DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Guide to Preparation of Mineral Survey Reports on Public Lands

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INTRODUCTION

Since the passage of the Wilderness Act of 1964, mineral surveys of Federal lands in or being considered for inclusion in the National Wilderness Preservation System have been a major cooperative program of the U.S. Geological Survey (USGS) and U.S. Bureau of Mines (USBM). The primary purpose of these mineral surveys is to provide to Federal land managers, the Congress, and the public a clear statement of the identified mineral resources and the mineral resource potential of the Federal land areas studied, so that the best knowledge of the mineral endowment is available to assist managers in making land-use decisions. The new knowledge of the identified resources and the mineral resource potential provided by this cooperative program is also valuable to industry and Federal strategic planners as it helps identify possible future sources of raw materials.

This document provides guidelines for scientists and authors who conduct and report the results of these surveys. It outlines the roles and responsibilities of the USGS and USBM, defines terms commonly used in these reports, establishes a classification of levels of resource potential and certainty, and presents a description of the formats to be used in publication. It has been reviewed by representatives of the USGS and USBM, and has been approved by both organizations as the operative document describing preparation of mineral survey reports. This guide supercedes instructions to authors in the June 15, 1979, memorandum by the Wilderness Coordinator, USGS, and the Chief of Mineral Land Assessment, USBM.

Beginning in 1965, results of Wilderness mineral surveys were published as old-style U.S. Geological Survey bulletins; some were first released as open-file reports. From 1979 until late 1984, the results were published as Miscellaneous Field Studies Maps (MF)--a simpler format introduced for faster release of information. Results will continue to be released in the MF series, except for the mineral resource report. The new-style USGS bulletin series, established in early 1984, seems to better meet the present requirements of mineral resource reports. It is larger (8 1/2 by 11 inches) than the old-style bulletin, will accommodate oversize maps, and provides for the use of color in figures. The USGS and USBM have agreed to publish future joint mineral resource reports in the new-style bulletin format.

A mineral resource report including appraisal of identified resources, assessment of potential for undiscovered resources, and summations of supporting geological, geochemical, geophysical, mine and prospect, and mining activity data is required for each area studied. These reports should focus on the the mineral resources and resource potential of the area. Expression of general scientific ideas or significant descriptive material should find other avenues of reporting. Separate companion reports (geology, geochemistry, geophysics, mines and prospects) providing the data basic to the evaluation should be prepared as needed, for publication in the MF series. Uninterpreted data, such as complete analytical data for stream-sediment samples, should be released in open-file reports.

The paramount considerations for mineral survey reports are to best determine the magnitude and quality of identified resources and the likelihood of the presence of undiscovered resources, to clearly explain how conclusions

were reached, and to present the results of resource evaluation in understandable language.

Acknowledgments

The principal writing of sections of this report was by W. F. Cannon, G. H. Goudarzi, W. R. Greenwood, P. W. Schmidt, T. A. Steven, R. B. Taylor, and R. G. Worl. Its ideas and language come from a much larger group of USGS geologists. Important contributions and comments have also come from colleagues in the U.S. Bureau of Mines, the U.S. Forest Service, the U.S. Bureau of Land Management, private industry, and academia. It has been extensively reviewed, both in its final form, and section by section during its compilation. The intense discussions generated during preparation and review of this report are a sign of the vigorous activity in the field of resource evaluation.

ROLES OF THE U.S. GEOLOGICAL SURVEY AND THE U.S. BUREAU OF MINES

Wilderness mineral surveys are conducted jointly by the U.S. Geological Survey and the U.S. Bureau of Mines. The USGS conducts geologic, geochemical, and geophysical investigations of the study area. The USBM examines courthouse records to identify all the mining claims in the study area; they examine the records of production and history; and they map and collect samples from mine workings, prospect pits, and surface exposures to determine the extent, tonnage, and grade of identified resources. This body of information is integrated and interpreted to delineate areas favorable for undiscovered mineral resources. The division of responsibilities in the joint USGS/USBM program of evaluating mineral resource potential of wilderness and proposed wilderness lands is outlined in the February 4, 1976, memorandum signed by the Wilderness Coordinators of the two agencies. In addition, the responsibilities and functions of the USGS and USBM personnel are fully set forth in the memorandum of understanding dated November 23, 1977, and signed by both the Director of the USGS and the Director of the USBM. Copies of these memoranda are provided in Appendix 1. A key paragraph from the 1977 memorandum (p. 3) follows:

> **"The total resource of a mineral commodity is the aggregate of its identified resources (reserves and subeconomic resources) and undiscovered resources (hypothetical and speculative resources); both the Geological Survey and the Bureau of Mines need to know and understand the magnitude and attributes of all of these resource components. This planned overlap of interests will be coordinated to maximize support and eliminate duplication by assigning lead responsibilities as follows: (1) the Bureau of Mines will be responsible for the appraisal of reserves (except OCS resources and reserves of leasable minerals for lease sale or under Federal or Indian lease); (2) the Geological Survey will be responsible for the assessment of undiscovered resources; and (3) identified subeconomic resources will be studied jointly, with the Geological Survey responsible for assessing geologic factors and the Bureau of Mines responsible for appraising engineering and economic factors."**

RESOURCE ASSESSMENT METHODOLOGY

The assessment of the mineral resource potential of an area requires the determination of the presence or absence of geologic environments favorable for the occurrence of mineral resources. This assessment generally is conducted by comparing geological, geochemical, and geophysical data and information on mines and occurrences from the areas being studied with similar kinds of data from analogous areas with known mineral resources. Mineral deposit models, especially those including interpretation of the ore-forming processes, are powerful tools in identifying the geologic environments that may be favorable for resources in areas under study. Models of certain mineral deposit types are well defined, and can be used to make reliable predictions of resource potential for analogous geologic environments. For these, tonnage and grade information assembled from deposits world-wide provide empirical evidence of the size of possible resource targets. Models of other kinds of mineral deposits are not as well defined, and individual variations among deposits may be greater than generic similarities. For these kinds of deposits, predictive applications of the model, including the determination of resource potential of areas under study, may not be as reliable, and estimates of tonnage and grade relationships may be misleading. All models must be fine-tuned to fit local areas and the differing amounts of data available in a particular study. In assessing the mineral resource potential of an area, the single most important factor is the judgment of an experienced economic geologist who integrates a wide range of geologic information, some of which defines the common factors that characterize the geologic environment favorable for a given class of deposit, and some that defines the unique factors that form ore bodies within the favorable environment.

For commodities such as oil and gas, probabilistic methods provide a technique for predicting the size of undiscovered resources in large areas, and are particularly applicable to unexplored parts of large sedimentary basins with a history of exploration and production. Such predictions are not justified for small areas because the statistical base is not large enough.

Evaluations of identified mineral resources and resource potential are time-dependent: (1) The data base changes as new studies and exploration are conducted; (2) the science of mineral resources and ore genesis is evolving; and (3) changes in economic and technological factors bring new commodities and new types of deposits into consideration. **Therefore, the date of resource appraisals and assessments must be given.**

Assessment procedures

The steps in resource assessment described here are adapted from Shawe (1981, p. 2), and provide a general guide for systematic evaluation. In practice, evaluation generally proves an iterative process in which increased understanding about an area gained through field work prompts reexamination of published data and formulation of revised models to be used in final assessment.

1. Compile available data from published and unpublished sources, including information from other Federal agencies, from State geological surveys, and from industry.

2. Identify and define the favorable geologic environments that might be present and compare them with appropriate published descriptive models; develop models for mineral deposits possible in the area.

3. Prepare a preliminary assessment of the mineral potential from available information, and determine additional data needed for resource evaluation.

4. Through field and laboratory studies, gather the data needed to assess the mineral potential of the area. Usually, geologic, geochemical and geophysical studies, and examination of mines and prospects will be required.

5. Prepare a final assessment of the mineral resource potential based on all of the data.

6. Present data in the form of maps, tables, and descriptive text to convey the magnitude and quality of identified mineral resources, and provide conclusions as to the mineral resource potential of the area in language appropriate to the audience.

