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THE SCIENTIFIC VALUATION OF MINERALS

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The science of mineralogy would be distinctly benefited by the adoption of scientific methods in the valuation of minerals. It would aid in preventing the pricing of minerals higher than is justified by the advance in general commodity prices since 1914. Lower prices would become popular and these would lead to a wider distribution of minerals and to the acquisition of more specimens by collectors and museums. While it is not likely that any scheme for the scientific valuation of minerals heretofore found would meet with general acceptance, the members of this Society could do much towards standardizing the methods of valuation of new finds which they make, and especially finds of new species.

The desire to be reimbursed for large expenditures in collecting, frequently leads to the placing of abnormally high prices on the specimens secured, while the finding of a new mineral engenders an enthusiasm which seems to justify these prices, though it actually does not.

If there is a considerable supply of specimens, high prices are not warranted, even though the cost to the finder is more than the total he can fairly ask for them. For example: if A spends $500, in visiting a locality and discovers one hundred specimens of a new, massive, calcium silicate, his specimens are not worth any more than the one hundred specimens of another new, massive, calcium silicate, scarcely distinguishable from A's, which B secures at a cost of $100. A specimen of one placed alongside of the other in a distant museum, whose curator knows that they are equally abundant and practically identical in quality, would not be appraised at five times the value of the other. A scientific valuation of these two minerals unquestionably would rate them as of the same value, regardless of their cost. Cost, then, is not a fair basis of valuation; neither is the price which a collector or a museum may pay.

About fifty years ago, Norman Spang of Etna, Pennsylvania, sold to Clarence S. Bement of Philadelphia, the pick of his collection of minerals. Each of these gentlemen had had large experience in buying minerals all over this country and Europe and they were probably better qualified than any other American collectors to appraise the value of such minerals. Each placed his own valuation on the individual specimens selected and their respective totals, approximating $22,000, were only about $100 apart. While it is not likely that either party scientifically appraised the specimens, their substantial agreement on values was doubtless due to the fact that their long years of experience in purchasing specimens made each an expert in recognizing the points which give to one specimen a value much in excess of another.

FACTORS IN SCIENTIFIC VALUATION

Eliminating from consideration many minor points, the chief factors in a scientific valuation of minerals are the following: (1) Commercial value, (2) Chemical composition, (3) Form, (4) Miscellaneous characteristics, (5) Rarity.

(1) Commercial Value

The determination of its commercial value, if any, should always be the first step in scientific valuation. If a mineral has only small commercial value this may be disregarded in its appraisal; but if its commercial value is high it is usually the most important factor to be considered. For example, a group of dioptase crystals or an Egremont twin of calcite has practically no commercial value, while its value as a scientific specimen is great. On the other hand a large, transparent diamond octahedron would be appraised on the basis of its gem value even though it possessed no greater educational value than an octahedron of hauerite or of magnetite whose commercial value was nil.

Commercial value would also be the controlling factor in valuing a heavy, formless gold nugget, possessing no elements of scientific interest, yet of large intrinsic value. Similarly a nugget of platinum or of iridosmine would have very high commercial value, though no real scientific value. In these instances, and others of like nature, the task of the appraiser is merely to ascertain the commercial value.

Assistance in the determination of commercial values will be found in the weekly "Market Report" in the *Engineering and Mining Journal*, but this should invariably be supplemented by making direct inquiries of merchants or brokers handling the material being appraised, for it would be easy to be misled into believing that a mineral possessed far higher value than it does, if the price of the metal there noted were taken as the basis of valuation. Due allowance must always be made for the cost of extraction, which at times is very high. Bismuth is there quoted at $2.75 per pound, and this quotation will correctly guide a mineral appraiser to the approximate commercial value of a specimen of native bismuth; but a quotation of around 14 cents per pound for antimony would not justify the adoption of that price as the scientific value of a specimen of native antimony.

Asbestos is the only non-metallic mineral quoted whose commercial value is not much less than its scientific value; but the quotations on "metallic ores" are worthy of consideration in appraising the value of some of the minerals containing tantalum, tungsten, uranium and vanadium.

The appraisal of important gems, either cut or rough, should not be undertaken by anyone who is not a gem expert. Slight differences in color, so small as not to be discerned by the untrained eye, may make one gem worth much more than another. A specimen of a gem mineral which is not perfect enough to be usable for cutting is frequently much overvalued. If it will not yield marketable gems it has no gem value and ought to be valued merely as a scientific specimen.

