HIDDEN MINES

AND

HOW TO FIND THEM

J. H. Higgins

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"What is there in it?"

HIDDEN MINES;

AND

HOW TO FIND THEM

CONTAINS
THE INFORMATION CALLED
FOR BY THE ORDINARY BUSINESS MAN, WHO IS INTERESTED
FOR BUSINESS REASONS ONLY,
IN

MINES, METALS AND ORES

BY

W. THOS. NEWMAN

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PREFACE

My object in attempting this work, is to provide a little practical information, on a subject, of great interest to many who have little or no knowledge of the matters treated herein; and who have neither the time, nor the opportunity, to undertake the study, necessary to an understanding of the great number of more scientific and more comprehensive books, now in print.

I have endeavored to give, in as simple language as possible, an insight into the enticing business of searching for and exploiting Mines, carefully avoiding such matters as are of purely scientific value, and confining myself to those likely to influence people who are engaged in prospecting, or interested in Minerals, from commercial motives only.

The use of scientific terms has been avoided where possible, and when used, care has been taken to explain their meaning and application.

In short this work is intended for the benefit of the business man, the investor, the ranger, the settler, and those generally, who, if given a little knowledge of Mines and Mining, might be induced to turn that knowledge to practical account.

The first part proper, deals with rocks, giving a general idea of how they are formed and altered, and how mineral deposits of value to commerce occur in them, with the names and characters of rocks commonly met with in mining sections.

The third part sketches the means employed to determine, or identify, the different ores and minerals, with a list of all known elements and their symbols.

Part four contains a description of each of the ores of the metals, of use as such in the arts, with a knowledge of how they are tested by simple means, and the methods employed in their treatment on a commercial scale.

The fifth section describes non-metallic minerals; or those used for purposes other than the extraction of their metals; as at present utilized, and contains also, a concise description of the various gems and precious stones, and how they may be identified.

The last section is a medley of facts, and hints, on various matters likely to interest anyone engaged in mining, or desirous of becoming so, and there follows a very complete glossary confined to mining terms and phraseology.

W. THOS. NEWMAN

Toronto, December 31st, 1894

CONTENTS.

PART I.

PART II.

PART III.

PART IV.

PART V.

PART VI.

ILLUSTRATIONS.

PART I.

PROSPECTING AND PROSPECTORS.

To one who has any taste for the freedom and sport of the untrodden wilderness, and the pure, ever-changing delights of "Nature undefiled" (and who has not, then is his taste perverted); every day of exploring brings its quota of enjoyment, hope springs eternal, the hardest labor brings with it such added health and strength as make it a pleasure, and the explorer at sixty, is as young in heart and feeling, as the ordinary business man at forty.

In no other way, and in no other business, can fortunes be made, which in the making necessarily enrich the community at the same time, and in no other calling can fortune be realized in a day, without causing misery and loss to others.

When the successful prospector finds a valuable mine, he at once adds the present value of the find, to the wealth of the nation. When he converts that mine into the medium of exchange which supplies his wants, and receives possibly a large sum therefore, he gives value for what he receives, and may enjoy his gains with a clear conscience. The opening of mines in any locality, means a direct and lasting benefit to all the dwellers therein; to the laborer—work, and good wages; to the farmer—an added market; therefore, the business of searching for and developing mines, is an honorable one, and the prospector takes rank as a public benefactor.

Prospectors are, as a rule, unusually active men, both mentally and physically, and hard workers when in the field. The greatest trouble with the majority of them is this:—they are attacked by a disease commonly called "swelled-head." The symptoms are the same in each case, the victim all at once, seems to be impressed with the mistaken idea, that each and every vein or deposit, *found by himself*, must necessarily be of immense value, and that a fortune is due the finder forthwith, nay; in many cases the discoverer seems to become firmly and honestly imbued with the idea, that he is already in indisputable possession of millions; and no amount of argument, or reasoning by his friends, can dispossess him of this hallucination, while ofttimes, his friends seem also to share his delusion. Nothing, apparently, can cure this disease, save only, the remedy used on the mad canine—cutting off his tail close to his ears—and this, financially interpreted, is what cures the majority. They continue in their conceit until, weary experience and a growing scarcity of cash, teaches them that their wealth, (which may in a sense be genuine enough) is not in the shape of legal tender.

The truth is, not one find in one hundred is worth more than it cost, until hundreds, and often thousands, of dollars be spent on its exploitation.

The prospector who understands his business, will never refuse a cash offer for his prospect, (received before proper development) if the same be sufficient to reward him for his time and labor.

Everyone who has had any experience of prospecting, and handling mining prospects, will recognize the truth of the saying, "that anyone may find a mine, but it takes a clever man to sell it," and as the business of mining becomes each year more universally understood, it will become more and more essential, that prospects be developed into mines before they can be disposed of to the satisfaction of the prospector, whose expectations are always in advance of any possible realization. In searching for gold or other mines, it is well to remember, that the first requisite is quantity. New processes and improved machinery, tend to closer saving and more economical work, and what is desired to-day is large bodies of low grade ore. Many a mine is paying dividends at the present time, that a few years ago could not be worked at all, because the ore was of too low grade to be profitably treated by the methods and appliances then in use. Every year is liable to see the tendency in this direction grow, and therefore deposits of low grade ore should be carefully looked after.

The chemist, and the scientific mechanic are constantly finding new uses for different materials. That which is worthless to-day, may commercially, be very valuable to-morrow, and as all these materials must come from the earth, each new appliance, or new application, becomes a matter of interest to all who deal with minerals.

Unlike most deposits of wealth, a mine grows larger the more it is used, and more valuable, as the value is taken from it, and in this connection there is a hint to prospectors. Most individuals of this class develop the roaming habits of gypsies, and with this a propensity for seeing riches a long distance away, much better than in the immediate neighborhood. There is no better prospecting field anywhere, than in the immediate surroundings of proved mines, where there is untried ground. Right under the feet of those who follow beaten paths, which have been walked over for years, lies "hidden wealth."

PART II.

ROCK FORMATION AND ORE DEPOSITS.

The first requisite to success, in searching for mineral deposits of commercial value, is a knowledge of what rocks are likely to have in them; mines containing certain ores, and under what conditions the ore occurs, in these rocks.

It does not follow, that a scientific knowledge of the names, or chemical constituents, of which rocks are formed, is necessary; although such an education is very desirable and valuable. To be able to recognize the rocks and minerals on sight, and a general knowledge of the manner in which they occur, is of greater value. There are between two hundred and fifty and three hundred distinct kinds of rocks; recognized and named by petrologists, and divided into three classes, as explained below; according to their origin.

Rocks are seldom definite compounds, but the various minerals are distributed in them in varying proportions, and in endless combinations each change making more or less difference in their appearance; and one rock often changes so gradually into another kind, that no hard and fast lines can be drawn between them. Thus, Granite will in a few yards become Gneiss, and the Gneiss in turn give way to Mica Schist, or some other rock, and so on.

The formation of rocks is going on continuously. The action of rain, frost, and many other agents of destruction, is slowly, but constantly wearing away the existing Rocks; the eroded material, (sand, clay, and vegetable matter picked up en route), being carried down by water and ice, ground finer and finer as it goes, until it reaches still water, and is deposited, in more or less irregular shapes.

The water of a river flowing into the Ocean, for instance, is constantly bringing down with it, particles of all kinds of matter, some floating with the currents, others in actual chemical solution. On arriving at the Ocean, and all along the route, these atoms are deposited in endless combinations, those of highest specific gravity, being generally the first to drop, the lighter being carried further on. The Minerals in solution, mingling with others in the salt water, are some of them precipitated and help to bind the rest.

The currents of the Ocean, are also carrying their share, perhaps, lime from the Coral Islands. Again the Ocean is continually encroaching on its shores, whole sections of the shore line disappearing in a few years, or even months, the loosened material being carried off to be deposited, in varying forms elsewhere. This process going on without intermission, day after day, year after year, results in layers of tremendous thickness being formed, great pressure is developed, and in course of time, the whole is solidified into a series of massive beds.

These beds, or layers, form what are called the Sedimentary Rocks. They consist of Limestones, Sandstones, Conglomerates, etc., as they are formed from shells and corals; sand; or boulders and gravel. These lie in alternate layers called Strata.

Other Rocks have been ejected from great depths in a fused state, and in most cases have cooled very slowly. These are called Igneous, or Eruptive Rocks. They are probably formed from original Rocks, which have been melted by subterraneous heat, and have been forced up by gases under enormous pressure, through fissures, formed by the expansion of the gases rending the crust.

Trap Dykes, and Granites, are of this origin.

In many cases, over large areas, the whole of the Sedimentary Rocks have undergone great changes, and have been perfectly or partially crystallized. These are called Metamorphic Rocks. The change is due to heat, which was not great enough to cause fusion, but which, was probably continued for ages.

These rocks are generally much contorted and fractured, and the fissures have been filled by the action of heated vapors, or heated springs, holding metals in solution, and by condensation and evaporation, and perhaps electrolytic action, dropping their contents; or by ejection of molten matter from below. Thus these rocks more often contain deposits of the metals of Commerce, than rocks of another origin. This brings us naturally to sections of rocky country likely to contain mines.

Where a section shows the rocks to have been much disturbed, and tilted at all angles; where Trap Dykes, and Quartz, and Spar Veins, are frequently met with; there, the prospector may hope to succeed. The soft, schistose character, of the rock in places is favorable. A discoloration, or burnt appearance, is generally caused by the decomposition of mineral in the rock, and most deposits of metal, are more or less softened and rotted on the surface, the decomposed matter being known as Gossan; (iron oxide).

Ore deposits, may be divided into four kinds, according to their modes of occurrence. These are called veins or lodes; pockets, placers, and beds, and veins occur also of four kinds.

Veins are most frequently met with, and are known as: Fissure Veins; (often called true veins.)

