

ORE CALCULATIONS
DEFINITIONS, METHODS AND PROCEDURES.

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Preface

The methods of determining ore reserves, contained in the "Historical Background," are not acceptable inasmuch as definitions of terminology are controversial and therefore may be subject to change at a later date. Information of the historical background, based on work done in the Colorado Plateau area by Government and/or Government-financed organizations, is being given only to develop a more logical set of reasoning processes in the calculation of ore reserves.

Methods and definitions of terminology contained in the "General Background" are accepted by the A.E.C., with reservations as noted in that Section.

SECTION I HISTORICAL BACKGROUND

Introduction

Given below are the definitions which apply to the various classes of ore reserve estimates; i.e., Proved Ore, Indicated Ore and Inferred Ore. In making up this classification system, an attempt was made to conform as much as possible with standard practice and yet to allow for the peculiarities of the field. A fourth class, Speculative Reserves, is added to the usual three, indicated above, to encompass reserves of which the existence is more uncertain than that of reserves covered by the usual three classes. This fourth class of reserves is added to give a complete picture of the potential of a claim, group of claims, or other specific area, for the purposes of long range planning. In estimating mill feed or the immediate production potential from any given claim or area, only those reserves which are in the proved or indicated categories should be considered.

Proved Ore

An ore block, sufficiently exposed by mine workings or by closely spaced drill holes so that its size and tenor is virtually certain, is termed Proved Ore. In A.E.C. practice, the mine examiner will feel at least 75% of the stated estimated reserves will actually exist.

Indicated Ore

The Indicated Ore classification applies to reserve tonnages which are exposed in a mine, trench, along an outcrop, or by drill holes spaced so far apart that the continuity of the deposit cannot positively be ascertained. The projection of ore from an exposure is based on the habit of the particular deposit being examined. Quantity and quality of the reserves are therefore determined, whenever possible, by what has been mined, or from adjacent ore shoots, rather than on a simple projection of the ore widths and values found in the exposure. The examiner will be certain that at least 50% of the stated Indicated reserves exist.

Inferred Ore

Ore in this class has usually, but not necessarily, been exposed, and most often lies in an extension of and beyond the projected limits of Indicated Ore. In some instances, a scattering of small lenses or weak mineralization along an exposure may be considered sufficient evidence for reserves in the Inferred class. Also included in this class is mineralization found in drill holes where the size, shape, and tenor must be inferred from geological evidence. Some Inferred blocks may cover ground which is considered geologically favorable for ore deposition, but which cannot be considered completely mineralized.

In these instances, the exact position, shape, and size of ore bodies included in the Inferred block cannot be definitely determined. The examiner will be certain that at least 25% of the stated Inferred reserves exist.

Speculative Ore

Estimated reserve tonnages of the Speculative class are based almost entirely on the geologic inference that where a favorable environment can, with some certainty, be projected beyond known ore bodies, a recurrence of such ore bodies may be postulated. A Speculative ore reserve block may cover a relatively large area such as a mining district or group of claims which can, from known factors, be roughly evaluated, but within which the exact location, size, or shape of ore bodies is indeterminate. For an entire Speculative block, the examiner feels certain that 30% of the stated reserves exist. For a specific claim or other small area within a Speculative block, the examiner is only certain that 5% of the stated reserves exist.

Mineability and/or Mineralization Factors

Because of the irregular and erratic character of the ore bodies, reserve blocks in classes less certain than Proved cover a large, mineralized and/or favorable area only a portion of the tonnage of which can profitably be delivered to the mill. To reduce the total tonnage available within a block to the tonnage considered mineable, a percent factor is applied to each ore block.

For Indicated blocks and some Inferred blocks, this factor is determined by laying out a typical reserve block to include the mineralized zone around an adjacent or nearby mined-out ore body. The percent of this block that has been mined will be the factor to be applied to the postulated ore block. This embodies the principal of a cut-off, based on grade and thickness, in that for the operator then mining the mineralized material that has been left along the edges of his workings indicates the cut-off for that particular operation.