Polished specimens of the decorative stones, other than those used for jewelry, may be conservatively appraised by adding to the value of the rough material double the cost of slicing and polishing. Of course this does not apply to specimens of exceptional excellence, nor to carvings, nor to pieces cut into ornaments of any kind. Such items in a collection may be properly regarded as articles of virtu and valued accordingly, rather than as mineralogical specimens.

(2) Chemical Composition

Minerals whose value is increased because of their chemical composition may be divided into three groups, namely: those containing (a) rare metals, (b) rare earths, (c) several acid radicals, or those in which the radicals are comparatively rare.

(a) In the first group are included minerals containing the precious or rare metals, gallium, germanium, gold, indium, iridium, osmium, palladium, platinum, rhodium, rubidium, ruthenium, silver, thallium and others. Practically all of these have greater or less commercial value, but aside from the "precious" metals, they give value to the minerals in which they occur much more largely in proportion to their applications in the arts than to their actual rarity. Sphalerite containing gallium or indium is not very valuable, because these metals are not extensively used in the arts; on the other hand a mineral containing germanium, such as germanite or argyrodite, is of considerable value because of the wider use of germanium oxide.

(b) The presence of rare-earths in a mineral gives it a value which increases as the percentage or scarcity of the rare-earths increases. Polycrase is valuable as a rare-earth mineral, but the South Carolina polycrase, which contains only a minute quantity of scandium, is not more valuable on that account, while the mineral thortveitite which contains a large percentage of scandium is exceedingly valuable. Allanite, though containing a number of the rare-earths, is not of much value because other minerals are so much better sources of supply. The number of known rare-earth minerals is steadily increasing, but the high values placed upon them do not seem to be justified by any chemical demand for the rare-earths. As such minerals are almost always discovered by good mineralogical chemists, they would be performing a real service to the mineralogical community if they were to keep the prices low.

(c) Only a few minerals contain more than two acid radicals. Other things being equal, minerals containing three radicals would be worth at least twice as much as those having only one or two; but it so happens that many of these are also rare-earth minerals and owe their high values largely to that fact. In the case of thaumasite (a sulphate, carbonate and silicate), a high valuation is prevented by the fact that there is an oversupply of the mineral. Polymignite contains three radicals and small amounts of two others, and this fact, coupled with its rarity, gives it high value.

Minerals containing rare acid radicals, such as the tungstates, uranates and molybdates, happen also to be in commercial demand. This makes it difficult to figure out what part of their high values is due to the rarity of the radical.

(3) Form

Large, perfect crystals, with brilliant faces and many of them, or groups of such crystals, other things being equal, are the most valuable forms of minerals. It is not possible, however, to adopt any standards for the valuation of minerals in general according to their crystallization. This is due in part to the fact that crystals are much rarer in some species than others, and also because the simplest forms of crystallization are rarer in some species than highly modified crystals. For example, a cube of garnet, even though it be present only as a small modifying form, would be worth two to ten times as much as good crystals which are combinations of the dodecahedron and trapezohedron, yet the latter form has six times as many faces as the cube. A knowledge of which faces are rare and which are common on each species, is essential to the correct appraisal of the values of crystals.

Perfection of crystal form may make a simple form of a mineral worth much more than a complex form. Indeed everyone who endeavors to secure perfect crystals knows how exceedingly difficult it is to obtain some of the simplest forms of crystals even reasonably free from distortion, superficial irregularities and bruises. A perfect crystal has never been found, and because of this fact an intelligent appraiser will place a very high value on a simple crystal of a common mineral if it nearly approaches perfection. A 2.5 cm. cube of fluorite might be fairly appraised at five dollars if it is nearly perfect and has brilliant faces, while another of the same size, distorted and somewhat bruised, would be correctly appraised at ten to twenty-five cents.

While loose crystals are more desirable for crystallographic study than those attached to the rock, the latter are often worth from two to five times as much as parts of a mineralogical collection.

A specimen with crystals attractively scattered over the gangue is worth from two to five times as much as another in which the crystals are closely grouped.

A specimen composed of a few large crystals is worth from two to five times as much as a specimen with the same quantity of the mineral in the form of many small crystals. This is especially true of large museum groups.

Freedom from bruises adds very much to the value of a crystal; for example, an Arkansas quartz crystal with both terminations unbruised might bring five dollars, while the same crystal, if one of the terminations were even slightly broken, would not bring over two dollars, and if both terminations were at all conspicuously damaged, might not be worth more than fifty cents. A great many collectors fail to appreciate the extent to which bruising lessens value.