These are cracks or fissures, caused by the contraction of the Earth's surface, or by the bursting of the crust from internal pressure. They cut right through different strata at any angle, frequently at right angles to the strike, or nearly so. Contact Veins; these run with the strike but between two distinct formations namely at the "contact." Gash Veins; are veins usually of small extent, surrounded and terminated on all sides by the same formation, and frequently are filled with galena.

A Vein also, sometimes consists, of a number of small veins or stringers, running parallel to and at all angles with one another, with rock between which holds pockets of ore, and which is sometimes impregnated with ore. This is called a Stockwerke. Occasionally a vein will be found lying in a horizontal position and is then known as a "blanket" vein.

Pockets; are masses of ore of any size, from a few tons upward, more or less as may happen, usually unconnected with each other, though often on the same strike, and sometimes connected by small seams, and indications of ore.

Placers; are deposits of gravel carrying ore, or metal; generally applied to gold diggings.

Sometimes secondary deposits occur, as for example Bog ores; these are spread out a foot or two deep, over larger or smaller areas, and may be called Beds.

A vein is considered by miners, more likely to be permanent, and productive, if the walls, and especially the footwall, be separated from the vein matter, distinctly, by a soft talcose casing or gossan, or by clay, (called the selvage,) and a contact vein also, is likely to be permanent. Deep mining shows, that veins continue pretty much the same below, as they appear on the surface, where the surface can be studied for some distance, although the metal contents or the gangue, may vary considerably. Often a vein, improves in richness as it is followed down, and particularly is this the case on first working, and down to the point of saturation, viz.:—the distance to which surface water has been able to penetrate, which may be five or ten fathoms. Veins, are often enriched at the point of contact where two veins meet, or where the vein is cut by a Trap Dyke. Also a vein that is poor or barren while cutting one formation will sometimes prove productive where it intersects another kind of Rock. Many veins contain their value in what is known as a "paystreak," the ore being a band in the vein, sometimes in the centre, sometimes on one side.

While rich ores are much sought after, large quantities of low grade *pay best.*

Iron bearing rocks are, preferably, the oldest geological formations, the ore beds being thicker, and larger, in these rocks. Mica, or hornblende gneiss, or schists, sometimes with a crystalline limestone band on one side, is the most likely formation for iron ore, for manufacture into the metal, and the beds are usually conformable to the strike and dip. The cleavable varieties and Ironstones, are found however, in both the Crystalline and Stratified Rocks.

The distance from the centre of the Earth to the surface is equal to 3,956 miles. In comparison our highest mountains are merely insignificant ant-hills; our grandest canons but plough furrows. The temperature is constant the year round, at about one hundred feet in depth, and at lower levels invariably increases about 1° Fah. for each 60 feet of descent, to the limited depth reached in ordinary mining.

VARIOUS ROCKS OF ORDINARY OCCURRENCE

ARGILLITES:

Clayslates, breaking into thin even slabs.

CONGLOMERATES:

Any rock composed of coarse fragments, or pebbles, cemented together. When these are angular it is called; a **BRECCIA.** When the fragments are rounded; a **PUDDINGSTONE.**

CHALK:

Soft, white limestone. Red "chalk" so called; is clayey oxide of Iron. French "chalk" is a soapstone.

CHERT:

Flint or Hornstone, occurring as nodules in Limestone.

DOLOMITE:

Carbonate of lime, containing carbonate of magnesia; strictly speaking, in equal proportions. Effervesces in acid on heating.

DIORITE:

Triclinic feldspar, and hornblende, with or without quartz. A tough rock, light gray, to blackish green in color.—Eruptive.

DOLERITE:

(Basalt, Trap.) Coarse grained. Color, dark green to brownish black.—Eruptive.

GRANITE:

Quartz, Feldspar and Mica, with no appearance of layers or cleavage, used for monuments, etc., taking a fine polish.—Eruptive.

GNEISS:

Like Granite, but in layers, used for building flagstones, etc.—Metamorphic.

GABBRO:

Cleavable Labradorite; (Lime-soda Feldspar) and Pyroxene. Color, dull red, gray to black; of Igneous origin.

HYDROMICA SCHIST:

Green to white in color; sometimes dark gray; and soft. Hydrous Mica often with quartz. Foliated, splitting into thin wedge shapes. Smooth greasy surface, and pearly lustre.

ITACOLUMYTE:

Flexible Sandstone—a schistose granular quartz with mica or talc. (Diamond bearing in Brazil.)

JASPER:

A flinty quartz of dull red, yellow, or green color, and breaking smooth like flint.

LIMESTONE:

Carbonate of Lime, or Calcite; generally contains some clay or sand. Color, cream or nearly white; blue, brown, and black. Usually contains fossils. Crystalline limestone forms the various marbles. Effervesces with a drop of hydrochloric acid. Sedimentary; or if crystalline; metamorphic.

MICA SCHIST:

Mostly Mica, with much quartz and some Feldspar. Divides easily into wedge-shaped slabs. Color, from silvery to black. Crumbles readily. Metamorphic.

PORPHYRY:

A massive rock, showing crystals distinct from the matrix.

QUARTZITE:

Indurated Sandstone; that is, composed of quartz, but not showing grains.

SANDSTONE:

Merely a solidified bed of sand, generally quartz sand, sometimes contains mica, clay or fossils. Used for grindstones; building, etc.

SERPENTINE:

Massive, easily cut with a knife, and greasy to the touch. Dark green, to yellowish, and mottled. Composed of silicate of magnesia, and a little iron. Takes a high polish, and is called "marble."

STEATITE-SOAPSTONE:

Consists of Talc. Massive. Feels soapy. Gray to green and white.

SYENITE:

A rock composed of Hornblende, and Feldspar without quartz. Flesh colored or grayish white.

TALCOSE SCHIST:

Slaty Talc. Mica Schist is often mistaken for Talcose Schist, but does not contain Talc.

TRAP:

The common term for, basic Igneous rocks.

Igneous rocks frequently overflow, on the surface, but sometimes the fluid matter does not reach the open, until by the erosion, or planing away of the overlying strata, it is exposed, appearing often as a chimney. Faults, veins, tilting and all such phenomena are purely accidents on

SCALE, 1,000 feet = 1 inch.

a.—Crystalline limestone. c.—Limestone. e.—Trap overflow t.—Slates. F.—Quartzite. o.—Granite (Eruptive). m.—Gneisses (Metamorphic). N.—Tilted Slates. R.—Contact Vein. P.—2nd Vein. L.—1st Vein. V.—Newest Vein. x.—Stringer (diagrammatic.)

a large scale. An idea of their occurrence may be had by supposing a confined heap, composed of alternate layers of sand, gravel and clay, to have a body of quicklime in the centre and the lime to become mixed with water. The effect would be to fissure the heap in all directions, and cause portions to be lifted bodily, while other parts would naturally fall in, and the slaked liquid lime would fill all crevices.

PART III.

HOW TO DISTINGUISH ORES.

Qualitative Analysis:—is the determination of the elements contained in an ore or mineral, and shows what the different ingredients are, but does not show the amount of each.

Quantitative Analysis:—shows not only the nature of a compound, but also the amount, or percentage, of each constituent.

The ores of the metals are distinguished, and recognized, by their hardness; color; streak; lustre; malleability; specific gravity; crystallization; and chemical reactions; minerals having a definite chemical composition. The first five tests, are those which are of most practical use to the prospector, and most easily made in the fields.

Hardness:—This quality is particularly useful, in distinguishing many ores, (such as Copper Pyrites from Iron) and in deciding the possible value, of pebbles as gems, and many non-metallic minerals. This is the quality of resisting abrasion, *not* resistance to blows. The scale runs from 1 (represented by Talc); to 10 (represented by the Diamond).

SCALE OF HARDNESS.	CHAPMAN'S SCALE.
1. Foliated Talc.	1. Yields easily to the finger nail.
2. Selenite.	2. Does not yield to nail, or scratch a copper coin.
3. Calcite.	3. Scratches a coin, but is also scratched by coin.
4. Fluorite.	4. Not scratched by coin, and will not scratch window glass.
5. Apatite.	5. Scratches glass feebly; easily cut by a knife.
6. Feldspar.	6. Scratches glass easily, and is hard to cut with a knife.
7. Quartz.	7. Cannot be cut by a knife.
8. Topaz. 9. Corundum. 10. Diamond.	Harder than flint or quartz.

COLOR:—This is readily seen by daylight, and the terms used to designate it are metallic: as lead-gray; iron-black; etc., non-metallic: as blue, bluish; gray, grayish; etc., etc. All ores showing bright red, blue or green colors externally, should be examined carefully.

STREAK:—Both the external color, and a surface that has been scratched, should be examined. The latter is called the streak, and frequently shows a marked difference from the outside color. This is best examined by drawing a small three cornered file across the sample, and then across the thumb, or on a streak-plate.

MALLEABILITY:—This is the quality of being flattened out under the hammer without breaking. As a rule, any ore that is soft, and easily cut, is likely to be of value, and if it will stand being hammered out, it is valuable. Also a mineral is said to be brittle, when easily broken, or sectile, when it can be sliced with a knife.

LUSTRE:—The property of reflecting light, or shining. The kinds of lustre are:—vitreous or stoney; metallic; pearly; silky; resinous (or like gum); adamantine.

Many ores tarnish on exposure, and this serves, in some cases as a guide, in determining the ore.

DIAPHANIETY:—The property of allowing light to pass through, as; transparent, when an object is distinctly seen through the substance; translucent, when light is transmitted but objects are not seen.

SPECIFIC GRAVITY:—Is the weight of a piece of mineral compared with an equal bulk of pure water, which is taken as a standard. This is difficult to ascertain in the woods, requiring a delicate balance. Weigh a small piece of mineral in the ordinary manner, and then suspend it by a hair, in distilled water at 60° and weigh again, subtract the second weight from the first, and divide the first by the difference—result is Sp. G. Usually the weight of a substance is a good guide to the amount of metal contained in it.