An aggressive and basically optimistic approach to resource evaluation is required--one with imagination and even daring. Undiscovered resources will remain undiscovered as long as investigations are limited to an inventory of known deposits or fail to suggest the potential for resources that are not proven but that are likely to be present. **Conclusions must be solidly based on evidence, the criteria for the conclusions must be clearly stated, and an account of the logic used in the analysis provided. The published report should clearly state the date of the assessment.**

TERMINOLOGY AND USAGE

Definitions of certain terms used frequently in resource reports have been agreed upon by the USGS and USBM, and are contained in USGS Circular 831 (1980); the most used of these are listed here. In principle, the definitions of mineral potential and levels of mineral resource potential suggested by Taylor and Steven (1983) are adopted here. Other definitions have been taken from the AGI Glossary of Geology, dictionaries, and other standard sources.

General terms

Dictionary definitions of the words assessment, appraisal, and evaluation almost completely overlap. In mineral resource reports, the term evaluation should be used in its most general sense to include all aspects of studies to determine the mineral endowment of an area, including both resources and resource potential; the scope includes all parts of a mineral survey. Appraisal should be used for studies related to identified resources and assessment for studies to determine potential for undiscovered resources. Inventory should be used in the sense of a catalog of identified resources, rather than in the sense of the determination of the quantity and quality of identified resources.

Mineral evaluation--The determination of the identified resources and mineral resource potential of an area.

Mineral appraisal--An evaluation of the identified resources of a property or area.

Mineral assessment--An evaluation of the likelihood for the occurrence of undiscovered resources in an area.

Mineral inventory--A description of the identified resources contained in operating and inactive mines and prospects in an area.

Certain terms are used in describing the minerals found in an area; careful use will assist in conveying precise meaning.

Mineral endowment--The aggregate total of mineral resources and mineral occurrences, both identified and undiscovered, that exists within an area whose boundaries, limits, and depths are specified.

Mineralization--Geologic process(es) by which specific types of deposits (rocks or minerals) are formed that may constitute resources (as distinct from common rock materials). **Mineralization is a process; the term should not be used as a substitute for mineralized rock or mineral concentration.**

Economic--Applies to a deposit where profitable extraction or production under defined investment assumptions has been analytically demonstrated, or can be inferred with a high degree of confidence. The word should not be used casually in mineral resource reports.

Mineral occurrence--A place where a useful mineral or material is present; this term has no resource or economic connotation.

Mineral deposit--A sufficiently large concentration of valuable or useful metal or material that extraction at a profit may be feasible under current or future conditions. In mineral survey reports this use of the term deposit should not be confused with eolian deposits, glacial deposits, sedimentary deposits, and the like, for which the word deposit is derived from the process of deposition of the rock mass.

Ore deposit--A concentration of valuable metal or material sufficiently large and rich that extraction at a profit is feasible at the time of report preparation.

Certain terms are specific to oil and gas and have well-established meanings.

Show--An indication of oil and (or) gas that can range from staining of sample cuttings to actual recovery of some amounts of oil and (or) gas inside drill pipe in a drill stem test. A show indicates that hydrocarbons are present in the rocks being evaluated, but is not adequate to establish that extraction of these materials is possible. The term does not apply to outcrop staining by oil, nor to an actual oil or gas seep.

Wildcat "discovery" well--An exploratory well that is proven capable of producing (by flow or pumping) from a previously untapped oil and (or) gas pool (reservoir).

Pool--An individual underground reservoir (within a field area) that contains economically recoverable amounts of oil and (or) gas. It is a single, separate reservoir that has its own separate pressure system.

Field--The surface area encompassing a group of oil and (or) gas wells. The area may encompass one or more pools and have wells producing from one, or from several different formations (reservoirs) at different depths.

Identified resources

The terminology for identified resources summarized here is taken from USGS Circular 831.

Mineral resource--A concentration of naturally occurring solid, liquid, or gaseous material in or on the Earth's crust in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible.

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 components.

Reserves--That part of an identified resource that meets specified minimum physical and chemical criteria related to current mining and production practices and can be economically extracted or produced at the time of determination. Reserves include only recoverable materials.

Mineral resource potential

The definition of mineral resource potential and of the several levels of resource potential given here essentially follows the suggestions of Taylor and Steven (1983).

Mineral resource potential--The likelihood for the occurrence of undiscovered mineral resources in a defined area; it is closely related to mineral resource favorability. Mineral resource potential is preferred in the description of an area; favorability is best applied to a specific rock mass (or type) or geologic environment. Mineral resource potential (likelihood of occurrence) cannot be classified according to the McKelvey diagram (McKelvey, 1972). The levels of resource potential that can be specified include HIGH, MODERATE, LOW, NO, and UNKNOWN.

In general, terrane can be classed as either favorable or unfavorable for the occurrence of resources based on geologic environments defined in terms of geological, geochemical, and geophysical characteristics. Geologic terranes considered unfavorable are generally classed as having LOW potential, recognizing that most of these areas still have some finite, albeit small, likelihood of containing mineral resources. Areas with terrane deemed favorable can be subdivided into areas of MODERATE potential and HIGH potential; the distinction is based on the nature of the evidence favoring the occurrence of undiscovered resources of a particular commodity or group of commodities. The division between LOW and MODERATE resource potential is of primary importance for land-use decisions because it separates favorable from unfavorable ground. The division between MODERATE and HIGH is no less important to those who explore for minerals.

LOW mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics define a geologic environment in which the existence of resources is unlikely. This broad category embraces areas with dispersed but insignificantly mineralized rock as well as areas with few or no indications of having been mineralized. Areas of low resource potential with indications of

mineralization such as ill-defined geochemical anomalies or widely dispersed, low grade veins can be separated from areas of low potential lacking such indications by using outlines or patterns on maps. Use of the low potential category requires specific positive knowledge; it should not be used as a catch-all category for areas lacking adequate data.

MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a reasonable likelihood of resource accumulation, where an application of mineral deposit models indicates favorable ground for the specified type(s) of deposits.

HIGH mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a high degree of likelihood for resource accumulation, where data support mineral deposit models indicating presence of resources, and where evidence indicates that mineral concentration has taken place. Assignment of high resource potential to an area requires some positive knowledge that mineral forming processes have been active in at least part of the area. **Resources or deposits need not be identified for an area to be assigned high resource potential.**

UNKNOWN mineral resource potential is assigned where information is inadequate to assign low, moderate, or high levels of resource potential to the area. For mineral resource surveys on public lands, this category will generally be used only for areas with thick alluvium or other covering rock unit and where geophysical and geochemical data are not adequate to determine the level of resource potential.

NO mineral resource potential is a category that should be reserved for a specific type of resource in a well-defined area. It is appropriate to say that there is no oil potential in an area where the only rocks present are unfractured Precambrian granite, but the term LOW is appropriate if there is a slightest possibility for resources. The rating of NO resource potential should not be used as the rating for all types of commodities in any area.

Certainty

A dual classification scheme using mineral resource potential and certainty has been adopted for use in mineral survey reports on public lands. The general format for the system using two ratings was suggested by Voelker and others (1979). One rating (the level of mineral resource potential) expresses the favorability of the area for a given resource, and a second rating (the level of certainty) indicates the confidence with which the rating of resource potential was assigned. The certainty rating should reflect (1) the adequacy of the geologic, geochemical, geophysical, and resource data base available at the time of evaluation, and (2) the adequacy of the mineral deposit model used as the basis for each assessment. Generally, the attributes of a mineral deposit type are determined first, the

requirements for high, moderate, and low resource potential developed next, and the nature and amount of data required for the various levels of certainty determined last. After setting these criteria, comparison with data from the area being assessed leads to assignment of the level of resource potential and the level of certainty.

Four levels of certainty are designated:

Level A. Available information is not adequate for determination of the level of mineral resource potential.
Level B. Available information suggests the level of mineral resource potential.
Level C. Available information gives a good indication of the level of mineral resource potential.
Level D. Available information clearly defines the level of mineral resource potential.

Logic dictates that Level A (inadequate data) must be coupled with Unknown resource potential. Usually, level A is used only if the unit that might contain the resource is covered, and where geologic projection (as for a buried coal bed), and geophysical and geochemical data fail to provide indication of the likelihood of resource occurrence.