In minerals not occurring in crystals, an attractive form is worth much more than a massive specimen; thus a botryoidal psilomelane is worth at least ten times as much as a massive one of the same weight, while the beautiful manganese oxide dendrites on limestone may be worth several hundred times as much as the same quantity of the mineral in purely massive form. If the dendrites are enclosed in translucent chalcedony, forming "moss agates," their value may be thousands of times the value of the massive form.

The valuation of moss agates presents a problem in scientific appraisal which must not be lightly passed over, namely whether the use of specimens of unusual beauty for ring stones and brooches and their sale in large numbers, chiefly in tourist resorts, establishes a mineralogical value identical with the high prices which they bring in tourist stores, where \$5 to \$25 are common prices and \$50 to \$100, and even more, are asked for exceptional specimens, on the basis of fancied resemblances to landscapes or various objects. It would seem safe to regard such prices as valuations of objects of art, or curios, rather than of mineralogical specimens, and if they are introduced into mineral collections and values commensurate with their cost are assigned to them, those values must represent art rather than science. Nevertheless, because many persons who are not mineral collectors create a demand for these objects their high prices are maintained and, therefore, their valuation as portions of such mineral collections as include them can scarcely be less than the market prices.

Many of the imitative forms which minerals, at times, assume are worth much more than their massive forms; thus "kidney ore" will bring ten to fifteen times as much as massive hematite. Other illustrations of increased value due to imitative forms are mammillary malachite, globular pectolite, coralloidal aragonite or "flos ferri," reticulated cerussite, stalactitic calcite and limonite, "star" quartz, pseudomorphs of chalcedony after coral, of opal after mollusk shells.

(4) Miscellaneous Characteristics

(a) Beauty. Theoretically beauty is not a factor in scientific valuation, as it is an element of art rather than science, but practically it is one of the most important factors in determining the value of mineral specimens. Even the most scientific mineralogist cannot resist the charms of beauty and will rarely fail to give preference to a specimen of real beauty in adding to his collection. From a scientific standpoint two crystals of beryl which are identical in size, luster, number of faces and sharpness of edges, are equally desirable for scientific study; but beauty instantly imparts largely increased value to the one which is transparent and of rich blue color, when compared with the other which is opaque and of dull grayish-green color. The blue crystal is conservatively appraised as worth twenty times as much as the other. No museum curator can afford to ignore the universal admiration of beauty, even though it costs so much to satisfy it.

Shapeliness is an element of beauty which possesses real value. A shapely specimen of rectangular outline and evenly sloping from the edges to the center, is worth at least twice as much as the same bulk of material of triangular outline.

The general neatness of a specimen is another element of beauty which contributes to its value. For example, if a specimen has its crystals massed along the edge it is worth not more than half as much as if they were attractively scattered over the surface of the matrix.

A collector with a cultured, esthetic taste will see at a glance the various elements of beauty, such as color, luster, diaphaneity, shapeliness, neatness and perfection of form, and will instantly select the one specimen from among a hundred which combines all of these qualities and will not be satisfied with any other, even though he finds that it is valued at several times as much as many of the others.

(b) SIZE. Other things being equal, specimens of cabinet sizes. 4×5 cm. to 7.5×10 cm. should be valued in proportion to their size, though crystals of fine quality increase in value much more than proportionally to their size. When specimens are larger than 7.5×10 cm., unless they are of high enough quality to be acceptable to museums, or can be broken up advantageously into specimens of cabinet sizes, they are worth very little. This fact is often overlooked, but the addition of specimens to a collection merely because they are of large size, hurts rather than improves a collection.

(c) HARDNESS, has but slight mineralogical value, but it contributes much to the commercial value of gems and it is the chief property of value in the abrasives.

(d) UNUSUAL CHARACTERISTICS. Freak specimens are always more valuable than those which lack unusual characteristics. Thus a twisted tourmaline should be worth two or three times as much as a simple crystal; a beryl broken, by nature, into several pieces with quartz filling the space between the pieces, will be correctly appraised at several times as much as the same crystal in one piece; a quartz crystal, distorted so that it resembles a cube, is easily worth double the value of a symmetrical crystal. Additional value is given to crystals if some of their faces show attractive etching, if crystals of other minerals are grouped in symmetrical position on one or more of their faces, if crystals are grouped in parallel position, if movable bubbles exist within the crystal, or if there are attractive enclosures of other minerals. The wonderful zonal growth shown in some cross sections of tourmaline crystals from Madagascar, increases their value several fold. Many other unusual characteristics exist which add more or less to the value of a crystal.