MAGNETISM:—Many ores are more or less magnetic. Black Iron ore (Lodestone) is considered to be the only one having decided attraction, but Nickeliferous Pyrrhotite is sometimes so magnetic as to form a perfect natural compass. Some minerals will only attract the needle after being heated, the iron in these being changed to the magnetic oxide by ignition.

CRYSTALLIZATION:—While Form and Structure are of great service in the determination of minerals, crystallography is a complete study in itself, and does not fall within the scope of this work. Those who desire to pursue the study of mineralogy, should procure a copy, of the Manual of Mineralogy and Lithology, by Professor James D. Dana, or the larger work: A New System of Mineralogy by Messrs. J. D. and E. S. Dana.

The list in the following chapter, comprises most of the ores, from which metals are obtained for commercial purposes, at present, with the exception of those used in small quantities, or for other reasons, not of much interest to the ordinary prospector or business man.

Although the amount of metal in *pure* ore, is given, practically ores are never found sufficiently free from impurities, to come up to the proper standards and due allowance should be made. The specific gravity varies accordingly.

Note, that very few ores, look in the least like the metal they contain, even the native metals in a natural condition being tarnished and often alloyed.

A drop of Hydrochloric Acid serves to distinguish a carbonate, by causing an effervescence, but not always, without heating the substance, during the test.

THE BLOWPIPE:—This is a most useful aid in determining the different minerals. A brief description only, need be attempted here. Those who desire to follow up the hints given, are referred to Professor Chapman's "BLOWPIPE PRACTICE" a standard work on the Blowpipe.

The essentials are; a blowpipe, (which is merely a tapered tube ending in a very small orifice, by which the flame of a spirit lamp, or candle, may be concentrated on a minute quantity of the substance to be examined, in powder) pieces of charcoal; grease lamp; spirit lamp; alcohol; borax; carbonate of soda; platinum and iron wire; bone-ash, a few pieces of glass tube (about $\frac{1}{4}$ inch in diameter,) and a pair of small pointed forceps.

The Blowpipe may be had from any jeweler. A little practice, is necessary to maintain a steady stream of air from the mouth.

In making most tests the mineral is powdered and laid, either with, or without, an excess of soda, in a hollow in a piece of firm charcoal. The substance proves infusible, or fuses without yielding metal, sometimes vaporizes entirely, and again, leaves a coating on the charcoal, or a globule of metal. The flame, in some cases is tinged various colors, by different minerals, (this should be noted against a dark background.)

The coating or deposit left varies for different minerals and the colors change as the support cools. These deposits are best examined on a smooth piece of plaster of paris, used in place of the charcoal.

To test for water, place a little powdered mineral in the lower end of a test tube, (closed at one end) and heat; the moisture if any, will be found condensed at the upper part.

A piece of mineral the size of a pin head, is held in the forceps to try the fusibility.

Sulphur, Arsenic, and Selenium compounds, give off their peculiar odors. Arsenic smells like garlic. Selenium, like decaying horseradish.

To detect Sulphur, moisten a little mineral and soda into a paste; fuse and place on a silver coin. The sulphur, if present, will stain the coin black.

Gold, Silver, Copper, Tin, and Lead; yield malleable beads, either with or without soda.

Platinum, Iron, Nickel, and Cobalt, give infusible metallic grains. Bismuth and Antimony, brittle beads, with deposit. Mercury, Cadmium and Zinc, are volatilized, the two latter leaving heavy sublimates.

Manganese colors a bead of borax, (formed on platinum wire (No. 27); by making a small loop on one end and fusing the borax into it, and then taking up a very small particle of ore;) a violet color. Chromium, a green color.

Strontia, and Lithia, color the flame, deep carmine red.

THE MICROSCOPE.—By an examination of very thin slices of rock under the microscope, the presence, or absence, of many minerals is ascertained. The word Macroscopic is used to signify an examination, made without the use of the microscope, or with only a pocket lens.

The following abbreviations are used throughout this work: BB.=Before the Blowpipe. H. =Hardness. G.=Specific Gravity.

The following table contains all the elements at present known to the chemist, and all are found in minerals. The atomic weights indicate the proportions in which they combine chemically. The symbols are the abbreviations, used in stating the composition in all text-books.

LIST OF ELEMENTS, WITH THEIR SYMBOLS, AND ATOMIC WEIGHTS.

Aluminium	Al.	27.	Hydrogen	H.	1.
Antimony	Sb.	120.	Indium	In.	113.4
Arsenic	As.	74.9	Iodine	I.	126.5
Barium	Ba.	137.	Iridium	Ir.	192.5
Beryllium	Be.	9.1	Iron	Fe.	55.9
Bismuth	Bi.	207.5	Lanthanum	La.	138.
Boron	B.	10.9	Lead	Pb.	206.4
Bromine	Br.	79.8	Lithium	Li.	7.
Cadmium	Cd.	111.7	Magnesium	Mg.	24.
Cæsium	Cs.	58.7	Manganese	Mn.	54.8
Calcium	Ca.	39.9	Mercury	Hg.	199.8
Carbon	C.	12.	Molybdenum	Mo.	96.
Cerium	Ce.	141.	Nickel	Ni.	58.6
Chlorine	Cl.	35.4	Niobium	Nb.	93.7
Chromium	Cr.	52.5	Nitrogen	N.	14.
Cobalt	Co.	58.7	Osmium	Os.	191.
Columbium (see Niobium.)			Oxygen	O.	16.
Copper	Cu.	63.2	Palladium	Pd.	106.2
Didymium	Di.	142.	Phosphorus	P.	31.
Erbium	Er.	166.	Platinum	Pt.	194.3
Fluorine	F.	19.1	Potassium	K.	39.
Gallium	Ga.	69.9	Rhodium	Rh.	104.1
Germanium	Ge.	73.3	Rubidium	Rb.	85.2
Glucinum (see Beryllium.)			Ruthenium	Ru.	103.5
Gold	Au.	196.7	Scandium	Sc.	44.

Selenium	Se.	78.9	Tin	Sn.	117.4
Silicon	Si.	28.	Titanium	Ti.	48.
Silver	Ag.	107.7	Tungsten	W.	183.6
Sodium	Na.	23.	Uranium	U.	240.
Strontium	Sr.	87.3	Vanadium	V.	51.1
Sulphur	S.	32.	Ytterbium	Yt.	172.6
Tantalum	Ta.	182.	Yttrium	Y.	89.
Tellurium	Te.	125.	Zinc	Zn.	65.1
Thallium	Tl.	203.7	Zirconium	Zr.	90.4
Thorium	Th.	232.			

The chemist groups the various ores, according to their chemical characters, as: Sulphides; Arsenides; Borates; Carbonates; etc. As this work is intended, primarily, for the use of miners and business men, who are only interested, in the commercially valuable substances the ores contain, and care nothing about other constituents, save as they may affect those values; I have grouped each under the head of the metal, or other valuable ingredient, and have considered it better, also, to leave out any special mention of the undesired contents of the ore, except where the same affects the commercial value.

Acid rocks, or slags; are those which contain a high percentage of free silica; (60 to 80 per cent.) Basic; those slags, or rocks, which contain little (not more than 45 or 50 per cent.) or no silica, in a free state. In smelting, those ores which contain a very large percentage of silica, require to be neutralized, by mixing an alkali (such as limestone) in the furnace, while with basic ores, the opposite course, is pursued.

Miners call any mineral substance found in nature, which yields anything of commercial value, an ore. While, speaking mineralogically, Galena is always a lead ore, when rich in silver, the miner calls it a silver ore. More properly, ores are a combination of one or more metals, (called in this connection bases) with one, or more acids, or mineralizing agents;—thus: Galena consists of 86.6 per cent. of lead, with 13.4 per cent. of the acid sulphur. Very often, this is associated with some silver-sulphide, and again may contain zinc sulphide, or the ore may be a mixture of the above, with sulphides of copper, and iron. Again, we have iron in the form of a sulphide, (Magnetic Pyrites, or Pyrrhotite) and also as a bisulphide, when it is non-magnetic. In this latter case we have an ore, of which the valuable constituent, is the sulphur.

Minerals are often rendered difficult to treat, from the presence of some substance foreign to the ore, as for instance; a very small amount of Titanic acid, in iron oxides; which will effectually prevent their being utilized as a source of the metal by present processes. The presence of arsenic, replacing sulphur, in gold ores which carry considerable quantities of iron; renders their treatment much more difficult, and often, unprofitable. Antimony and Zinc are frequently very troublesome. The presence of these minerals causes the quicksilver to "flour," or "sicken," in which condition a coating forms over it, and prevents the gold from amalgamating, thus causing a loss of more or less metal in the tailings.

In testing any ore by the means here outlined, make the trials in the order mentioned, and allow a margin for slight variations, which will be found to exist almost invariably, even in samples from the same vein, blown out together. With the description of the ores will be found the simplest test or tests known, to distinguish or identify each, but they will only serve the purpose intended, when mixed with a sufficient portion of common sense.

PART IV.

NATIVE METALS AND ORES.

GOLD.

One cubic foot of Gold is worth, $363,561.96. Standard gold or silver, equals 900 parts of pure metal, and 100 of alloy, in 1,000 parts of coin.

The largest nugget of gold ever found was at Ballarat, Australia, in June, 1858. It was 20 x 9 inches; weighed 2,166 ounces, and contained $41,883 value of gold.

Pure Gold is estimated at 24 carats fine. Thus gold having one twenty-fourth part copper, or silver, would be 23 carat gold. Equal parts gold and another metal, would be 12 carat gold. All native gold, contains more or less silver, and sometimes other metals. Average of Canadian: between 85 and 90: Californian, 87 and 89: Australian, 90 and 96 per cent. gold.

Crystallizes in the isometric system, but crystals are seldom found.