For Speculative blocks and many Inferred blocks, the factor must be sufficiently small to exclude the large areas of barren material existing between individual ore bodies. In these instances, the factor will be determined by the spacing of exposed ore bodies within or adjacent to the block or by the frequency of occurrences in geologically similar areas which have been completely explored.

This factor, which has for convenience been called the Mineability and/or Mineralization Factor, may range to 90% or higher for some Indicated blocks, and to as low as less than 5% for some of the Speculative blocks.

For some blocks a tons per area factor, determined from known deposits or explored areas, may be applied directly to the area within a block in lieu of a Mineability and/or Mineralization Factor.

In considering the application of the Mineability and/or Mineralization Factor, it should be noted that in many instances it will be difficult to calculate exactly a factor which can be accepted as mathematically correct. In such cases, the opinion of the examiner, based on personal judgment and past experience, will greatly influence the selection of the factor.

SECTION II GENERAL BACKGROUND

(Accepted by A.E.C., with reservations as noted.
Based on a Standard Procedure, prepared by
R. P. Fischer, for U.S.G.S. Reports.)

Definitions

RESERVES: Uranium bearing material in deposits that are known from exposures in natural outcrops and mine workings, and from drill holes.

UNKNOWN (GEOLOGIC) RESERVES: Deposits not yet found which are predicted on the basis of geologic evidence and interpretation. Estimates applying to reserves of this type are based on an appraisal of geologic evidence and a statistical study of the calculated grade and size of adjacent known deposits.

TOTAL RESOURCES: includes both known and unknown reserves.

MEASURED RESERVES: those in which tonnages are computed from closely spaced measurements made on outcrops, in trenches or workings or from closely spaced drill holes, and for which the grade is computed from detailed sampling. The computed grade and tonnage are considered to be accurate within a 20% limit of error. Since uranium-bearing deposits, blocked out with this accuracy, are so small and/or rare of occurrence, they are included with indicated reserves.

INDICATED RESERVES: those for which grade is computed from production records, drill hole samples, or exposures in natural outcrops, trenches, or mine workings, and for which tonnages are computed by projection for a reasonable distance on geologic evidence (nearly mined-out bodies) from points of exposure (drill holes, trenches, mine workings and natural outcrops).

INFERRED RESERVES: those for which quantitative estimates are based largely on broad knowledge of the geologic character of the deposits and for which there are few, if any, samples or measurements.

THICKNESS CUT-OFF: on the basis of present mining practices, reserves are classified by thickness into (a) those ONE FOOT OR MORE thick, and (b) those LESS than ONE FOOT thick.

GRADE CUT-OFF: the deposits contain two metals of value, uranium and vanadium in an average ratio of 1 part U_3O_8 to 8-16 parts V_2O_5 . With present price schedules, both metals must be considered in reserve appraisals and in selecting grade cut-offs.

RESERVES OF 1 FOOT OR MORE THICK ARE CLASSIFIED BY THREE GRADE CUT-OFFS:

- (1) 0.10 percent U_3O_8 and/or 1.00 percent V_2O_5 -- corresponds to AEC purchase cut-off for Uranium, and the Monticello mill cut-off for Vanadium.

(NOTE: AEC Grade "A" ore)

- (2) 0.05 percent U_3O_8 and/or 0.5 percent V_2O_5 -- calculated in case future conditions permit or demand mills to accept lower grade ore.

(NOTE: AEC Grade "B" ore)

- (3) 0.02 percent U_3O_8 and/or 0.20 percent V_2O_5 -- calculated to obtain better idea of size, shape and distribution of weakly mineralized deposits, as well as their tonnages and amount of metal contained in them.

(NOTE: Not accepted by AEC for calculation)

RESERVES LESS THAN ONE FOOT THICK ARE GROUPED INTO TWO CLASSES, AND A GRADE X THICKNESS FACTOR IS APPLIED:

- (1) Class calculated at a cut-off equivalent to a one foot layer containing 0.30 percent U_3O_8 and/or 3.00 percent V_2O_5 . Deposits of this type are presently mineable at a profit in some places.