(e) ASSOCIATED MINERALS. While the associated minerals do not, as a rule, increase the value of a specimen, there are many instances in which they do. This is particularly true if the associates give a clue to the genesis of the mineral; for example, a phenacite specimen with crystals of both phenacite and fluorite implanted on a crystal of beryl, whose termination is deeply etched, as is sometimes seen at Mount Antero, Colorado. A cleavage mass of galena, surrounded with bands of anglesite and cerussite is of interest to one studying the origin of the secondary minerals, and in like manner many specimens possess interest to the geologist and will have added value in a scientific collection because of their associated minerals. The most notable increases in value due to associated minerals occur when the matrix of a mineral is of an unusually attractive character, for example wire gold on a limpid quartz crystal might be worth two to ten times as much as the gold alone. Drusy quartz on bright blue chrysocolla or on rich green atacamite or malachite, might be valued at five to twenty times the value of the quartz alone. Every collector will think of many other instances of attractive associations. While there is invariably an increase in value when such associations occur, in many instances they are so common as to add but little to the value; for example, apatite in salmon-colored calcite, vesuvianite in blue calcite.

(5) Rarity

Rarity in minerals may be classed as due to the quality of the specimen being greatly superior to the average, or to the scarcity of the species, variety or form. In each instance rarity adds greatly to the value of a specimen. It is, indeed, one of the most important factors in the scientific valuation of minerals.

Every collector has experienced the thrill of securing a unique specimen; every curator points with pride to certain specimens which are finer than those in any other collection. It was the rarity of such large crystals which led one of our American collectors to pay $1000 for a single large octahedron of gold, though its bullion value was probably not over twenty dollars. It was the rarity of size and excellence of quality which led Mr. Holden to pay $5000, for the two magnificient crystals of kunzite now in the Harvard University collection. It is the rarity of such superlative beauty of color and luster and transparency, linked with the perfection and mammoth size of the matchless specimens of proustite in another of our great American collections which gives them a value so vastly greater than that of the silver they contain. In the wonderful collection of silver specimens in Kongsberg, Norway, there is a spinel-twin of silver of marvelous size and perfection, which might reasonably be appraised at a thousand times its bullion value. The correct appraisal of such specimens is a difficult task and even experts would doubtless disagree in some instances. These are all illustrations of rarity due to superior quality.

If instead of being rare, superlatively fine crystals of a mineral occur in great abundance, the law of supply and demand will largely determine their prices. An excellent illustration of this is the great find of golden calcite crystals at Joplin, Missouri, about thirty years ago. Many hundreds of them were brought on the market at prices not more than a third of those they would bring today, after the exhaustion of the supply.

There are rare varieties of some common species which command much higher prices than other varieties of the same mineral or similar varieties of other species; thus the satin spar variety of calcite is worth five times as much as a granular or a cleavable calcite and double the value of the gypsum satin spar. Other illustrations are given in discussing "Form."

It should not be overlooked that if a mineral species is not attractive, the demand for it will be very much smaller than if it were beautiful. Even though the species is a new one and might, therefore, be expected to bring a good price, it is actually worth only a low price, for its unsalability at a high price, will force a reduction in its valuation to such a figure as will attract buyers because of its cheapness.

Any systematic scheme of valuation must first determine whether the specimen has commercial value and if so what it is. Next the factor of rarity, or the number of specimens found, must be considered. The table presented herewith will serve as a starting point. All factors other than rarity are excluded, it being assumed that specimens are of standard size, 7.5×10 cm., pure or nearly pure, massive and of average quality. If only one specimen is found it is valued at $100, with steadily decreasing valuations until $2 is reached if one hundred specimens are found. This plan is roughly in conformity to the law of supply and demand. If the quality of the mineral is high the value would be greatly in excess of $100 for a single specimen, while if it is poor the value would be much less. Quality, however, is considered in a later table.

PRELIMINARY VALUATION ON BASIS OF RARITY

Specimens are of standard size, 7.5x10 cm., pure or nearly pure, massive, and of average quality.