COLOR:—Is the only, *yellow*, malleable, mineral found in a natural state. Many minerals, such as Pyrites, are mistaken for gold, but gold need never be mistaken for anything else. H.= 2.5-3. G.=19.3.; varying with amount of alloy. B.B. gives malleable bead. Is not touched by simple acids, but dissolves in Aqua Regia, which consists of one-fourth nitric to three-fourths hydrochloric acid.

Gold also occurs as a Telluride (combined with Tellurium); sometimes of a bronze-yellow color, and again of a lead-gray color.

In searching for gold, examine first the gravel bars, and the holes in the rocks, forming the beds of streams. Never waste time in looking in the upper part, of the gravel bed,—*get down to the bottom.* If the gold is there at all, that is where it will be found, along with platinum, iridosmine, magnetite, pyrite, copper ores, blende, zircon, heavy spar, monazite, and various crystals.

Carry with you a bottle of quicksilver. After picking out the coarse pebbles (carefully examining some of them by breaking them), place a shovel of the finer stuff, in a shallow circular pan;

FOR GRAVEL.

Fig. 1.

FOR QUARTZ.

Fig. 2.

SCALE, 1 inch=1 foot.

The best size and shape for a "pan" is shown in the cuts. Fig. 1 is the ordinary miner's pan for gravel washing. Fig. 2 is made of wood, or iron enameled white, and is better for quartz.

(a frying pan, free from grease, will do very well, on a pinch) and with a circular swing, wash it with water. A little practice will enable anyone to retain the finer, heavier, sand, and allow the lighter coarse stuff, to slip over the edge of the pan into the stream. When nothing remains, but a little black sand, examine with pocket lens for colors of gold, then put in another shovel of gravel, and repeat the process. Finally, after a number of shovels of gravel, taken from as many places as possible, have been so treated, put in some quicksilver, and thoroughly shake and rub the fines together, then pour the quicksilver into a piece of buckskin, and squeeze it through the buckskin back into a clean dish, to be returned to its bottle. Place the remainder on a shovel, and heat to redness. If you have anything malleable left it is gold, together with some silver, and any lead in the ore.

Next examine *all* quartz veins. The softer the quartz in appearance, the better the chance of its carrying gold. Though the writer has seen specimens of quartz, as clear and hard looking as glass, containing gold, it is a reasonable theory that when gold is present, it usually interferes with the perfect crystallization of the quartz. Quartz is called the "mother of gold," and all gold, so far as known, is derived from quartz veins. Those veins cutting talcose schists, or clay slates, are the most favorable, rather than mica schist, or gneiss. The gold is frequently so fine, as to be invisible except to a powerful microscope.

A small pestle, and mortar, are necessary, to crush the quartz to fine sand, which may be treated as above.

Another and better method of trying quartz is, to fill a piece of glass tubing, an inch in diameter, one-third full of the powdered rock, and shake it well with quicksilver. This is very convenient, and by marking the space occupied by a known weight of ore, a very close estimate may, after some practice, be made, of the quantity of free milling gold, the quartz in a given vein carries. Or the ore may be dissolved in Aqua Regia, and a solution of copperas added, when the gold will be precipitated as a brown powder, which, on being rubbed, will show the metal.

Mica, and sulphide of iron, (Pyrite), are most often mistaken for gold, but these are brittle minerals.

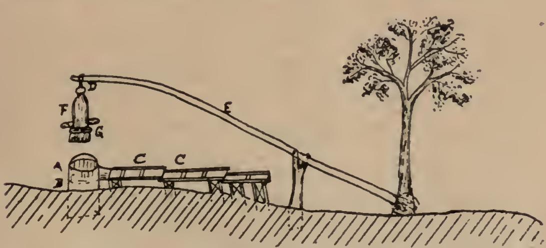
In known gold bearing territory, it is advisable to have an assay, of the quartz of *all* well-defined, persistent veins, as gold is frequently so fine, as to be invisible, even to a strong pocket lens.

"Gold is where you find it," is an old saying amongst miners, and no man may say it will not be found in a given locality; where the geological formations; subcrystalline slates, and schists; occur.

Very few veins carry visible gold, and they are seldom the most valuable. A free milling quartz, (by which is meant, an ore free from arsenic, or any other refractory substance, and amalgamating by simple contact with mercury,) carrying as low as $5.00 per ton, in gold, will pay handsomely if the vein is large, easily accessible, the metal evenly distributed, and easily milled.

A prospector should work a find of auriferous gravel, to some extent, before offering it for sale. He should sell a quartz lode, before working it, if he can find a purchaser, after sufficient development to show it as a fair prospect.

The following sketch shows a simple and cheap means of working in a small way, a rich quartz lode, carrying coarse gold freely. It is known as a "Dolly," and two men with this device, will crush enough ore each week, to give a very satisfactory "clean up" by Sunday.



A -Cushion bars. B. -Hollowed block. C.—Sluices. D.—Chain-hook. E.—Spring pole. F.—Dolly. G.—Iron shoe.

To make a "Dolly," cut a square hole, (in a hollow basin in the top of a solid block, or section of a log firmly planted on the bank of a stream), six inches wide; fit in wrought iron bars, six inches long, one-half inch thick, three inches deep, and firmly secured. Cut away a portion of one side, to which attach a spout leading over the higher end of a sluice-box. The sluices may be covered on the bottom, by strips of blankets, and should have cross-bars called riffles, nailed across the bottom sufficiently tight to hold fine sand. After having all as solid as may be, dump in some quartz, broken comparatively small, "swing your Dolly," and turn in more water at intervals, as you get "choked."

Placer mining is carried on by hand, washing with a pan, or with a "cradle," (a small trough on rockers); or by the use of streams of water under pressure, washing down the gravel, through sluices. This latter is called hydraulic mining.

Gold ores are treated in different ways, in all cases being first reduced, by stamping or grinding, to a fine pulp.

First.—In Freemilling; the ore is simply crushed under stamps, wet, and the pulp is passed over copper plates, with surfaces covered with mercury. The gold attaches itself to the quicksilvered surface, in the form of amalgam, that is combined with quicksilver, and is scraped off at intervals, retorted to get rid of the mercury, and the residue melted into bars.

In the Black Hills, with well arranged mills, ores carrying but $4.00 per ton are worked successfully, and in California, under exceptionally favorable conditions, ores having but $1.00 of gold contents. The ore in this case being quarried rather than mined.

By panning, or horning down, a pulverized sample the free gold may be seen, and by amalgamating, by rubbing with quicksilver, you may judge if the ore be freemilling.

Secondly.—By concentration; most gold ores carry other minerals, such as the sulphurets of iron and copper, or lead, also zinc, and sometimes tellurides, selenides, or antimonites, with in nearly every instance more or less silver. In these cases the ore is concentrated, that is, the rock matter is got rid of by washing, and the sulphurets obtained in a more or less "clean" state. For this purpose Frue vanner machines are chiefly used, two old style, or one improved machine, being usually allowed to each battery of five heavy stamps.

The principle of the Frue vanner concentrating machine is, an endless rubber belt, four feet wide, running up an inclined table, and dipping on the under side into a tank of water, where the mineral is washed off. At the head of the table jets of water, playing on the belt, wash back the lighter sand, and the water flowing down the incline washes it away. In addition there is a steady shaking motion from side to side, or, at right angles, which materially assists in the separation of the mineral from the gangue.

The concentrates can be sold to refining companies, (the most profitable way, in many cases), or may be further treated, and the gold obtained by chlorination or smelting.

In chlorination, the concentrates are placed, after roasting, to expel sulphur, arsenic, etc.; in gas-tight tubs, or barrels, holding two or three tons each, and chlorine gas is generated (by the introduction of chemicals; sulphuric acid, manganese oxide, and salt,) which is allowed to permeate the ore, and forms chlorides of gold, and silver. The metals are afterwards precipitated separately, the solutions run off, the metal collected, dried, melted, and cast into bars.

Or, the sulphide ores may be reduced by roasting, and amalgamating in pans, or by smelting direct. We have last year, to record another new process, which appears to be successful in treating mispickel ores; namely, those carrying a great deal of arsenic. This is known as the Carter-Walker process, by which the ore is roasted in closed chambers, the acids saved, and the gold obtained by vaporizing mercury.

Colonel Harvey Beckwith, the widely known expert on gold mining and milling, makes a favorable report on this process, which may possibly solve the difficult problem, of how to treat mispickel ores, carrying gold.

ANTIMONY.

This metal is used, chiefly, as an alloy. It is a brittle silver-white metal obtained from its ores, which occur in the primary rocks, frequently with silver, lead, zinc, and iron ores. G.=6.7.

The ore from which most of the metal of commerce is obtained, is the sulphide;

STIBNITE. GREY ANTIMONY.

Trimetric, commonly with fibrous appearance. Color and streak, lead-gray. Lustre, shining. Tarnishes. Brittle. H.=2. G.=4.5—4.62. Contains 71.8 per cent. of antimony; with 28.2 per cent. of sulphur. B.B. Is volatilized, with dense white fumes. 7.1 cubic feet=one ton. This ore is soft, and will melt in the flame of a candle.

NATIVE.—Generally massive, occasionally in rhombohedral crystals. Color and streak, tin-white. H.=3—3.5. G.=6.6—6.75. Pure Antimony; often with silver. B.B. volatilizes, tinging the flame green, and leaving a heavy white deposit on charcoal. 4.8 cubic feet in one ton.

Compounds of Antimony and Silver, are often met with, and when rich in silver make a valuable ore.

SILVER.

Is a pure white metal, very ductile, harder than gold, but softer than copper. G.=10.53.

The ores of silver are found in rocks of all geological ages, in any kind of vein below the coal measures. The ores are of many different kinds, and silver is found abundantly in many other ores, such as lead, antimony, zinc, and copper ores.