The chief difficulties in assigning the certainty rating for a deposit type are encountered in selecting points on the continuum of information that separate levels B, C, and D. For Level B, available data should suggest the level of resource potential; the general geologic environment must be known but some key evidence about rock units, structure, or applicable ore models might be lacking, and the past activity of resource-forming processes in the area would not be determinable. For example, in the case of a magnetite-skarn, level B might mean that although an intrusive mass of considerable size was identified, the presence of beds favorable for replacement could not be predicted geologically, and no aeromagnetic survey was available. For Level C, available data should give a good indication of the level of resource potential. For the magnetite-skarn, above, level C might indicate that the composition of the intrusive mass could be determined and was regarded as a favorable source of metals, that beds favorable for replacement could be geologically projected as in contact with the mass, but that no aeromagnetic survey was available, and that the activity of a resource-forming process could not be determined. For Level D, the available data must clearly define the level of resource potential. For the magnetite-skarn, level D might indicate that a highly magnetic zone was detected by an aeromagnetic survey, and that it surrounds the margins of a granodiorite stock where limestone beds were projected as in contact with the intrusion. In this example, even though magnetite might not have been seen, the likelihood of deposit occurrence can be regarded as high, with a high degree of certainty; further, the deposit model indicates that resources are likely in this environment. Generally, Level D requires knowledge that processes capable of forming resources have been active in at least a part of an area classified as of high resource potential. Assignment of a High resource potential rating is usually accompanied by a C or D level of certainty; however, there may be instances where designation of a B level might be appropriate, based on new and evolving (wildcat) concepts and ideas. At the other end of the scale, at least level D

is required if a rating of No potential is assigned to an area for a specific commodity; the "No" rating requires the same degree of certainty that is required for identified resources, and thus is rarely used.

The resource potential of a defined area for a selected commodity (or group of commodities) in a specific deposit type should be designated by the dual letter scheme shown on the mineral resource potential/certainty diagram (fig. 1). This scheme should be used throughout the mineral resource report to provide consistency and ensure that each part, especially the mineral resource potential map, will make sense alone. For example, H/C will always refer to an area that has high resource potential with good, but not fully adequate supporting data, and M/B will always refer to an area that has moderate resource potential but minimal supporting data.

DESCRIPTIONS OF MINERAL RESOURCE POTENTIAL

Experience has shown that describing mineral resource potential in the text can be tricky, and unless care is taken in the mode of expression, meanings can be unclear. A complete statement of mineral potential contains the following elements: (1) location (an area with delineated boundary), (2) degree of potential, (3) commodity or commodities, and (4) type of occurrence. The degree of certainty of the assessment should be given in the text, or summarized in a table, or provided on the map. It does not have to be provided in all of these places.

It is important to use the nomenclature of this guideline in mineral survey reports on Federal lands, and to avoid using terms that have been given special meaning in other reports. For example, the terminology defined for the Wilderness program summary report, USGS Professional Paper 1300 ("probable," "substantiated"), should not be used in mineral survey reports. Categories such as "very low" or "very high" have not been defined, and should not be used. Likewise, the language used in the McKelvey diagram for resources that have been found (identified, demonstrated, measured, indicated, inferred) and for undiscovered resources (speculative, hypothetical) should not be extended to descriptions of mineral resource potential.

Examples of descriptions of resource potential

Some examples of problems in usage drawn from author drafts of previous wilderness reports follow; although real, the misuse of words is heightened here by simplification of the statements.

Not Acceptable	Suggested Alternative
The XYZ district is an identified resource. [A district is not a resource.]	The XYZ district contains identified resources of 100 million tons of rock containing 0.8 percent copper.
The XYZ area is a demonstrated copper porphyry deposit. [An area is not a deposit.]	A porphyry copper deposit in the XYZ area contains demonstrated subeconomic resources of 100 million tons of rock containing 0.2 percent copper.

Not Acceptable	Suggested Alternative
The XYZ area has a high potential for inferred resources of copper. [The term "inferred" is incorrect.]	The XYZ area has high potential for copper resources in a copper porphyry system.
The XYZ area has potential for copper, silver, and uranium. [This statement doesn't indicate the level of potential, whether resources are being evaluated and is an incorrect use of the word "potential."]	The XYZ area has known occurrences of copper, silver, and uranium which must be considered in evaluation of the resource potential of the area.
The XYZ area has large resources with a high potential for gypsum. [The meaning seems to be that large deposits are present, but that tonnage cannot be specified. These identified resources should not be described with the language of resource potential.]	Identified resources of gypsum in XYZ area are of a quality that meets industrial specification, but the size of the deposits has not yet been determined.
The XYZ area has a high potential for vein copper occurrences. [Reports must focus on the likelihood for resources, not occurrences.]	The XYZ area has high resource potential for copper in vein deposits.
The XYZ area has a low potential for placer gold as the inaccessibility of the area has caused the area to be of little economic interest. [The level of resource potential should be based on likelihood of endowment.]	The XYZ area has moderate resource potential for placer gold, although the inaccessibility of the area has discouraged exploration.
The XYZ area has a high potential for coal in 12-in. beds. [High potential should be reserved for descriptions of resource potential.]	The ABC formation is known to occur in the XYZ area, but the coal beds in it are less than 12 in. thick.
Several anticlines in the XYZ area have possible oil and gas potential. [Possible potential is not an acceptable term for these reports.]	The XYZ area has high potential [or moderate potential] for oil and gas resources in several anticlines.
A moderate potential for the occurrence of copper in massive sulfide deposits exists in the metavolcanic rocks of the XYZ area. [Focus on the resource potential, not on the likelihood of occurrence.]	The XYZ area has moderate potential for copper resources in massive sulfide deposits.

Not Acceptable	Suggested Alternative
The XYZ area has a low potential for silver resources because the favorable ground is beneath the ABC ski lift. [The rating of potential should not be changed because of the ski lift; rather, give the area an accurate rating possible, then state the other facts as they are.]	The XYZ area has high potential for silver resources in disseminated deposits. Because the most favorable ground is beneath the ABC ski lift, exploration has been discouraged.
The XYZ area has a low potential for the discovery of copper deposits. [Evaluate the likelihood for resources, not for the discovery of deposits; the two are quite different.]	The XYZ area has low potential for copper resources in vein deposits.
The XYZ area has a low potential for porphyry copper deposits, as the volcanic cover is too thick for successful application of current exploration methods. [The level of resource potential isn't dependent on our ability to find the deposit.]	The XYZ area has high potential for copper resources in porphyry-type deposits. However, the thick continuous cover of volcanic rocks in the area makes exploration difficult.
The coal beds are not of economic interest. [Very likely, this kind of judgment is ad hoc, rather than well-considered; check definition of "economic" given above.]	The coal beds are thin and discontinuous and range from 10 to 15 in. in thickness.
Resource potential is classified according to the McKelvey diagram. [The McKelvey diagram doesn't classify resource potential.]	Classification of resource potential generally follows the definitions of Taylor and Steven (1983)/ or- follows definitions of Goudarzi (1984).
Resource potential is classified according to Circular 831. [Circular 831 doesn't define resource potential.]	Classification of resource potential generally follows the definitions of Taylor and Steven (1983)/ or- follows definitions of Goudarzi (1984).

Considerations unique to certain commodities

LOCATABLE MINERALS

Appraisal of identified locatable mineral resources and reserves of metals and other commodities belonging to the "locatable" category (under the Mining Law of 1872) should follow the classification given in USGS Circular 831. In the mineral surveys described here, this appraisal is the responsibility of the USBM. In certain areas, called "acquired lands," where title to all resources was acquired by the Federal Government from private parties, rights to mine metals must be purchased through a royalty payment

arranged by lease. This change in legal category does not change assessment methodology or classification of identified mineral resources.

URANIUM

The resource potential for uranium should be assessed in the same way as that of other locatable commodities; the classification of identified resources should follow that of USGS Circular 831; the likelihood of undiscovered resources (resource potential) should be described using the suggestions in the present document.