Number of specimens found:	Value per specimen:	Total value of find:
1	$100.00	$100.00
2	75.00	150.00
3	50.00	150.00
4	40.00	160.00
5	35.00	175.00
6	30.00	180.00
7	25.00	175.00
8	22.50	180.00
9	20.00	180.00
10	18.00	180.00
12	15.00	180.00
15	12.00	180.00
20	10.00	200.00
25	8.00	200.00
30	7.00	210.00
35	6.00	210.00
40	5.50	220.00
45	5.00	225.00
50	4.50	225.00
60	4.00	240.00
70	3.50	245.00
80	3.00	240.00
90	2.50	225.00
100	2.00	200.00

COMPLETE SCHEME FOR THE VALUATION OF NEW MINERALS

There are many difficulties in the appraisal of specimens of varying quality. No such scheme of valuation as is herewith presented can possibly give definite figures or percentages, but it must leave much to the judgment of the appraiser, and to this extent it is not scientific. On the other hand, if mineralogists will take time to study the factors presented in this paper in connection with the second table, a much closer approximation to scientific valuation can be attained than has heretofore prevailed.

Scientific Valuation of a Mineral Specimen

Section A

If the specimen has commercial value:

1. Determine, as nearly as possible, what it is worth commercially.
2. Determine its value as a specimen by adding to or deducting from its commercial value, in accordance with Section B: 2, 3, 4, 5, 6, 7.

Section B

If the specimen has no commercial value:

1. ·Assign a preliminary valuation on the basis of its rarity (see table above).
2. Modify this valuation according to size.
3. If it is not massive, increase the valuation as suggested under "Form."
4. If it has an unusual chemical composition, increase its valuation as suggested under "Chemical Composition."
5. If it has unusual beauty, increase the valuation as suggested under "Beauty."
6. If it has other exceptionally interesting characteristics, increase the valuation accordingly.
7. If its associated minerals are of unusual interest, add a little for them.

The figure thus obtained will be its value.

Illustrations

Silver: an old mineral, with commercial value.

Specimen is 7.5×10.0 cm., weighs 620 grams (about 20 oz. Troy), is shapely and well crystallized.

A. Commercial Value:

20 oz. Troy at 50c oz.	$10.00
Less estimated cost of selling	2.00
Net commercial Value	$ 8.00

B. 1, 2.	Rarity and size not applicable.	
3.	Excellence of crystallization quadruples value	$32.00
4.	No change for chemical composition.	
5.	Unusual beauty, including shapeliness, brilliancy and attractive placing of crystals, increases value	16.00
6, 7.	Value not changed by other characteristics or associated minerals.	
Value of Specimen		$48.00

Pyroxmangite: a new mineral, no commercial value.

Specimen is 5×15 cm. and shows good cleavage.

Total number of specimens found, 21, as follows:

1 specimen 5×15 cm.	75.00 sq. cm.
20 average 3.75×7.5 cm.	562.50 sq. cm.
Total area of find	637.50 sq. cm.

equals 8.5 (say 9) specimens of standard size, 7.5×10 cm.

There being no commercial value, appraise on basis of rarity for 9 specimens.

B. 1. Preliminary valuation........................$20.00
2. Valuation not changed on account of size, as area equals standard size.
3. Increase valuation because of cleavage to......... 25.00
4. No change for composition.
5. Poor shape decreases value 20%, to............. 20.00
6, 7. Value not changed by other characteristics or associated minerals.

Value of specimen..................................$20.00

BALDAUFITE: a new mineral; no commercial value.

Specimen is 5×7.5 cm., half standard size; shows a small group of minute crystals and a little of the massive mineral, on matrix.

Exact number of specimens found not known, but it is certainly very scarce; assumed to be as follows:

1 spec. 7.5×10 cm.	75.00 sq. cm.
3 spec. 5.0×7.5 cm.	112.50 sq. cm.
4 spec. 3.0×5.0 cm.	60.00 sq. cm.
6 spec. 2.0×4.0 cm.	48.00 sq. cm.
Total area of find	295.50 sq. cm.

equals 4 specimens of standard size, 7.5×10 cm.

B. 1. Preliminary valuation........................$40.00
2. Size reduces value 50% to.................... 20.00
3. Increase valuation because of crystallization to..... 40.00
4. No change for composition.
5. Beauty insufficient to justify increase in valuation.
6, 7. No exceptional characteristics or associated minerals add value.

Value of specimen..................................$40.00

CONCLUSION

It is hoped that this paper, which plows the first furrow in the field of scientific valuation of minerals, may stimulate consideration of a neglected subject and ultimately lead to the adoption of some standards of valuation which will check the present tendency to overvaluation, and by making the appropriations of the museums and colleges and the dollars of the collector, go farther, will benefit all who love minerals for their beauty of form and color, and who find their study the open sesame to many of the great truths of the universe, so long locked up in the atoms and molecules of their crystals.