(NOTE: Not accepted by AEC)

- (2) Class calculated at a cut-off equivalent to a one foot layer containing 0.10 percent U_3O_8 and/or 1.00 percent V_2O_5 .

(NOTE: Not clearly stated)

Calculation of Reserves

TONNAGE: Methods of calculating volume (and hence tonnage since 14 cubic feet is considered to be equivalent to one ton) of deposits more than one foot thick differ with geologic interpretation of the form of the deposit.

If the deposit is considered to be roughly tabular or lenticular, reasonable projections are made between drill holes. Average thicknesses of ore samples of all intercepted ore within a block are assumed to be the average thickness of the deposit.

If the ore deposit is considered to be composed of small bodies or pods of mineable thickness connected by layers of mineralized sandstone too thin to mine, reserves are estimated by assuming that each drill hole in ore indicates a single mineable body that (a) is comparable in tonnage to the average ore body mined nearby, or that (b) the deposit contains a tonnage per unit area comparable to that of a deposit that has been mined nearby.

INDICATED RESERVES: computed by projection for a reasonable distance on geologic evidence.

(For AEC drilling projects, the distances used in the past, based on habit of ore occurrence at the localities drilled, has been:

- (a) Projection between drill holes 25 feet apart, though in a few places they have been projected between holes as much as 50 feet apart.
- (b) Projection of not more than 50 feet beyond drill holes.)

INFERRED RESERVES: deposits are classed as inferred if projection exceeds the above distances. Inferred reserves are projected to the assumed limits of the deposit, as determined by geologic evidence and interpretation.

TREATMENT OF A SINGLE DRILL HOLE IN ORE: Instead of designating a limited tonnage of indicated ore in the immediate vicinity of the hole, the reserve block is projected to its assumed limits and the ore is classed as inferred.

SECTION III AEC ACCEPTED FOOTAGE AND GRADE CUT-OFFS

Bonus Ores

GRADE "A" ORE

For ore one foot or more thick:

.1 percent U_3O_8 and 1.0 percent V_2O_5

For ore less than one foot thick:

Grade x thickness = product (either U_3O_8 or V_2O_5), as indicated in the following table:

Grade U_3O_8	Grade V_2O_5	Thickness in feet	Product U_3O_8	Product V_2O_5
.12%	1.2%	.9	.108 %-foot	1.08 %-foot
.13%	1.3%	.8	.104 %-foot	1.04 %-foot
.15%	1.5%	.7	.105 %-foot	1.05 %-foot
.17%	1.7%	.6	.104 %-foot	1.04 %-foot
.20%	2.0%	.5	.100 %-foot	1.00 %-foot
.25%	2.5%	.4	.100 %-foot	1.00 %-foot
.34%	3.4%	.3	.102 %-foot	1.02 %-foot
.50%	5.0%	.2	.100 %-foot	1.00 %-foot
1.00%	10.0%	.1	.100 %-foot	1.00 %-foot

GRADE "B" ORE

The calculation of Grade "B" ore is confined to the final project report.

For ore one foot or more thick:

.05 percent U_3O_8 and .5 percent V_2O_5

For ore less than one foot thick:

Grade x thickness = product (either U_3O_8 or V_2O_5), as indicated in the following table:

Grade "B" Ore (Continued)

Grade U ₃ O ₈	Grade V ₂ O ₅	Thickness in feet	Product U ₃ O ₈	Product V ₂ O ₅
.06	.6	.9	.054 %-foot	.54 %-foot
.07	.7	.8	.056 %-foot	.56 %-foot
.08	.8	.7	.056 %-foot	.56 %-foot
.09	.9	.6	.054 %-foot	.54 %-foot
.10	1.0	.5	.05 %-foot	.5 %-foot
.13	1.3	.4	.052 %-foot	.52 %-foot
.17	1.7	.3	.051 %-foot	.51 %-foot
.25	2.5	.2	.05 %-foot	.5 %-foot
.50	5.0	.1	.05 %-foot	.5 %-foot

Penalty Ores

When a mineralized bed, slightly below ore grade, lies in juxtaposition with ore and, when averaged in with the ore, does not bring the overall average below ore grade, then it should be included in the calculations thereby raising the tonnage figure and reducing the grade.