NATIVE SILVER—only, is *white* in color, among ores of silver, though dark and dull on the surface, and has streak, silver-white and shining. Often tarnished brownish-black. Malleable; cuts with knife. Occurs in octahedrons, arborescent shapes, or massive. H.=2—3. G.=10.1—11.1. Generally contains some copper, and sometimes gold. B.B. gives malleable bead.

ARGENTITE. **SILVER GLANCE.**

In dodecahedrons, and modifications, or massive. Color and streak, blackish lead-gray. Cuts with knife, slightly malleable. H.=2—2.5. G.=7—7.4. Contains 87.1 per cent. of silver, with 12.9 per cent. of sulphur. A valuable silver ore.

B.B. gives malleable bead of silver. 4.4 cubic feet make one ton.

PYRARGYRITE. **DARK RED SILVER ORE.**

Rhombohedral. Usually in crystals, sometimes massive. Color, black to bright red. Streak, bright red. Lustre, brilliant. H.=2—2.5. G.=5.7—5.9. Contains 59.8 per cent. silver; with 17.7 sulphur; and 22.5 per cent. of antimony. Usually in crystals. B.B. gives bead with soda. 5.5 cubic feet weigh one ton.

PROUSTITE. **LIGHT RED SILVER ORE.**

Like Pyrargyrite. G.=5.4—5.56. Contains 65.5 per cent. of silver; with the antimony replaced in part, or wholly, by arsenic. 5.8 cubic feet weigh one ton.

STEPHANITE. **BRITTLE BLACK SILVER.**

Trimetric; often in compound crystals, or massive. Color and streak, iron-black. H. = 2.5. G.=6.27. Contains 68.5 per cent. of silver; 16.2 of sulphur; and 15.3 of antimony. B.B. gives bead with soda. 5 cubic ft. weigh one ton.

Dissolved in weak nitric acid, will silver a piece of clean copper.

CERARGYRITE. **HORN SILVER.**

Isometric. In cubes, or massive. Color, gray, green, or blue. Lustre, resinous. Streak, shining. Cuts like horn or wax, and on an outcrop looks like dirty cement. Melts in candle flame. Contains 75.3 per cent. of silver; and 24.7 per cent. of chlorine. A valuable ore. B.B. gives bead easily.

BROMYRITE, OR BROMIC SILVER.—Silver and bromine. Bromine, 42.6 per cent. Silver, 57.4 per cent. A common ore.

There are many other ores of silver, but the above list comprises all the ores commonly worked.

Silver ores are treated by freemilling, or direct amalgamation in pans, each charge being worked for several hours, through a series of pans. This method is applicable to Native Silver; Horn Silver, and certain forms of sulphides. The presence of such base metals as Iron, Copper, Lead, Zinc, or Antimony, interferes with the process when concentration, and sometimes roasting-milling, or roasting the ore with salt, must be resorted to.

Silver mining requires expensive plant, and large capital, with expert management.

The simplest test for the presence of silver is: to dissolve the ore in nitric acid, and pour in strong salt water. This throws down white flakes, and on exposing these to the sun, they will turn black if the ore contain silver.

Have any ore suspected to contain silver assayed. On an average, at least $10 per ton as mined, is necessary to constitute a paying ore.

One cubic foot of silver is worth $13,008.67.

LEAD.

NATIVE.—Is a soft, bluish gray metal. Leaves a mark on paper. Malleable. B.B. fuses easily, and volatilizes, leaving a yellow ring on charcoal. Of rare occurrence. G.=11.85.

GALENA. **LEAD SULPHIDE.**

Isometric. In cubes, also granular, or rarely fibrous. Color and streak, lead-gray. Shining. Easily broken. H.=2.5. G.=7.25—7.7. Contains 86.6 per cent. of lead (when pure); 13.4 per cent. of sulphur; and from one or two to several thousand ounces of silver. B.B. covers charcoal with yellow deposit. If carefully treated, finally yields bead of lead. If bead be placed on a bone-ash cup, or a cavity in charcoal, filled with fine bone-ash, smoothly pressed in; and further treated, the lead will be absorbed, and the silver obtained nearly pure. 4.3 cubic feet weigh one ton. Galena is the chief source of lead.

MINIUM. **LEAD OXIDE.**

Color, red to yellow. Pulverulent. G.=4.6. B.B. yields bead of lead. Manufactured for the arts.

CERUSSITE. **WHITE LEAD ORE.**

Color, white to gray. H.=3.—3.5. G.=6.48.

Contains 75 per cent. lead, with oxygen, carbonic acid and impurities. Artificially made.

There are many other ores of lead, containing various amounts of silver, almost all of which, are found in association with galena, some abundant in certain localities, others of rare occurrence. All are distinguished at once, by specific gravity, and by yielding lead before the blowpipe.

Lead ores are valuable, in the proportion of their silver contents, but when worked for lead alone, should average not less than 40 per cent. of metal.

Lead ores carrying silver, are treated by concentration and smelting, or smelting alone. Like nickel, and copper, the first product or matte is frequently sold to refiners. The plant is necessarily costly, and all furnace operations depend for success, on skilful management by experts. Also, it is almost an essential, that a mixture of ores from different mines be made, and these must be carefully selected, and taken in certain proportions, which continually vary, for different ores. Fragments of lead ore, or heavy spar in crumbling magnesian limestone, depressions in a straight line, or the red color of the soil on the surface indicate lead veins, which are found in rocks of all ages up to the carboniferous, the largest being usually found in Silurian limestones overlying slates.

PLATINUM.

Is a bright, white metal, heavier than gold. It is used chiefly for chemical and electrical apparatus. G.=21.15 when pure.

NATIVE.—Color and streak, steel-gray. Lustre, metallic, bright. Isometric, but seldom in crystals. Can be drawn out. Malleable. H.=4—4.5. G.=16—19. Not touched by simple acids. Dissolves in Aqua Regia. Found in gravel, with gold, usually alloyed with other rare metals, and copper or iron. Derived from crystalline rocks. B. B. Infusible, and wholly unaltered; these qualities identify it at once. 2 cubic feet weigh one ton.

SPERRYLITE.—Color, tin-white. Lustre, bright. H.=about 7. G.=10.6. Contains 56.7 per cent. of Platinum. Crystals very minute. Found only in the Sudbury section of Ontario; in detritus composed of gossan, and rock in a decomposed condition, apparently derived from seams of ferruginous mica schist, with some copper pyrites.

The largest nugget of native platinum known was found in 1827, in the Ural mountains, and weighed 21 pounds. It measures 4 x 7 inches.

MERCURY.

Has a strong affinity for other metals, gold, silver, lead, etc., forming an amalgam. It is

Used to extract gold and silver; for mirrors, barometers, etc., and largely in medicine. Commonly called QUICKSILVER.

NATIVE.—Bright, white, and liquid, at normal temperature, melting at 39°. G.=13.6 at 32°. Occurs in globules scattered through the gangue, derived from the sulphide;

CINNABAR.—In rhombohedral crystals, or massive. Color, bright red, blackish or brownish. Lustre, unmetallic. Streak, scarlet-red. Crystals are nearly transparent. **LIVER ORE**;—Is dull, of same color and streak. H.=2—2.5. G.=8.5—9. It is identical with the brilliant red pigment, vermillion. B.B. vaporizes. 3.6 cubic feet weigh one ton. Can be cut with a knife. Contains 86.2 per cent. of mercury; and 13.8 per cent. of sulphur. Found in schists and slates, both the older rocks, and those of later age. Never found in quantity, in the more crystallized rocks, such as Gneiss. The mercury of commerce is obtained by distillation, although, it is sometimes dipped up in buckets, from fissures in the rocks containing the ores.

COPPER.

Is a very tough, ductile metal, of a fine red color, taking a bright polish, but quickly tarnishing. Used largely in the arts, both alone, and in brass and other alloys, also in plating. Large quantities are now used in electric railway plant.

NATIVE.—Isometric, and tree-like forms. Color, copper-red. Malleable. Can be drawn out. H.=2.5—3. G.=8.84. Pure copper occurring in veins; in grains, and masses: usually enriched where crossed by dykes. Sometimes accompanied by native silver, and occasionally spread out in floors. B.B. yields bead of copper, which shines brightly while hot, but becomes covered, on cooling, with black oxide. Dissolves easily in nitric acid. It is mined when yielding but one per cent. of copper.

CHALCOCITE. COPPER GLANCE.

Trimetric. In compound crystals, also massive. Color and streak, blackish to lead-gray, often tarnished blue, and green. H.=2.5—3. G.=5.5—5.8. Contains 79.8 per cent. copper; and 20.2 per cent. of sulphur. B.B. gives bead of copper. 5.7 cubic feet weigh one ton.

BORNITE. VARIEGATED PYRITES.

Isometric. Generally massive. Color, copper-red to pinchbeck-brown. Tarnishes rapidly. Streak, grayish-black, slightly shining. Brittle. H.=3. G.=5. Contains copper 55.58 per cent.; iron, 16.36 per cent.; with sulphur, 28.6 per cent.; but varies greatly. B. B. fuses to magnetic globule. Also called ERUBISCITE.

CHALCOPYRITE. PYRITES.

Dimetric. Generally in octohedral crystals, or massive. Color, brass-yellow. Streak, greenish-black, dull. H.=3.5—4. G.=4.15—4.3. Contains 34.6 per cent. of copper; 34.9 per cent. of sulphur; and 30.5 per cent. of iron. Will not scratch glass. B.B. gives brittle bead. 7.6 cubic feet weigh one ton. Should carry not less than six per cent. of metal, as mined, to make a profitable ore.

TETRAHEDRITE. GRAY COPPER ORE.

Isometric. In tetrahedral forms. Color, steel-gray, to iron-black, with streak inclined to red. H.=3—4.5. G.=4.5—5.12. Contains 91.9 per cent. of copper, but varies greatly, sometimes containing 10 per cent. to 30 per cent. of silver, with usually iron, zinc, and antimony. A valuable ore, and easily worked. B.B. gives bead of copper, or copper and silver. 6.6. cubic feet weigh one ton. Sometimes contains platinum.

