery of the associated primary product.

In order to provide an approximate understanding of the amount of an economically recoverable commodity in advance of a detailed engineering analysis that will produce a price or cost/unit weight, it is useful to consider a tonnage associated with an approximate minimum average grade for the Demonstrated Reserve. In the U.S., the average grade mined is about .13% U_3O_8, so possibly .1% might be considered as a geologically determinable, physical lower boundary for Economic Reserves. This same average grade could be projected into the Undiscovered category for an estimate of that part of the Undiscovered Resource that might be economic by today's standards. Likewise, an average grade suitable for defining the lower boundary of Marginal Reserves might be useful to further subdivide the Reserve Base. One might also want to include concepts of thickness and depth with average grade in making geologically measurable judgments on the economic recoverability of resources. The point is, the system recognizes both geologic and engineering processes in gaining a perception on economic recovery, requiring only that you state the parameters of the subdivision.

The concept of Forward Cost provides one such economic subdivision, and it could be fitted into the proposed U.S. resource classification system by determining which Forward-Cost categories represent the three economic subdivisions. The Forward Cost, however, used by itself obfuscates the discovery/consumption bookkeeping, which is, after all, one of the principal reasons for keeping track of the Resources. For example, the tonnage estimate for $30/lb ore may change from year to year, but there is no way for an outside analyst to determine whether it is a function of change associated with costs, new discoveries, or consumption.

From my perspective, Forward-Cost subdivisions may be useful for some types of analyses, and the proposed U.S. resource classification system recognizes their validity, but they do not stand in place of numbers reported in terms of their physical properties: tonnage and grade, and perhaps, as well, thickness and depth.

In summary, correlative Resource classification systems are required for good communication. The systems should provide for the inclusion of all Resources, be composed of clearly definable and statistically distinct subdivisions relative to geologic certainty of occurrence, and be further subdivided economically, both by measurable physical properties that relate to economics, as well as by economics as determined by engineering, cost, and price considerations. The proposed U.S. Resource classification system, which is consistent with the proposed U.N. system, meets these criteria, and we urge the adoption of these or other correlative systems by all Resource reporting agencies. In so recommending appropriate changes in existing systems, we are well aware that definitional changes cause temporary disruption in annual resource report understanding. We believe strongly, however, that the times require clear communication of the best possible resource estimates--properly classified.

RESOURCES OF (commodity name)*

AREA: (Mine, district, field, State, etc.) UNITS: (tons, bbls, ounces, etc.)

Cumulative Production	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	% _____ Probability Range % _____	
	Measured	Indicated		Hypothetical	Speculative
ECONOMIC	Reserves		Inferred Reserves		
MARGINALLY ECONOMIC	Marginal Reserves		Inferred Marginal Reserves		
SUBECONOMIC	Identified Subeconomic		Resources		
Occurrences	Includes nonconventional and low-grade materials				

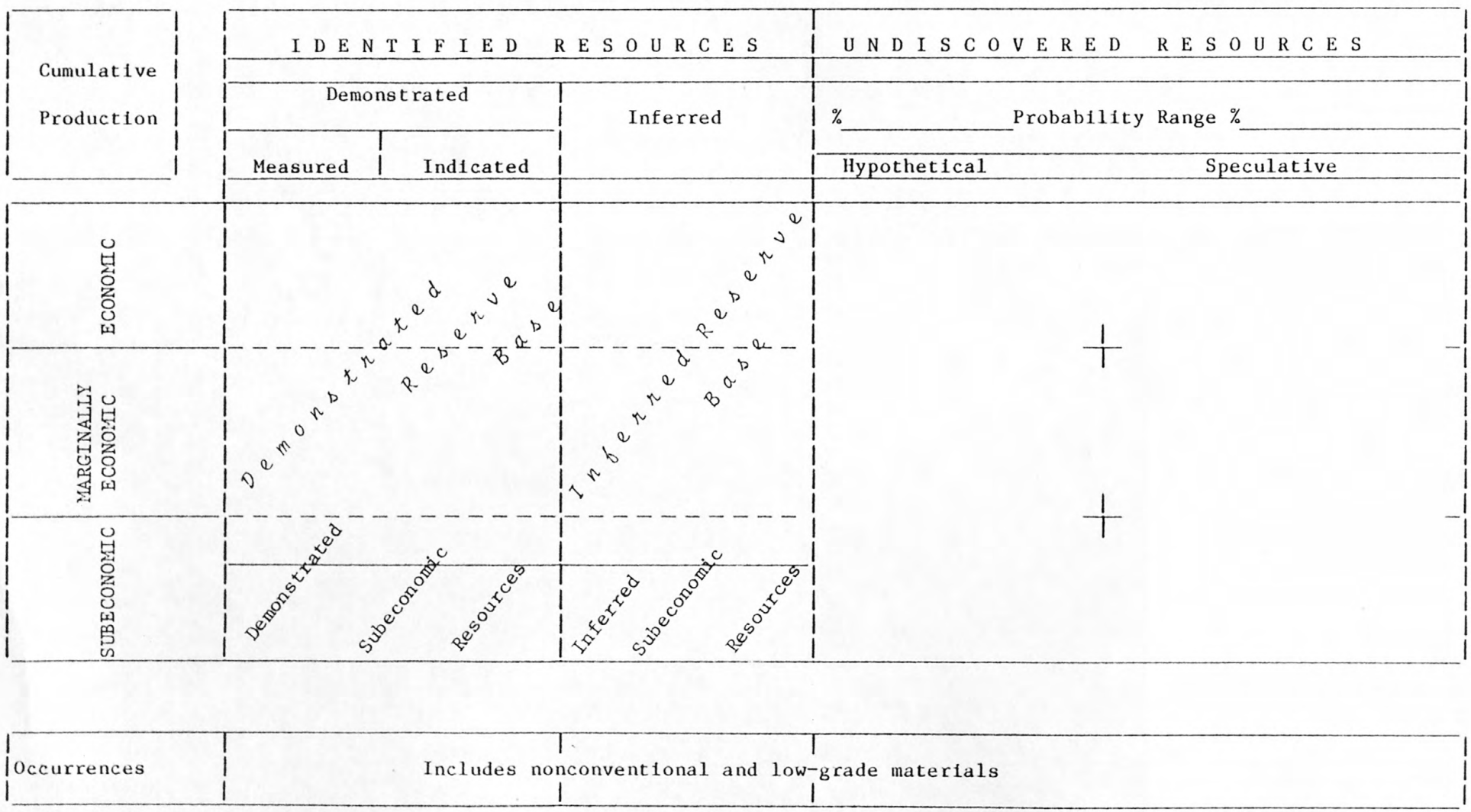
By: (author) Date:

* A portion of reserves or any resource category may be restricted from extraction by laws or regulations.

FIGURE 1. -- Classification of Mineral Resources

RESOURCES OF (commodity name)*

AREA: (Mine, district, field, State, etc.) UNITS: (tons, bbls, ounces, etc.)



By: (author) Date:

* A portion of reserves or any resource category may be restricted from extraction by laws or regulations.

FIGURE 2 -- Classification of Mineral Resources