A classification of favorability, based upon maps at 1:250,000 scale, has already been made for many parts of the United States by the U.S. Department of Energy's National Uranium Resource Evaluation (NURE) program. The NURE program, in which the USGS took part, evaluated the entire United States at a scale of 1:250,000 as to favorability for uranium. Favorable ground was regarded as likely to contain uranium concentrations greater that 0.01 percent U_3O_8 in deposits of at least 100 tons of material above a depth of 5,000 feet. These minimum requirements define uranium concentrations of current or possible economic extraction. Notable exclusions are the Chattanooga Shale and the Conway Granite, which are judged by uranium resource experts as not economic for the foreseeable future. The likelihood for this endowment was expressed in the NURE program as FAVORABLE, UNFAVORABLE, and UNEVALUATED. Recognition criteria for various types of known deposits (analogs) were developed to make the favorability determination (Mickle and Mathews, 1978). UNEVALUATED is applied to those areas where information regarding the recognition criteria was deficient because of inaccessibility, surficial cover and unavailable subsurface information, or lack of time. Within the FAVORABLE areas, those parts that contain presently economic resources are delineated. The latest evaluation was made as of July 1, 1983, and an update is planned for January 1, 1985. The favorable areas are computerized and map printouts are available from the Branch of Energy Minerals.

The language of NURE assessment methodology is not the same as the language suggested here for mineral resource reports, nor is the NURE specification of minimum endowment for favorability the same as that defined here for resource potential. Uranium potential should be evaluated as any other material, and mineral deposit models used to predict mineral potential in specified environments. The NURE results, where available, should be considered in making resource assessments; these studies provide data and interpretations by experienced geologists. Areas considered favorable in the NURE program are likely also to be considered as having moderate or high resource potential, following the criteria of the present document.

COAL

Evaluation of an area for coal should be done with the awareness that a special classification has been drawn up for coal resources. Where data exists, coal resources should be classified following the practices set forth in USGS Bulletin 1450-B and elaborated in Circular 891. The USGS responsibility includes the determination of the quality and magnitude of identified resources (resource base); the USBM has responsibility for determination of the quality and magnitude of the reserve base. Coal data,

such as thickness data points, should be cooperatively collected and shared so that the greatest precision can be attained in these determinations. Extrapolation of data on the thickness of coal beds, and hence extrapolation of the location of identified resources, is not generally done for a distance of more than 3 miles from the point at which information is available. Beyond that distance, an assignment of mineral potential should be made using levels of potential based on the favorability of the sedimentary sequence for the occurrence of coal and the nature of the coal that would be expected. Although coal that might occur below a depth of 6,000 feet should be mentioned in the report, an assignment of moderate or high potential for coal below that depth should not be made.

OIL AND GAS

Assessment of oil and (or) gas potential follows the same logic as used for locatable commodities. Favorability of geologic environment is the most important single consideration. This includes: (1) the extent and thickness of porous reservoir rocks, (2) the presence or absence of organic-rich rocks that might be the source of hydrocarbons, (3) the thermal maturity of the source rocks, (4) the likelihood of the presence of structural and (or) stratigraphic traps, (5) the presence of impermeable rocks that might act as a seal over possible traps to prevent the escape of hydrocarbons, and (6) the likelihood of a sequence of geologic processes acting in proper order for generation, migration, and trapping of hydrocarbons. Detailed knowledge of structural or stratigraphic traps at depth is rarely available, nor is it required. Levels of oil and gas resource potential should be assigned only to areas so large that even the appearance of an attempt to target individual plays is avoided.

GEOTHERMAL ENERGY

Assessment of geothermal potential should be based on an evaluation of the geologic environment, as suggested for other commodities. Hot springs, CO_2, H_2S gas vents, and recent deposits of siliceous sinter and travertine are some of the local criteria for favorability. Occurrences of sulfur, alunite, and hydrothermal kaolinite may also be favorable signs. High regional heat flow and youthful volcanism are also indications that geothermal resources should be considered. Components of an economic geothermal system include hot rock (usually magmatic heat), water (steam) to act as a carrier, porosity and permeability in the water-bearing reservoir, a large volume-reservoir to support production, and a cap rock on the system to help accumulation and storage of hot water and steam.

COMMON VARIETIES

Certain earth materials such as sand, gravel, and building stone are salable materials that are acquired by the private sector from the Federal Government under purchase agreements and are generally referred to as common varieties. Because they are bulky, used in great quantities, and have low unit value (dollars/ton), their location relative to place of use is usually the prime factor in determining if they can be exploited at a profit, and hence whether they have value as resources. It is normal practice in reports on public lands, to discuss these commodities and their distribution. Areas

that have identified resources of these kinds, or have high or moderate potential for these materials are generally not shown on mineral resource potential maps. Exceptions should be made if the material is judged to have unusual importance relative to the raw material needs of the region. Usually, more accessible supplies of the same materials are abundantly available outside the area of study; a statement to this effect generally is appropriate, and furnishes the information needed for land-use decisions.

CONTENT AND FORMAT OF THE MINERAL RESOURCE REPORT

The principal report on each study area will be a MINERAL RESOURCE REPORT containing a mineral resource potential map. This report and map will be published as a USGS bulletin. For most areas, companion reports on geology, geochemistry, geophysics, mines and prospects and identified resources will be needed, and will be published as MF maps. Supporting data, such as analytical results or detailed descriptions of mines and prospects, may be released as USGS or USBM open-file reports. These MF maps and open-file reports should present all of the data used in preparation of the resource potential map and report.

Outline of the mineral resource report

1. Cover: Standard format

2. Title: MINERAL RESOURCES OF THE XYZ WILDERNESS STUDY AREA, A, B, AND C COUNTIES, STATE NAME

3. Statement--Studies related to wilderness

4. Contents, illustrations, tables

5. Summary--Mineral resources of the XYZ wilderness study area (USGS and USBM, USGS lead)
   - 5.1 Abstract
   - 5.2 Character and setting
   - 5.3 Resources
   - 5.4 Resource potential map

6. Introduction (USGS and USBM, USGS lead)
   - 6.1 Name, size, location, access, geographic features
     USBM--investigations, sources of data;
     USGS--types of surveys, names of investigators, sources of data
     Acknowledgments
   - 6.2 Geologic setting (optional)

7. Appraisal of identified resources (USBM authorship)
   - 7.1 Mining and mineral exploration history
   - 7.2 Mines and prospects, mining claims and leases
   - 7.3 Summary of exploration information (table)
   - 7.4 Mineral economics (optional), minability of deposits, metallurgy

7.5 Reserves and identified resources
(tabular summary, classification according to USGS Circular 831)
7.6 Recommendations for further work

8. Assessment of potential for undiscovered resources (USGS authorship)
   8.1 Geology
      1. Geologic setting
      2. Description of rock units and structures with emphasis on those related to mineralization and to resources
   8.2 Geochemistry
      1. Analytical methods (brief description)
      2. Results of survey (summary only)
   8.3 Geophysics
      1. Methods (brief description)
      2. Results of survey (summary only)
   8.4 Mineral and energy resources (types)
      1. For each resource type present in study area
         a. Describe the appropriate mineral deposit model
         b. Compare criteria from model with characteristics of appropriate parts of study area and identify level of resource potential
         c. Discuss criteria for certainty of assessment, compare with results of survey and rate certainty level
   8.5 Recommendations for future work

9. References cited (include all USGS and USBM references cited in text)

10. Resource potential map (page size or 2-page spread in text, or oversize map in pocket)

Content of the mineral resource report

1. Cover

A standard cover will be used for all mineral resource bulletins to assist program identification. Elements include:

Front
1. Title
2. USGS, USBM, and either BLM or NFS logos
3. U.S. GEOLOGICAL SURVEY BULLETIN [NUMBER]
4. Index map of state(s) showing location of area superimposed on standard landscape drawing

Back
1. Author, title, publication information on spine of document or near fold
2. U.S. Department of Interior logo
3. Continuation of landscape drawing from front cover

2. Title

The title of the bulletin should be in standard form for all reports:

Mineral resources of the XYZ wilderness study area, A, B, and C Counties, State name [do not insert numbers in title]

3. Statement - Studies Related to Wilderness

One of the following statements must appear on a separate page of the mineral resource report immediately preceding the contents, illustrations, and tables listing (as well as on the first sheet of all MF maps and in all open-file reports prepared to support the mineral resource report).

3.1 FOREST SERVICE AREAS--statement for Mineral Resource Bulletin ONLY.

STUDIES RELATED TO WILDERNESS

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and related acts, the U.S. Geological Survey and the U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Areas officially designated as "wilderness," "wild," or "canoe" when the act was passed were incorporated into the National Wilderness Preservation System, and some of them are presently being studied. The act provided that areas under consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. The act directs that the results of each survey are to be made available to the public and be submitted to the President and the Congress. This report discusses the results of a mineral survey of the (name) (number, if assigned) Wilderness (Wilderness Study Area, recommended wilderness, or planning area), (name) National Forest, (name) Counties, (State). The area was established as a wilderness by Public Law (number, date) or/ classified as a further planning area or/ proposed wilderness during the Second Roadless Area Review and Evaluation (RARE II) by the Forest Service, January 1979.