CUPRITE. RED COPPER ORE.

Isometric. In octahedrons, or massive, sometimes earthy. Color, red, of various dark shades. Streak, brownish-red. Lustre, adamantine. Brittle. H.=3.5—4. G.=5.85—6.6. Contains 88.8 per cent. of copper, with 11.2 per cent. of oxygen. B.B. gives bead of copper. 5 cubic feet weigh one ton.

CHRYSOCOLLA. THE SILICATE.

Color, bright green. Lustre, shining or earthy. G.=2—2.4. Contains 30 per cent. to 35 per cent. of copper, with silica. A secondary deposit, but sometimes valuable. B.B. with soda, gives a bead of copper.

MALACHITE. GREEN CARBONATE.

This ore is polished, and used for inlaid work, and even jewellery. Colors, blue or green, of varying shades (deep blue to light green). Streak, paler. Soft ore, dull in appearance. Contains 56 per cent. of copper; 14 per cent. of oxygen; 22 per cent. of carbonic acid; and 8 per cent. of water. Not important as a source of metal. B.B. colors the flame green, and quickly yields metallic copper. 8.2 cubic feet weigh one ton.

AZURITE. BLUE CARBONATE.

Color, deep blue. Sometimes transparent. Streak, bluish. Brittle. H.=3.5—4.5. G.= 3.5—3.85. Used only for ornamental purposes.

Copper occurs, as arsenate, phosphate, vanadate, and in very many combinations, other than those described, which are the important ores to the miner.

Native copper is recognized at once. The ores are distinguished mainly by lively colors, and nearly all turn bright green on exposure, and B.B. tinge the flame green. The value of a find of any ore of copper depends *on the quantity*. The native metal veins are the paying mines, and always act on the compass. When the prospect of the deposit being large is satisfactory, get an assay. The ores of copper may sometimes be shipped to advantage, after simple concentration, and are readily purchased by refiners. There are several other ores, of little interest commercially.

Copper ores are reduced, by smelting, after concentration by hand or machines, and in the case of sulphide ores, a preliminary process of calcination, or roasting, is resorted to.

NICKEL, AND COBALT.

NICKEL.—Is a brilliant, white metal, which does not tarnish, and is very ductile. It is used chiefly as an alloy, and in plating.

COBALT,—Is a lustrous, reddish-gray metal, very brittle, and sometimes granular—sometimes fibrous. Is not used as a metal, except in plating, but mainly for the production of smalt, the blue coloring matter. Neither are found native.

NICKELIFEROUS PYRRHOTITE.—From this ore is obtained much of the nickel of commerce. It is identical with ordinary magnetic pyrites, save that it carries the nickel. The nickel at Sudbury, Ontario, is derived almost entirely, from this ore, which is intimately mixed with copper pyrites, and often contains besides the nickel; cobalt; occasionally a little galena; silver, or gold; and in at least one case, tin. Although the average nickel contents of the ore, is less than 2½ per cent., it runs as high as 30 per cent., and even 40 per cent., in certain samples. Anything over two per cent. in nickel will pay to mine, if in large quantities. **DIORITE**—(a tough, hard, greenish to black colored, eruptive rock); appears to be the true nickel-bearing rock at Sudbury, and the deposits of ore already discovered will supply all demands for the metal which are likely to be made for many years, while but a comparatively small section of the nickel-bearing area has been properly prospected.

Other ores of nickel, of which some are found in the Canada range, are:—

LINNAEITE. SULPHIDE OF COBALT AND NICKEL.

Isometric. Generally massive. Color, pale steel-gray, tarnishing copper-red. Streak, dark gray. H.=5.5. G.=4.8—5. Contains when pure, 58 per cent. of Cobalt, generally replaced in part by nickel, with 42 per cent. of sulphur. B.B. yields no metal, but colors borax bead deep blue. 6.5 cubic feet weigh one ton.

MILLERITE. CAPILLARY PYRITES.

Rhombohedral. Usually in needle-like crystals. Color, brass-yellow, to bronze-yellow, with gray tarnish. Streak, bright. H.=3—3.5. G.=4.6—5.65. Contains when pure; 64.4 per cent. of nickel, and 35.6 per cent. of sulphur. B.B. yields no metal. 6.2 cubic feet weigh one ton.

COBALTITE.

Isometric. Color, silver-white, with a reddish tinge. Streak, grayish-black. Brittle. H.=5.5. G.=6.63. Contains 45.2 per cent. of arsenic; 19.3 per cent. of sulphur; and 35.5 per cent. of cobalt; often with iron and copper. B.B. gives sulphur and arsenic fumes, with magnetic globule; with borax, a cobalt-blue bead.

SMALTITE. COBALT GLANCE.

Isometric. Occurs in many forms, often massive. Color, tin-white. Streak, dark gray. H.=5.5—6. G.=6.4—7.2. Contains from 22 per cent. each of nickel, and cobalt, to 44 per cent. of nickel alone, with 50 per cent. of arsenic, and some iron. B.B. yields no metal. 4.7 cubic feet weigh one ton.

NICCOLITE. COPPER NICKEL.

Hexagonal. Generally massive. Color, copper-red. Streak, brownish-red. Lustre, metallic. H.=5—5.5. G.=7.3—7.7. Contains 44 per cent. nickel, and 56 per cent. of arsenic. B.B. yields no metal. 4.2 cubic feet weigh one ton.

GERSDORFFITE.

Color, steel-gray. Streak, blackish-gray. Lustre, bright. H.=5.5. G.=5.6—6.9. Contains 35 per cent. of nickel, (sometimes more); 45 per cent. of arsenic; and 20 per cent. of sulphur. 5 cubic feet weigh one ton.

GARNIERITE. NICKEL SILICATE.

Color, green. Streak, uncolored. Yields 6 to 8 per cent. of nickel. Chiefly mined in New Caledonia; also found in Oregon, U.S.A.

The following new ores of nickel are reported by Dr. Emmens, from Sudbury, Canada.

FOLGERITE.

Massive, with platy structure. Color, bronze-yellow. Streak, greyish-black. Lustre, metallic. H.=3.5. G.=(approximately) 4.73. Contains 32.87 per cent. of nickel.

WHARTONITE.

Color, pale bronze-yellow. Streak, black. Lustre, metallic. Tarnishes rapidly on exposure. H.=about 4. G.=about 3.73. Contains 6.10 per cent. of nickel. 8 cubic feet weigh one ton.

BLUEITE. JACK'S TIN.

Color, olive-gray to bronze. Lustre, metallic. Streak, black. H.=3—3.5. G.=4.2. Non-magnetic. Contains 3.5 per cent. of nickel. Named after Mr. Archibald Blue, Director of Ontario Bureau of Mines.

ASBOLITE. EARTHY COBALT.

Color, black or blue-black. Contains over 20 per cent. of cobalt oxide. Occurs as a bog ore with manganese, iron and copper, and nickel.

There are many other ores of nickel and

cobalt, occurring rarely, or as products of other and more abundant ores. All occur in the lower formations, and cobalt ores, invariably, are found in connection with nickel.

Compounds of nickel before the blowpipe yield no metal, but leave a bead of borax, gray with specks of reduced nickel.

Cobalt and nickel ores are first smelted into a rich concentrate or matte, and then refined by the use of acids; in most cases. The ore as in copper, is when a sulphide, first roasted to expel the greater portion of the sulphur. The refining, when done with acids is a slow and costly process, but new methods are being successfully adopted, and it is probable that this will, in the near future, be done by electrolysis.

The mining and treating of these ores, requires large capital, and great skill is necessary to obtain economical results.

Smelting furnaces were formerly, built of common brick, and lined with fire-brick, whether blast furnaces, or reverberatory furnaces; but the American water jacket furnace, is to-day the ideal blast furnace, being built of cast iron, wrought iron, or mild steel, protected by an outer wall, or jacket, of the same material, through which a stream of water constantly circulates, thus protecting the furnace, so that, except for an accident, nothing compels a stoppage, unless for a general overhauling of the plant, at long intervals. The molten metal, and slag, is allowed to run constantly, as fused, into a water protected well, (on wheels, easily removed without stopping the operation), and thence, the metal, sinking by its greater gravity, is tapped into moulds or pots, while the lighter slag flows steadily from a spout at the top, and is removed in iron pots on wheels, or sometimes granulated by allowing it to drop into water.

By the introduction of a powerful blast, of hot or cold air, a great saving of fuel is effected, and a much greater capacity obtained. A furnace has lately been introduced which utilizes the sulphur contained in pyritic ores as fuel, thus making the ore smelt itself.

TIN.

Is a silvery white metal, of high lustre, and malleable, but not ductile, used in alloys, or as a coating for other metals.

There are but two ores of tin, and these occur usually in small veins of quartz. Tin is also obtained from gravel, and is then called Stream Tin. The veins occur in granite, gneiss, and mica slate, and the associated minerals are copper and iron pyrites. They are considered worth working, when but a few inches wide.

STANNITE. **BELL METAL ORE.**

Massive, or in grains. Color, steel-gray to iron-black. Streak, blackish. Brittle. H.=4. G.=4.3—4.6. Contains 27 per cent. of tin; 30 per cent. of sulphur; 30 per cent. of copper, and 13 per cent. of iron. Found sparingly, hardly to be called an ore of tin, and oftener worked for copper. 7.2 cubic feet make one ton of ore.

CASSITERITE. **TIN ORE.**

Dimetric. Crystals often compounded. Also massive, and in grains. Color, brown to black. Streak, gray to brownish. Lustre, shining. H. =6.—7. G.=6.4—7.1. Its high specific gravity is characteristic. Contains 78.67 per cent. of tin, and 21.33 per cent. of oxygen. B.B. with soda gives bead of tin.