This is in accordance with mining practice. No miner can visually distinguish between a grade of 0.09 percent U₃O₈ and 0.11 percent U₃O₈. He will mine all of it or none of it, and tonnage calculations must be made accordingly.

GRADE "A" ORE

(For mixing only when in juxtaposition with ore in the same hole or adjacent holes.)

For grade of ore less than .1 percent U₃O₈ and 1.0 percent V₂O₅ and more than .05 percent U₃O₈ and .5 percent V₂O₅:

Grade x thickness = product (either U₃O₈ or V₂O₅), as indicated in the following table:

Grade U ₃ O ₈	Grade V ₂ O ₅	Thickness in feet	Product U ₃ O ₈	Product V ₂ O ₅
.09	.9	1.2	.108 %-foot	1.08 %-foot
.08	.8	1.3	.104 %-foot	1.04 %-foot
.07	.7	1.5	.105 %-foot	1.05 %-foot
.06	.6	1.8	.108 %-foot	1.08 %-foot

GRADE "B" ORE

The calculation of Grade "B" ore is confined to the final project report.

(For mixing only when in juxtaposition with ore in the same hole or adjacent holes.)

For grade of ore of .05 percent U_3O_8 and .5 percent V_2O_5 or less:

Grade x thickness = product (either U_3O_8 or V_2O_5), as indicated in the following table:

Grade U_3O_8	Grade V_2O_5	Thickness in feet	Product U_3O_8	Product V_2O_5
.05	.5	1.0	.05 %foot	.5 %foot
.04	.4	1.3	.052 %foot	.52 %foot
.03	.3	1.8	.054 %foot	.54 %foot
.02	.2	2.5	.05 %foot	.5 %foot
.01	.1	5.0	.05 %foot	.5 %foot

Considerations for Ore Calculations

AREA FOR CONSIDERATION: Area for consideration of extent of ore will be within the limits as previously specified. When only one or two holes are considered, circles of influence and ovals, parallel to the trend, are acceptable if they are in agreement with cut-off points or within reasonable limits. Single holes will be considered Inferred, as will any area that exceeds the area of definite influence.

If circles or ovals, parallel to the trend, are not in accord or within reasonable limits with relation to cut-off points, area of extent of ore may be established by drawing lines from cut-off point to cut-off point, resulting in closure. It is within the limit of accuracy of the preceding data to utilize the planimeter for determining the area of the irregular closure.

CUMULATIVE TONNAGE GRADES: Since tonnage grade cumulatives cannot be made on splits of a hole, cumulative grade will be derived on a footage-grade basis. Since holes are not computed separately in an ore estimate except where only one hole is drilled, the cumulative grade per block will be on a grade footage basis. However, on the final or total figures of combined ore blocks, the total average grades will be derived on a tonnage-grade basis.

SECTION IV ORE CALCULATION PROCEDURES

The purpose of Sections II and III is to establish procedure for the proper completion of the following:

1. Monthly Tentative Ore Reserve Estimates, prepared in the Grand Junction Office from progress reports and ore reserve estimates received from the field projects.
2. Preliminary Reserve Statements on Ore Blocks, prepared at the field project. These will follow the form of Trace Elements Memorandum Report No. 177.
3. Final Report, entailing re-calculation and revision, deletion or addition of information embodied in the previous two items.

This Section IV outlines, step by step in their normal sequence, actual operations incident to the calculation and reporting of ore reserves. There are 18 steps, outlined as follows, with subsequent explanations and diagrams, where necessary, for each step.