3.2 FOREST SERVICE AREAS--statement for MF maps and open-file reports.

STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal lands to determine their mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a (geologic or geochemical or geophysical or mineral) survey of the (name) (number, if assigned) Wilderness (Wilderness Study Area, recommended wilderness, or planning area), (name) National Forest, (name) Counties, (State). The area was established as a wilderness by Public Law (number, date) or/ classified as a further planning area or proposed wilderness during the Second Roadless Area Review and Evaluation (RARE II) by the Forest Service, January 1979.

3.3 BLM AREAS--statement for all reports, including mineral resource bulletins, except for areas within the California Desert Conservation Area.

STUDIES RELATED TO WILDERNESS

Bureau of Land Management Wilderness Study Areas

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and the U.S. Bureau of Mines to conduct mineral surveys on certain areas to determine their mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the (name) (number) Wilderness Study Area, (name) County, (State).

3.4 BLM AREAS--statement for all reports on areas inside the California Desert Conservation Area.

STUDIES RELATED TO WILDERNESS

Bureau of Land Management Wilderness Study Areas

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and the U.S. Bureau of Mines to conduct mineral surveys on certain areas to determine their mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the (name) (number) Wilderness Study Area, California Desert Conservation Area, (name) County, California.

4. Contents, illustrations, tables

The table of contents and lists of illustrations and tables should be prepared according to standards for the USGS bulletin series.

5. Summary

The summary should stand alone, and if taken from the report should fulfill the purpose of the articles recently assembled into the Wilderness Program summary report, USGS Professional Paper 1300. Write to an audience of intelligent laymen, decision makers, Congressional aides, and concerned citizens. Present conclusions only, not the arguments, uncertainties, qualifications, or base data. Total length should be no more than five double-spaced typed pages and an additional page-size map. Prepare the Summary to the following outline.

TITLE OF SUMMARY [the name(s) of the area(s)]

5.1 Abstract.--Two to four sentences about location, size of area, dates of study, and statement about identified mineral resources and resource potential (about half a page). For BLM areas and National Forest areas with number designations, include the number immediately following the name of the area the first time it is used.

5.2 Character and setting.--Information on location, geography, general geology, sketch of resource activity in area (about a page).

5.3 Mineral reserves, identified resources, and resource potential.--Use broad commodity categories rather than detailed model by model approach; (this section should be about two-thirds of the summary, up to four pages; use tabular format if possible).

5.4 Include a page-size map showing areas of MODERATE (pink) and HIGH (red) mineral potential; areas of LOW potential should be left uncolored; certainty ratings should not be shown here; mines with identified resources should be shown in red; use simple culture and drainage base, and label a few outstanding geographic features. Include a small index map of the State to show location of the area.

6. Introduction

6.1 The introduction should be prepared by the USGS senior author (project leader) working closely with the USBM project leader, and should contain all introductory statements so that a minimum amount of introductory material is needed in succeeding sections. The lead paragraph should contain concise descriptive information including the name or names of the study area(s), their size, location, access, and kinds of terrain. For BLM areas and for National Forest areas with number designations, the number designation should follow the area name the first time it is used in the introduction. For example: Beaver Creek (CO-050-016) Wilderness Study Area, Colorado.

USGS and USBM procedures and investigations used for the study should be described briefly. These should be general accounts, not detailed and lengthy step-by-step descriptions. All sources of resource data, including published reports and informal communications should be included. The introduction is a good place to credit information from the files of Federal and State agencies, written and oral communications, and use of unpublished reports or data.

The final paragraph of the introduction (6.1) should contain all acknowledgments, including those relating to assistance provided by local offices of State and Federal agencies.

6.2 Geologic setting--a brief section, under a subheading in the introduction, describing the structural and stratigraphic framework and salient features of the geology may be necessary in some reports as introductory material to facilitate writing of the section on identified resources. If presented in this position of the report, the section on geologic setting in part 8 should be eliminated.

7. Appraisal of identified resources

This section, authored by the USBM, is the section used to summarize the result of USBM investigations and to present the appraisal of identified resources. Paragraphs or subsections should summarize (1) mining and mineral exploration history and current activity, (2) quality and quantity of identified resources, and (3) investigations on minability and metallurgy of identified resources if studies were made. The discussion of mining and

mineral exploration should present a concise, but thorough, outline of past and present activity followed by discussion of localities where there are identified resources and of operations in areas assigned MODERATE or HIGH mineral resource potential by the USGS. Discussions on minability and metallurgy should summarize techniques used and methods evaluated. The mineral economic factors concerning each commodity for which identified resources or high or moderate resource potential has been found in the area should be discussed and related to the area of study.

The most important part of this section is the description of identified resources. All parameters of identified resources should be described--grade, tonnage, and data used to make these determinations--this appraisal is usually best presented in tabular form. For coal, this section should include the discussion of the reserve base.

Detailed descriptions of mines and prospects, patented and unpatented claims and their locations, and full accounts of minability and metallurgical studies appear in USBM MLA open-file series reports and should be referenced, not quoted.

8. Assessment of mineral resource potential

This section, authored by the USGS, should summarize the results of USGS studies and present the assessment of mineral resource potential. Paragraphs or subsections should summarize (1) the geology of the area, including the geologic setting, and structures and rock units related to mineral resources; (2) geochemical investigations, including brief descriptions of sampling techniques and analytical procedures, and a summary of the results with emphasis on descriptions and interpretations of geochemical anomalies; (3) geophysical investigations, including descriptions of surveys and their results, with emphasis on description and interpretation of anomalies related to resources; and (4) interpretation of the potential for undiscovered resources.

The most important part of this section is the presentation of the assessment of mineral resource potential. The geologic environments for known and undiscovered resources must be clearly defined, and mineral deposit models (occurrence and/or genetic models) must be described concisely; these must be compared with the characteristics of appropriate parts of the study area, and the levels of resource potential and certainty be accurately determined and stated, so as to provide information on the commodities expected and on the deposit type being assessed. Discussions can be organized either on a model-by-model basis, or by commodity or groups of commodities. Areas that have moderate or high mineral resource potential should be summarized in tabular form. For coal, the discussion should include the appraisal of identified resources (resource base) as well as identification of areas of moderate and high coal resource potential.

Detailed geology and complete accounts of geochemical and geophysical investigations and results should be handled by reference to other publications on the area (MF maps, USGS and USBM open-file reports).

9. References cited

All references cited in the report should be listed in a single reference section that includes both USGS and USBM citations; use standard USGS reference format (see references cited at the end of the present document).

10. Mineral resource potential map

The mineral resource potential map is to be included as a figure, or if oversize as plate 1 in the mineral resource report. The map should be published at the principal scale of the resource survey, generally at 1:50,000 (large areas may best be covered at 1:100,000, small areas at 1:24,000). The map base should be a composite of the topographic map (screened) and either the geologic map, or a simplified version of the geologic map. The map should clearly show the boundary of the study area and the names of geographic features mentioned in the text. For most maps, a second color (red) overprint will be used to show mines and areas containing identified resources (as provided by the USBM), and areas of moderate (pink=screened red) and high (red) resource potential. Land information (patented or unpatented claims) may be shown if appropriate. The marginal text should be limited to the map explanation, correlation diagram, a brief description of map units, standard marginal notes (base and mapping credits), scale, diagram showing relationships between levels of resource potential and certainty classification (fig. 1), and title (Mineral resource potential map of the XYX (AZ-010-29) area, A, B, and C Counties, State).