Looks like blende, or a dark garnet. Very hard, will strike sparks with steel. 4.7 cubic feet weigh one ton. Mined chiefly in Cornwall. The Cornish mines were worked in Roman times, and are now very deep. The tin veins in Dakota, U.S., are gold-bearing, and the formation is quartzite, sandstone, and slate, overlying granite. Phosphate minerals also, occur abundantly.

BISMUTH.

NATIVE.—Rhombohedral. Generally massive. Color and streak, silver white, with slight red tinge. Tarnishes. May be hammered out a little when heated, but is brittle when cold. H.=2—2.5. G.=9.7—9.8. B.B. fuses very easily, vaporizes, and leaves a dark yellow coating on charcoal, which becomes paler on cooling. Pure Bismuth, 3.2 cubic feet weigh one ton. Found with ores of silver, cobalt, and gold. Used chiefly as an ingredient in fusible metal, also in medicine, and as a pigment. Bismuth occurs in several other ores. Found in same formations as copper. Occurring in gneiss and other crystalline rocks.

CADMIUM.

This metal is white like tin, but so soft it leaves a mark on paper. Used as a solder (with tin) for aluminum. There is but one ore:

GREENOCKITE; THE SULPHIDE.—In hexagonal prisms. Color, light yellow. Lustre, brilliant; nearly transparent. H.=3—3.5. G.=4.8—5. B.B. fuses easily, and leaves, if fused on a piece of plaster of paris, a dark brown, or reddish brown deposit. 6.5 cubic feet weigh one ton.

Cadmium is often associated with zinc ores.

ZINC.

A brittle, bluish-white metal, crystalline, and very lustrous on fresh broken surface. Used with copper, to make brass; as roofing sheets; and as paint; also to coat iron (galvanized.) B.B. covers charcoal with zinc oxide, yellow while hot, white when cold.

SPHALERITE. BLENDE.

Isometric. Generally massive; rarely fibrous. Various colors. Streak, white to reddish brown. Cleavage perfect. Waxy. Brittle. H.=3.5—4. G.=3.9—4.2. Contains 67 per cent. of zinc; 33 per cent. of sulphur. B.B. nearly infusible. Looks like pieces of resin or dirty gum. 8 cubic feet weigh one ton. Known as BLACK JACK.

ZINCITE. RED ZINC ORE.

Hexagonal. Usually in separate grains. Color, bright red. Streak, orange. Lustre, brilliant; translucent. Foliated like Mica. H.=4—4.5. G. =5.4—5.7. Contains 80.3 per cent. of zinc; and 19.7 per cent. of oxygen. B.B. gives no bead, but fuses with borax, and leaves a coating on coal. 5.8 cubic feet weigh one ton. A valuable zinc ore.

SMITHSONITE. CARBONATE OF ZINC.

Rhombohedral. Usually massive. Color, impure white, green or brown. Streak, uncolored. Lustre, stony. Translucent. Brittle. H.=5. G.=4.3—4.45. Contains about 52 per cent. of zinc, with often some Cadmium. B.B. infusible alone, but with soda leaves a deposit on charcoal, which moistened with nitrate of cobalt, turns green.

CALAMINE. DRYBONE.

Trimetric. Usually massive. Color, white, bluish, grayish, or brownish. Streak, uncolored, Lustre, vitreous. Nearly transparent. Brittle. H.=4.5—5. G.=3.16—3.9. Contains 67.5 per cent. of zinc oxide; 25 per cent. of silica; and 7.5 per cent. of water. B.B. almost infusible. Yields no metal, but acts same as Smithsonite. 10 cubic feet weigh one ton.

Zinc ores occur in rocks of all ages, generally associated with lead ores, and often with copper, iron, tin and silver. There are various ores of zinc not of much value, as a source of the metal. It is often a detrimental substance in gold and silver mines, making the ore difficult to treat. The metal is obtained by distillation in retorts of various forms. The furnaces, and accessories, require considerable capital, and skilled management.

IRON.

NATIVE.—Found in the metallic state in meteorites, and occasionally, in grains in some rocks, but never in commercial quantity, unless we except, some masses of a ton weight found in Sweden.

PYRITE. **NON-MAGNETIC ORE.**

Isometric. Usually in cubes, or massive. Color, brass—yellow. Streak, brownish-black. Lustre, of crystals, brilliant. Brittle. H.=6—6.5. G.=4.8—5.1. B.B. yields no metal, but a magnetic globule. Contains 46.7 per cent. of iron; and 53.3 per cent. of sulphur, which latter constitutes the valuable part of this ore, being used to obtain the sulphuric acid of commerce. Will scratch glass. 6.5 cubic feet equal one ton.

PYRRHOTITE. MAGNETIC PYRITES.

Hexagonal. Generally massive. Color, between bronze-yellow and copper-red. Streak, grayish-black. Often with dark tarnish. H.=3.5—4.5. G.=4.4—4.65. B.B. yields no metal, but changes to the red oxide. Contains 60.5 per cent. of iron; 39.5 per cent. of sulphur. Tarnishes easily. Valuable as an ore of nickel. (See under head of *Nickel*.) Also used to make green vitrol. 7.1 cubic feet equal one ton.

ARSENOPYRITE. MISPICKEL.

Trimetric. Also occurs massive. Color, silver-white. Streak, grayish-black. Lustre, shining. Brittle. H.=5.5—6. G.=6.3. B.B. yields no metal, but fumes of arsenic, which have the odor of garlic, and may be perceived on striking the ore smartly with a hammer. 5 cubic feet equal one ton. Contains 46 per cent. of arsenic (which is its valuable constituent); 19.6 per cent. of sulphur; and 34.4 per cent. of iron. Sometimes it is rich in gold, but until recently this could not be profitably extracted, owing to the difficulty of getting rid of the arsenic, which prevented its successful treatment. Now, however, with lately perfected processes, it is possible to treat the most arsenical ores economically, and prospectors should have mispickel ores examined for gold. None of the above ores are used for the making of iron and steel.

HEMATITE. SPECULAR IRON ORE.

Under this and following heads are included most of the ores from which pig iron and steel are made. Varieties are: micaceous, red hematite, red chalk, clay iron stone. Rhombohedral, massive, granular, sometimes micaceous, also earthy. Color, red, steel-gray or iron-black. Streak, cherry-red, or reddish brown. Hardness varies; from 6.5 down to earthy ores. Contains 70 per cent. of metallic iron; (when pure); and 30 per cent. of oxygen. B.B. infusible. The streak will identify this ore under all its forms. The darker the ore the *redder* the streak. Not magnetic before heating unless it contains magnetite. 6.6 cubic feet equal one ton.

A Bessemer ore, (by which is meant, an ore suitable for the manufacture of steel by the Bessemer process, now chiefly employed) should be practically free from sulphur, and phosphorus, and entirely free from titanic acid. The higher the percentage of metallic iron the more valuable the ore, anything over 60 per cent. being high grade.

MAGNETITE. MAGNETIC IRON ORE.

Isometric. Massive; also granular. Color, iron-black. Streak, black. H.=5.5—6.5. G.= 5—5.1. Contains (when pure) 72.4 per cent. of metallic iron; and 27.6 per cent. of oxygen. B.B. infusible. 6.4 cubic feet equal one ton. Strongly magnetic, so much so that deposits are frequently discovered by the variation of the compass. If your compass wavers, and inclines to point very much east or west, look for iron along the nearest contact. By means of a dip-needle (a magnetic needle suspended to swing freely up and down between two pivots, instead of round, on one, like the compass;) the ore deposit may be found *when no exposure exists*, but a very magnetic ore will cause the needle to turn completely over when in small quantities, and in some cases it is very misleading. An expert in the use of the needle can get surprisingly accurate knowledge of a deposit, even when covered by many feet of barren rock. An attraction confined to a few feet, is apt to be caused by a boulder. If it continues *along the strike* it indicates a lode. A continuous attraction is better evidence of value than a strong one. Sometimes found, as a black sand. Often in quartz veins, distributed in small pieces through the vein, but not in commercially valuable quantity, and such veins seldom contain *any* ore of value.

LODESTONE.—Some specimens are natural magnets. Place a piece on a light chip of wood floating in a basin of water, and it will turn north and south, being a natural compass.

FRANKLINITE.

Isometric; also massive. Color, iron-black. Streak, reddish-brown. Brittle. H.=5.5—6.5. G.=4.5—5.1. Usually magnetic, but less so than magnetite. Formula, like magnetite, but with part of iron replaced by zinc and manganese. B.B. with soda on charcoal, gives zinc coating. Occurs in large deposits.

LIMONITE. **BROWN HEMATITE.**

Massive; with smooth surface, or spongy. Color, dark brown to ochre-yellow. Streak, light brown to dull yellow. H.=5—5.5. G.=3.6—4. Various forms; from a hard clay ironstone, to yellow and brown ochre. Same as hematite, but contains 14 per cent. of water. 8.4 cubic feet equal one ton of ore.

BOG ORE.

This occurs in low ground, and is of considerable value; furnishing large quantities of iron, though chiefly used, by local furnaces, and for fluxing more difficult ores. Contains, when pure, about two-thirds its weight of iron. Occurs in beds a few feet deep, spread over larger or smaller areas.

SIDERITE. **SPATHIC IRON.**

Rhombohedral. Usually massive, and foliated. Color, light grayish to brownish-red. Streak, uncolored. H.=3.—4.5. G.=3.7—3.9. Contains 62.1 per cent. of iron protoxide. Often with manganese. B.B. infusible, but becomes magnetic. 8.4 cubic feet equal one ton. Used largely for the manufacture of iron and steel, and found in many rocks, gneiss, mica schist, and clayslate.

CHROMITE. **CHROMIC IRON.**

Isometric. Usually massive, with rough surface. Color, iron-black to brownish-black. Streak, dark brown. Lustre, submetallic or dull. H.=5.5. G.=4.3—4.6. Slightly magnetic. B.B. fusible with borax. Nearly the same as magnetite, but contains Chromium. 7 cubic feet equal one ton. Used largely as paint.