Outline

1. Progress Map, Base, will be brought up to date during each period.
2. Progress Map of Offset Holes will be brought up to date during each period.
3. Mineable Area Map will be brought up to date during each period by calculations that follow.
4. Ore Reserve Calculation Sheets will be kept up to date by entering data as they become available.
5. Determine boundaries for ore blocks by drawing graphs for ore holes to establish boundary points limiting the ore body. (This method is optional for monthly reports, but it will be necessary for the Final Report.)
6. Plot area of determined boundary limits on the Mineable Area Map.
7. Planimeter calculations of square feet of area of ore body.
8. Enter the total square feet of area of ore blocks on Ore Reserve Calculation Sheet.
9. Determine mean thickness of ore.

10. Enter thickness of ore horizon on Ore Reserve Calculation Sheet.
11. Calculate Volume of ore.
12. Enter volume of ore on Ore Reserve Calculation Sheet.
13. Calculate tons of ore.
14. Enter tonnage figure on Ore Reserve Calculation Sheet.
15. Calculate grade averages for holes, blocks and totals.
16. Enter appropriate information to date, derived by the preceding operations, on the Tentative Ore Reserve Estimates form, which has spaces and headings for the necessary information.
17. Transmit Ore Reserve Calculation Sheets and Tentative Ore Reserve Estimates to the Exploration Section Office in Grand Junction immediately after the 25th of each month. (After being verified and reproduced, copies will be returned to the project for the next month's operations.)
18. Transmit all maps to the Exploration Section Office in Grand Junction, for printing, immediately after the 25th of each month. (After verifying and printing, maps will be returned to the project for the next month's operations.)

Detailed Discussion of Outline

1. A Base Progress Map will be supplied each Project by the drafting department. On this map, the field staff will plot the location of all initial grid holes, as they are drilled. Offset holes will not be shown on this Base Progress Map, but an asterisk will be placed by the initial hole controlling a series of offsets, and the legend will indicate that offset holes are shown on an attached or secondary map. All holes must be numbered. The legend for the Base Progress Map will indicate the project location, and will be as follows:
 - a. Blank holes will be indicated by a circle 0
 - b. Mineralized holes, confirmed by assay, will be indicated by a circle and a vertical line ◊
 - c. Ore holes will be indicated by a solid circle ●
 - d. Holes not sampled, but for which mineralization is indicated by gamma-ray, will be indicated by a circle and four quadrant lines ◆
 - e. Holes that are mineralized but for which no assay returns have been received to date will be indicated by a circle and a vertical dash line within the circle .. 0
 - f. Holes having offsets, which will be shown on a secondary map, will be indicated by an asterisk *

2. An Offset Hole Progress Map will be made in the field, as indicated in the preceding paragraph. A scale of 1" = 200' is suggested so as to include all offset holes on a minimum number of sheets. Initial grid holes will be indicated by number, and offset holes will be indicated by letter. The same legend as used on the Base Progress Map, including the project location, will be used for the Offset Hole Progress Map.
3. Mineable Area Maps (for field and Exploration Section Office use, only) will be made on the same scale as Offset Hole Progress Maps. The same legend will be used, including the project location.
4. Ore Reserve Calculation Sheets (see example attached). Entries on Ore Reserve Calculation Sheets will be made from Sample and Analysis data. Each ore block will be listed on a separate sheet. At this point in the process, entries may be made up to and including chemical assay. Only holes that are considered "ore" and holes below grade that fall within the bounds of the ore body will be listed. (Refer to Section II, GRADE CUT-OFF, RESERVES OF 1 FOOT OR MORE THICK, and RESERVES LESS THAN ONE FOOT THICK) If there is more than one ore horizon, with a separation greater than can be mined in a single drift, the reserve calculations will be made separately.
5. Boundary Procedure for Ore Blocks. Become familiar with the following procedure for use in preparing the Final Report:
 - A. For a grid hole and an offset hole, rimming a possible ore body, where the cut-offs fall between the holes, a graph may be used to determine these cut-off points. (See following graph examples). In all cases, the maximum distance of either U_3O_8 or V_2O_5 will be used for the cut-off point.

(Example for Paragraph 5A - Continued)

CUT-OFFS BETWEEN HOLES (Cont'd.)

Plot Graph for .1 % - ft. U308