In order that mineral resource potential maps may stand alone, and make sense in the absence of supporting reports, simplified versions of the dual letter designation scheme for resource potential and certainty must be included in the map explanation. Areas of HIGH, MODERATE, LOW, or UNKNOWN resource potential will be shown by appropriate labels and color patterns. The following is suggested for the explanation:

LEVELS OF RESOURCE POTENTIAL

H red	GEOLOGIC TERRANE HAVING HIGH MINERAL RESOURCE POTENTIAL
M pink	GEOLOGIC TERRANE HAVING MODERATE MINERAL RESOURCE POTENTIAL
L	GEOLOGIC TERRANE HAVING LOW RESOURCE POTENTIAL
U	GEOLOGIC TERRANE HAVING UNKNOWN RESOURCE POTENTIAL

LEVELS OF CERTAINTY

A AVAILABLE INFORMATION IS NOT ADEQUATE FOR DETERMINATION OF THE LEVEL OF MINERAL RESOURCE POTENTIAL
B AVAILABLE INFORMATION SUGGESTS THE LEVEL OF MINERAL RESOURCE POTENTIAL
C AVAILABLE INFORMATION GIVES A GOOD INDICATION OF THE LEVEL OF MINERAL RESOURCE POTENTIAL
D AVAILABLE INFORMATION CLEARLY DEFINES THE LEVEL OF MINERAL RESOURCE POTENTIAL

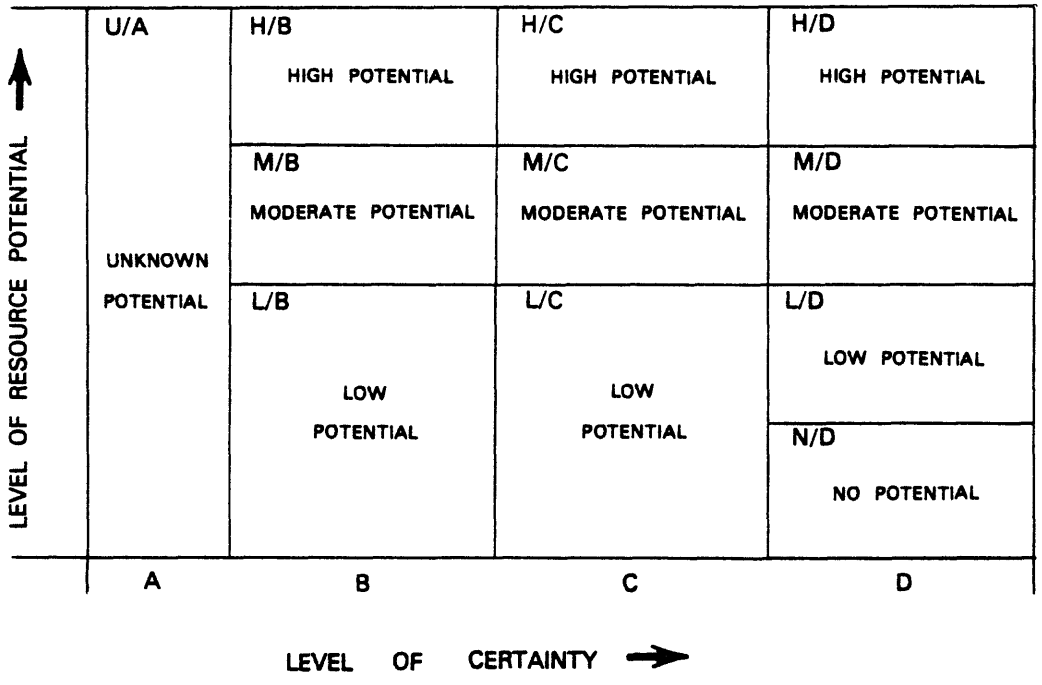

Figure 1.--Relationships between levels of resource potential and certainty.

MISCELLANEOUS FIELD STUDIES MAPS (MF)

When appropriate, geologic, geochemical, geophysical, and mine and prospect maps may be published in the USGS MF series; these often are prepared for publication after the mineral resource report has been submitted for technical review. Generally, one MF map, limited to a single sheet, for each discipline is recommended. All MF maps that report on a particular study area will have the same number, but each map will have a different letter suffix (MF-1258-A, MF-1258-B, etc.). The letter designations will be assigned in the order that the reports are approved for publication by the Director of the USGS. Where appropriate, maps from different disciplines can be included on a single sheet on one MF map; for example, "Geophysical and geochemical maps of the Green River Wilderness...". This approach may avoid printing overly small map sheets, or publishing too little data on certain sheets.

Geologic map (USGS authorship)

A geologic map is essential to the mineral resource assessment of an area, but it is not the end in itself. The emphasis should be on delineating rock units and structures that control the distribution of known resources and the geologic environments favorable for occurrence of undiscovered resources.

The geologic map will generally be at a scale of 1:50,000, but depending on needs for detail, it can be at a scale from 1:24,000 to 1:125,000. The scale of the geologic map will be the principal scale for all subsequent maps on the area and should be chosen carefully. Factors that should be considered in this choice include the size of the area and the geologic, geochemical, and geophysical detail needed for assessment.

The description of rock units should be presented as an expanded explanation. A marginal text should describe the geologic structure and other geological information and emphasize the information needed to interpret the resource potential. **Interpretations of mineral resource potential must be reserved for the mineral resource bulletin.** Cross sections should be used where needed to clarify geologic relationships. The appropriate Wilderness Statement (see section 3.2, 3.3, or 3.4) should be provided.

The geologic map will generally be printed in black on a screened (gray) topographic base. If the complexity of the map warrants, a second color may be used, either for the topographic base (brown), or for overprints (red, perhaps to show mineralized areas). However, a written request for this second color must accompany the manuscript when it is sent to the Branch of Technical Reports (BTR) for editing. Final determination of this need, and the design of a two-color map will be made by the Office of Scientific Publications.

Geochemical maps (USGS authorship)

Geochemical investigations for the mineral surveys are aimed at providing geochemical data interpretable in terms of conceptual models of mineral deposits. In addition to delineating geochemically anomalous areas related to mineralization, basic geochemical data related to rock type, age, and structures contribute to establishing the geochemical character of the region. An orientation study or equivalent experience in similar geological terrane is critical to the design of both the sampling and the analytical program.

Results of the geochemical surveys should be presented on a screened topographic base, generally also presenting simplified geology. Data may also be presented on maps at smaller scale without a topographic base (for example, maps showing the study area boundary and stream drainage basins). Tables may be included as well as histograms and any other appropriate illustrations. An explanatory text on the margin of the map(s) should interpret the data, including the anomalies, in geochemical and geologic terms. The appropriate Wilderness Statement (see section 3.2, 3.3, or 3.4) should be provided. **Specific interpretations of resource potential must be reserved for the mineral resource bulletin.** Documentary material, such as analytical data, will be stored in appropriate USGS computer data banks such as RASS, and should be released as open-file reports.

Geophysical maps (USGS authorship)

Regional geophysical investigations, including aeromagnetic and gravity surveys provide a framework for three-dimensional analysis of the distribution of rock masses. These surveys may help decipher the geologic setting of known

deposits and aid in identification of others. Other regional geophysical techniques, such as the airborne gamma-ray and electrical methods, would contribute toward a better understanding of the regional structure and the mineral resource potential of a given area, but are not commonly a part of mineral surveys.

Results of geophysical surveys should be presented at the principal map scale on a screened geologic (generally simplified) and topographic base. Marginal texts should interpret the data in geophysical and geological terms. The appropriate Wilderness Statement (see section 3.2, 3.3, or 3.4) should be provided. **Specific interpretation of the resource potential should be reserved for the mineral resource bulletin.**

Mines and prospects map (USBM authorship)

Mineral resource surveys must include information about the nature and distribution of identified resources, and mining and exploration activity. A map showing mines and prospects, mineral occurrences, and mining claims should be prepared, if needed for resource evaluation. This map should also show the locations of USBM sample localities. A marginal text should summarize mineral production data, reserves, and identified resources, and provide an account of past and present mining and exploration activity if this information is important to land managers. Tabular summaries are to be used, if possible, to assist concise presentation of resource data. The appropriate Wilderness Statement (see section 3.2, 3.3, or 3.4) should be included. **Discussions of the potential for undiscovered mineral resources should not be made on this map, in the marginal text, or in the tabular material.**

This map should be prepared on a screened topographic base at the principal scale of the geologic map; use of the simplified geologic base provided by the USGS is optional.

Other maps (USGS or USBM authorship)

Additional maps may be prepared to meet specific resource evaluation needs. Maps might be used to report on investigations using special geophysical techniques or to present specific commodity information. The total number of maps as supporting documents can be considered flexible so long as each is directed toward mineral resource evaluation. **The mineral resource potential of the area will not be discussed on these maps.**

OPEN-FILE MAPS AND REPORTS (USGS or USBM authorship)

All data obtained during the mineral surveys pertinent to resource evaluation or of scientific value should be published. The U.S. Bureau of Mines has been releasing their data in MLA series open-file reports and has made them available to other Federal agencies. All data obtained for mineral resource evaluations by the U.S. Geological Survey should be prepared in a format that could be readily released in USGS open-file reports if needed in advance of scheduled deadlines. This would greatly assist release of data, should a publication of a joint USGS/USBM mineral survey report be delayed. **Great care must be taken to ensure legibility of all parts of the open-file report; maps in particular must be prepared to be readable after reproduction by the open-file facility.**

The USGS open-file series may be the most appropriate means of release of data needed by a small user group; sample locality maps, chemical analyses, data from individual geophysical stations, and similar material should be published in this way. Computer data tapes can be released to the public through the NTIS system. Contractor-prepared aeromagnetic maps are customarily released as open-file reports, and then published with interpretations in the MF series.

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Appendix 1. Memoranda describing USGS and USBM roles in mineral surveys

United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VIRGINIA 22092

February 4, 1976

Memorandum

To: Staff Geologists, USGS
Field Coordinators, USBM Through: Field Chiefs

From: National Wilderness Coordinator, Geological Survey
National Wilderness Coordinator, Bureau of Mines

Subject: Division of responsibilities in the joint GS/BM program of evaluating mineral resource potential of wilderness and proposed wilderness lands

As a follow-up to our annual meeting, and in conjunction with the proposed expansion of the joint GS/BM wilderness mineral resource potential program and the concomitant influx of new personnel, it appears to be an appropriate time to clarify the responsibilities of our two bureaus. We wish to emphasize that our evaluations are a joint responsibility, the goal of which is to portray an area's mineral resource potential to the best of our ability in the time allotted.

In general, the GS has the primary responsibility to map the geology and geophysics and to outline geochemical anomalies, and to evaluate and interpret these data to determine the potential for mineral and mineral fuel resources. The primary responsibility of BM is to locate, sample, and evaluate mines, prospects, and associated mineralization, and to document past and ongoing production and exploration, and from these data measure reserves and paramarginal mineral and mineral fuel resources. This follows the theme of the division of responsibilities set forth in existing agreements from both Directors, whereby the Bureau of Mines is responsible for evaluating reserves and the Geological Survey, resources. Joint efforts require teamwork if the goals are to be reached effectively and efficiently. Each team member needs to know his responsibilities as well as those of his teammates. However, keeping in mind the overall purpose of our work, we must retain some degree of flexibility and, where circumstances dictate, allow for departure from a strict interpretation of the division. The responsibilities follow:

Geological Survey:

1. Map the geology of the surface and, where necessary in concert with the USBM, of mine workings as well.

2. Systematically collect and analyze geochemical samples of stream sediments,

soils, and rocks from the entire area; prepare geochemical maps that show regional and local anomalous concentrations of valuable minerals and key elements that may indicate the location of valuable minerals.

3. Prepare regional geophysical maps and interpret the geophysical anomalies as a guide to configuration and location of potential concentrations of minerals and mineral fuels beneath the surface.

4. Evaluate the resource potential for oil and gas, coal, radioactive minerals, and other energy related commodities by compiling data from the literature and company records and conduct field and laboratory investigations as necessary.

5. Compile data pertaining to geothermal energy and evaluate its potential.

6. Collect and evaluate geologic and geochemical data from past and ongoing exploration by private industry or other sources.

7. Evaluate the mineral resource potential of the area based on the compilation and interpretation of results of the above studies.

Bureau of Mines:

1. Compile and document past mining claims and related mining activities.

2. Conduct field work to locate and examine claims. Map associated surface and underground workings and mineralization.

3. Collect and assay samples from mine workings and associated structures. Determine possible extensions of mineralized structures in existing workings, where necessary, in concert with USGS.

4. Evaluate the reserves for oil and gas, coal, radioactive minerals, and other energy related commodities by compiling data from the literature and company records and conduct field and laboratory investigations as necessary.

5. Collect and evaluate assay and metalurgical data on past and ongoing exploration by private industry or other sources.

6. Perform engineering sampling, as necessary, on potential ore occurrences shown by GS geochemical sampling.

7. Conduct minability and metallurgical studies where significant mineral resource deposits are known to be present.

8. Evaluate the mineral reserves and paramarginal resources of the area based on the compilation and interpretation of results of the above studies.

Together the two agencies will interpret the total body of data to determine mineral resource potential. Maps and a report will be prepared to show these results. Both agencies will appear at local and Congressional hearings and consult with the agencies administering the lands so that the conclusions resulting from the mineral resource evaluations will be effectively interpreted and used.

John D. Wells, USGS

Will Dare, USBM

United States Department of the Interior

BUREAU OF MINES
2401 E STREET, NW.
WASHINGTON, D.C. 20241

November 23, 1977

Memorandum

To: Director, Geological Survey
Director, Bureau of Mines

From: Cochairmen, USGS/BM Coordinating Committee

Subject: USGS/BM Memorandum of Understanding

Enclosed for your approval and signature is a Memorandum of Understanding between the Bureau of Mines and the Geological Survey. It was prepared by the Subcommittee on Reserves-Resources Definition chaired by Sheldon P. Wimpfen and Richard P. Sheldon. It has been extensively reviewed in both agencies and has our approval.

J. D. Morgan

John D. Morgan, Jr.

(Sgd) M. R. Klepper

Montis R. Klepper

Enclosure

Approved: [J. D. Morgan] DEC 6 1977
Director, Bureau of Mines Date

Approved: [illegible] DEC 9 19[illegible]
Acting Director, Geological Survey Date

EBM:SPWimpfen/WCPrinz:ajb 11/23/77
bcc:Files-AD-MMSDA-FO
AS—EM (2)
Director's Reading File (2)
Director's Reading File USGS
AD/FO Reading File, Rm. 1054 CP
J. D. Morgan, Jr., Rm. 1038 CP
S. P. Wimpfen, Rm. 1054 CP
M.R. Klepper-USGS
W. C. Prinz-USGS

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

GS/BM MEMORANDUM OF UNDERSTANDING

The Geological Survey and Bureau of Mines provide resource expertise to help meet Department of the Interior responsibilities for the management of Federal lands and for providing scientific and technical leadership in national land and mineral decisions. Jointly they share responsibility to help meet Department of the Interior resource objectives provided in the Mining and Minerals Policy Act of 1970. This Memorandum of Understanding is issued to clarify the primary roles of the two agencies and to establish mechanisms that assure effective collaboration where these roles overlap. The resource classification adopted by the Geological Survey and Bureau of Mines (see Principles of the Mineral Resource Classification System of the U. S. Bureau of Mines and U. S. Geological Survey: U. S. Geological Survey Bulletin 1450A, 5 p., 1976) is the basis for allocating responsibilities in this Memorandum of Understanding; except as regards the leasable minerals under the following acts: Mineral Leasing Act of 1920—February 25, 1920 (41 Stat. 437, as amended); Mineral Leasing Act for Acquired Lands—August 7, 1947 (61 Stat. 931, as amended); Outer Continental Shelf Lands Act—August 7, 1953 (67 Stat. 462, as amended); Geothermal Steam Act of 1970—December 24, 1970 (84 Stat. 1566); and Federal Coal Leasing Amendments Act of 1975 (90 Stat. 1083).

Responsibilities and Functions of the Geological Survey: The Geological Survey has two principal resource missions: First, it generates, analyzes, and publishes data concerning the earth and provides knowledge about the location, extent, and character of mineral, land, and water resources. It conducts areal resource assessment surveys and assesses the geologic

availability of resource materials. Second, it classifies leasable mineral lands and the water power potential of federally owned lands, evaluates Federal mineral lands offered for lease, and supervises industry activities on mineral leases on Federal, Indian, and Outer Continental Shelf lands. This includes economic and engineering evaluations and reserve calculations on individual Federal leases and tracts subject to Federal leasing.

Responsibilities and Functions of the Bureau of Mines: The mission of the Bureau of Mines is to help to ensure the continued viability of the domestic minerals and materials economy and the maintenance of an adequate minerals base so that the Nation's economic, social, strategic, and environmental needs can be better served. In carrying out its function of the appraisal of mineral reserves, the Bureau of Mines places emphasis on the definition and quantification of the near-term component of the identified national resource base and provides information that relates to future U.S. and world mineral production under varying conditions. The Bureau of Mines conducts engineering and economic studies of the mineral development and production process, including engineering and economic evaluations of individual mineral deposits from the standpoint of extraction technology and supply capability. It assesses and develops technology for mining and mineral processing and gathers, interprets, and publishes information on the statistics and economics of mineral reserves, production, consumption, and trade. The Bureau of Mines also performs research and development in such areas as recycling, mineral substitution, land reclamation, and the environmental impact of mineral activities.

GS/BM Roles in Mineral Appraisal and Assessment: The Geological Survey assesses and analyzes the geologic availability of resources of all mineral and energy commodities with emphasis on the undiscovered categories (hypothetical and speculative resources), and reports such parameters as location, quality, quantity, and geologic setting of identified resources. In addition, it classifies and evaluates leasable minerals in Federal and Outer Continental Shelf lands.

The Bureau of Mines is primarily concerned with reserves, that is those resources that can be developed under present economic conditions, and also with known resources that are now subeconomic but which through changes in price or technology may be converted into reserves. For these resource categories the Bureau of Mines reports such parameters as location, quality, quantity, and related engineering and economic factors that include capital and operating costs, amenability to mining and metallurgical treatment, support requirements such as power, water, and labor, and environmental impacts of extraction processing or beneficiation and fabrication.

The total resource of a mineral commodity is the aggregate of its identified resources (reserves and subeconomic resources) and undiscovered resources (hypothetical and speculative resources); both the Geological Survey and the Bureau of Mines need to know and understand the magnitude and attributes of all of these resource components. This planned overlap of interests will be coordinated to maximize support and eliminate duplication by assigning lead responsibilities as follows: (1) the Bureau of Mines will be responsible for the appraisal of reserves (except OCS reserves and resources and reserves of leasable minerals for lease sale or under

Federal or Indian lease); (2) the Geological Survey will be responsible for the assessment of undiscovered resources; and (3) identified subeconomic resources will be studied jointly, with the Geological Survey responsible for assessing geologic factors and the Bureau of Mines responsible for appraising engineering and economic factors.

GS/BM Roles in Areal Mineral Resource Studies: The Geological Survey: (1) maps the geologic features of areas and, where necessary and within the scope of regional geologic mapping, maps the geology of mine workings and associated surface workings in coordination with the Bureau of Mines; (2) collects and analyzes geochemical samples and prepares geochemical maps; (3) prepares geophysical maps and interprets geophysical features; (4) collects and analyzes geologic, geochemical, and geophysical data from past and ongoing exploration by private industry or other sources; and (5) assesses the total mineral resource potential of areas based on compilation, analysis, and interpretation of information from above studies and other sources.

The Bureau of Mines: (1) compiles and documents past mining claims and related mining activities of areas: (2) conducts field work to evaluate claims and deposits and maps underground and associated surface workings in coordination with the Geological Survey; (3) takes engineering samples from mines and mineral deposits; (4) investigates possible extensions of mineralized structures exposed in existing workings and outcrops by all appropriate means, and coordinates estimations of inferred resources with the Geological Survey; (5) collects and evaluates assay, engineering, metallurgical and economic data on past and ongoing exploration by private

industry or other sources; (6) performs engineering and technologic tests as appropriate; (7) conducts minability and metallurgical studies on significant subeconomic identified resources; (8) evaluates the mineral reserves and identified subeconomic resources of areas based on the compilation and interpretation of all available pertinent data; (9) estimates future mineral needs; and (10) considers the economics and environmental impact of proposed mineral development activities.

The Geological Survey and Bureau of Mines have joint responsibility for the appraisal of reserves and assessment of mineral resources potential in Federal lands, where specified in law or otherwise implied and where not subject to mineral leasing (OCS, Geothermal Steam and Mineral Leasing Acts). The Geological Survey has the primary responsibility for geologic, regional geophysical, and geochemical surveys, and the evaluation and interpretation of these data to assess total mineral resource potential. The primary responsibility of the Bureau of Mines is to identify, sample, and evaluate mines, prospects, and associated mineralization and to document past and ongoing production, and from these data to appraise reserves and estimate identified subeconomic mineral resources.

Coordination of these program activities is essential even though the efforts of the two bureaus may not always be concurrent or at comparable levels of activity. The Geological Survey will supply data for Bureau of Mines estimates of identified subeconomic resources and aggregated reserve data for Federal or Indian leased deposits for reporting of reserves; and the Bureau of Mines will supply appropriate data to the Geological Survey for purposes of subeconomic resource assessment.

On lands subject to mineral leasing (OCS, Geothermal Steam and Mineral Leasing Acts), the Geological Survey: (1) classifies and evaluates leasable minerals for lease sale purposes, calculates reserves of leasable minerals on Federal, Indian, and Outer Continental Shelf lands based on geologic, geophysical, economic, and engineering data, and conducts or contracts drilling for information on mineral, water, and geothermal resources of these lands; (2) considers the environmental impact of proposed leasable mineral development activities on Federal, Indian, and Outer Continental Shelf lands, and analyzes site-specific environmental impacts of lease sale activities or operations on leased lands; and (3) documents past and ongoing production, value, and royalty from Federal and Indian leases.

GS/BM Responsibilities for Computerization of Resource Information: Although the resource information missions of the agencies are similar, significant differences are recognized. The Geological Survey maintains resource data files that are oriented primarily toward the geologic characteristics of the total resource base and toward mineral leasing activities and which presently include: (1) Computer Resource Information Bank (CRIB), a compilation of mineral occurrence data from all available spurces: (2) Petroleum Data System (PDS) which contains detailed information on U.S. oil and gas at the pool or field level; (3) National Coal Resource Data System (NCRDS), which contains information on coal resources by State, county, or township and section; and (4) resource, reserve, production, and revenue data files involving leasable minerals on Federal, Indian, and

Outer Continental Shelf lands. The Bureau of Mines maintains resource files that are oriented primarily toward economic availability and engineering characteristics of identified resources, particularly reserves. The central element of this effort is the Minerals Availability System (MAS), a file of data on known domestic and foreign mineral and ocean floor deposits that includes the Mineral Industry Location System (MILS) and the Mine Map Repository System.

Policy in building and disseminating computer-based files will be directed toward: (1) reduction of unnecessary duplication of data gathering and software development; (2) identification of data elements of common interest; (3) development of standard data characteristics and common data handling methodology to facilitate transfer of information; and (4) coordination of programs for data collection and dissemination.

GS/BM Responsibilities for Dissemination of Resource Information:

The results from jointly conducted resource programs are, when practical, published jointly in one of the agencies existing publication series so that the basis for resource considerations in land-use or commodity-related decisions are located in one document for ready reference. The agency that publishes the report assumes responsibilities for editing and processing these joint reports; the costs are jointly shared or otherwise provided, and planning for the publication format and content are jointly agreed upon.

Representatives of the Geological Survey and Bureau of Mines will appear together, whenever pertinent, for consultation at local, congressional,

or Departmental hearings so that the best collective information and advice can be provided on the broad spectrum of near-term to long-term resource problems.

GS/BM Resources Program Coordination: The Geological Survey/Bureau of Mines Coordinating Committee, which meets once a month in the Washington, D. C. area, will continue to be the main vehicle for joint program coordination and planning, for resolving disputes, and for approving operational agreements. The Committee and its subcommittees provide the forum before which critical issues are identified and discussed, and resolutions proposed. Specific tasks and problems are referred to appropriate subcommittees for consideration, solution, or recommendation; the full Coordinating Committee approves subcommittee reports and recommendations, which then are put into action. Agreement by the Cochairmen of the Coordinating Committee has binding authority of the Directors.

From time to time coordination and communication at the field level will also be required to discharge joint resource responsibilities effectively. When necessary, the Coordinating Committee or an appropriate subcommittee may convene a program discussion or work group in a field station to become informed about and resolve field program problems or subsequently present the issues to the full Coordinating Committee. Field personnel and organizations will use their own agency channels to bring such locally unresolvable problems before the Coordinating Committee.

In the event of changes in the Federal mining laws, or Departmental functions and responsibilities, this Memorandum of Understanding will be reevaluated.