Iron occurs in nature in endless combinations, but the above ores include all of interest (as iron) to commerce. B.B. all iron ores become magnetic, and some contain manganese and zinc, as mentioned above.

The metal iron is obtained from its oxide ores, by smelting in blast furnaces, with limestone as a flux, the plants being of large capacity, and requiring very large capital for their successful operation. Steel, is made chiefly by the Bessemer process of forcing air upward through the molten metal, in open crucibles, no further fuel being required. Coke is the usual fuel used in smelting, but large quantities of iron are made with charcoal, and for some purposes, the iron so made, is superior to any other. In any case a mixture of ores is required.

The value of a deposit depends, after quality is proved, on its being of great extent, and within easy reach of shipping facilities. An iron mine filling *all* the above conditions, is possibly, the best investment to be got. (See also, Iron Rocks page 19.)

MANGANESE.

Is never used as a metal in the pure state, but is used chiefly as a source of oxygen. It is largely used in the arts for bleaching, clearing glass, and many other purposes. It is never found in the metallic state. B.B. the ores yield no metal, but color a borax bead violet.

PYROLUSITE.

Trimetric. Massive, sometimes fibrous. Color, iron-black. Streak, black. H.=2—2.5 G.=4.8. Contains 63.2 per cent. of manganese; 36.8 per cent. of oxygen. 6.6 cubic feet equal one ton. This ore is now used as a source of oxygen, for illuminating purposes.

PSILOMELANE.

Occurs massive. Color, black or greenish-black. Streak, reddish-black and shining. H.=

5—6. G.=4—4.4. Contains nearly same amount of manganese as pyrolusite, but varies, and contains some baryta or potassa. 7.6 cubic feet equal one ton.

WAD. **BOG ORE.**

Massive, or earthy. Color, and streak, black or brownish-black. H.=1—6. G.=3—4. Earthy, soils the fingers. 9.1 cubic feet equal one ton. Used as a paint, and sometimes consists of irregular globules in beds, a foot or more in depth, mixed with soil.

RHODOCHROSITE. **MANGANESE CARBONATE.**

Rhombohedral. Color, rose-red. Cleaves like Calcite. H.=3.5—4.5. G.=3.4—3.7. Contains 61.4 per cent. of manganese protoxide; and 38.6 per cent. of carbonic acid, with part of manganese often replaced by calcium, magnesium, or iron.

The ores are found in same formations, and under same conditions as iron, and also *containing silver*, which makes a very valuable ore, and one easily worked.

MOLYBDENUM.

MOLYBDENITE; THE SULPHIDE.—Hexagonal, in plates, or masses foliated in thin plates like tinfoil. Color and streak, lead-gray, the streak with green tinge. Lustre, bright on fresh cleavage. H.=1—1.5. G.=4.5—4.8. B.B. infusible, but gives fumes of sulphur. 6.9 cubic feet of pure molybdenite equal one ton.

This ore is used but little, chiefly in the preparation of a blue color, and is sometimes mistaken for graphite (blacklead), which it resembles, but from which it is easily distinguished, as graphite leaves a black mark on paper, while molybdenite has a greenish-black streak, which is best seen by drawing a piece across a china or other plate. Occurs in crystalline rocks, but sparingly; also with lead and copper ores. Contains 59 per cent. of molybdenum; and 41 per cent. of sulphur.

GRAPHITE.

PLUMBAGO. **BLACKLEAD.**

Hexagonal. Usually foliated, also massive. Color, black to steel-gray. Streak, as a common *lead* pencil. Lustre, metallic. H.=1—2. G.= 2.25—2.27. Soils the fingers, and feels greasy. Contains 95 to 99 per cent. of carbon. B.B. infusible. Not touched by acids. 13.9 cubic feet of pure graphite equal one ton. Largely used in the manufacture of pencils, crucibles, stove polish, and lubricants for heavy machinery. Also in electric lighting, plating, etc.

Commonly called blacklead. Found chiefly in crystalline limestone, also in gneiss, and mica schist, and generally forms only a small percentage of the ore, distributed evenly throughout the gangue in specks; or in masses of all sizes. A valuable mineral when pure. Such impurities as lime, and iron, destroy its value. Test for lime with hydrochloric acid.

TELLURIUM.

NATIVE.—Hexagonal. Commonly massive. Color, and streak, tin-white. Brittle. H.=2—2.5. G. =6.1—6.3. B.B. fuses, tinges the flame green, and volatilizes. 5.4 cubic feet equal one ton. Also obtained in combination with silver, and lead ores, which is the chief source of supply.

RARE METALS.

Certain rare metals mentioned below, are quoted at high prices in price lists of chemicals, and people are led to believe that they exist as mines. Some *are* found native, but the cause of their being seldom used, and high-priced is in most cases the great expense attending their extraction, and reduction, to the metallic state, or their scarcity. Those usually mentioned are not of much interest, except to chemists. There is but a very limited market for any metal so priced, even if a quantity should be found. **BARIUM** exists in nature as baryta (or heavy spar) a sulphate, (described in part V.) **MAGNESIUM** is a very light, tough, white metal, never found native. **PALLADIUM** is a malleable, steel-gray metal, inclining to white, found native, with some platinum, and iridium, generally in small grains, in gold diggings, and occasionally native gold is alloyed with palladium. **RHODIUM** is found as an alloy with gold. **IRIDOSMINE** is a compound of **IRIDIUM** and **OSMIUM**, occurring usually in small flat grains. H.=6.7. G.=19.5—21. Slightly malleable, and used for points to gold pens. **SODIUM** is the metallic base of common salt, (Chloride of Sodium). **URANIUM** is the metallic base of pitchblende; never found native. (See under Pitchblende.)

There are many other metals known only to chemists, or rarely used, whether native or artificially extracted. None are of interest to commercial mining.

PART V.

OTHER MINERALS OF COMMERCIAL VALUE.

We have now, briefly described, the chief ores from which metals of commerce are extracted, and as such, of greatest interest to the general public.

ALUMINIUM.

Is a metal of great promise, being only one-third as heavy as iron, of great tensile strength (26,000 pounds against 16,500 pounds for cast iron, per inch) and hardness, a beautiful white color, with no taste or odor, not liable to tarnish or corrode, and taking a polish which is not excelled by any other metal, yet it is not of special interest to prospectors, being the base of clays, and therefore, the most abundant of all metals. Its price depends purely on the discovery of cheaper methods of extraction. A cubic foot weighs but 163 pounds, while iron weighs 487, and gold 1206 pounds per cubic foot.

The most valuable source of aluminium, at present (and likely to remain the most valuable until new processes of extraction are developed) is an ore called:

BAUXITE; This mineral is a soft granular, compact, iron-stained clay, and the color is white to brown or reddish, or sometimes bluish. G.= 2.55. It is a hydrated sesqui-oxide of aluminium and iron, soluble in sulphuric acid. A find of value.

CORUNDUM. **EMERY.**

Occurs of many colors, blue, red, etc. H.= 9, or next the diamond. G.=3.9—4.1. An oxide of aluminium.

When in clear blue crystals forms the gem called Sapphire. When crystals are red they are called Rubies. (See under Precious Stones.)

Found chiefly in mica schist, and granular limestone.

The variety having bluish-gray and blackish colors, is called EMERY. Used very extensively, as a polishing material in the shape of powder. Distinguished at once by its hardness.

ALUM SHALE.—The alum of commerce is obtained from shale, or some rock containing alunogen or other alum bearing mineral, by heating the rock in lumps to produce aluminium sulphate. This is then lixiviated in stone cisterns, the lye concentrated by evaporation, and potassium added to the last solution. On cooling the alum crystallizes out.

COMMON FELDSPAR. **ORTHOCLASE.**

Monoclinic. Usually in thick prisms, and massive, granular, or fine grained. Not striated.

Color, white or flesh-red, sometimes greenish-white. Translucent to opaque. B.B. fuses with difficulty. Not touched by acids. Moonstone and Sunstone are varieties. Contains 64.7 per cent. of silica; 18.4 per cent. of aluminium; and 16.9 per cent. of potash. Largely used in the manufacture of chinaware.

CRYOLITE.—This is a peculiar, translucent, snow-white compound. H.=2.5. G.=2.95—3. Contains 12.8 per cent. of aluminium; 32.8 per cent. of sodium; and 54.4 per cent. of fluorine. Used as a source of aluminium, and its salts; soda; and an opaque white glass. Melts easily in the flame of a candle.

KAOLIN. **CHINA CLAY.**

This is a clay derived from the decomposition of feldspar, and used in the manufacture of fine chinaware. A good deposit of this clay, easily accessible, and free of grit or iron, is a find of value. Soapy to the touch. Insoluble in acids. It is one of the essentials in a good clay for any purpose, but is rarely met with in a pure condition fit for the above use.

To try the quality of the clay, wet a little in a white dish and observe that in a good article, it does not turn darker. Also observe that it is not "gritty," but an analysis is needed to test it, and even that will not fully prove its value. B.B. will turn from white to brown if it contains iron.

FIRE-CLAY.—Pure, unctuous clay, with about 45 to 60 per cent. of silica, and free, or almost free from soda, potash, or alkaline earth. Found generally, underlying coal seams.

POTTERS CLAY.—Must be plastic, and free from iron, and usually contains some free silica.

MARL.—Clay containing much carbonate of lime; from 40 to 50 per cent. Sometimes contains many shells, or fragments of shells. Used as a fertilizer.

SHALE.—Is an indurated compressed clay, and is often ground and extensively used for bricks, tile, etc. For vitrified bricks, a clay, or shale is required with a high fusion point, but capable of incipient fusion, to an extent which will close up the pores, so as to completely prevent the absorption of water, before the material absolutely melts.

MEERSCHAUM. **SEPIOLITE.**

Color, white or creamy, sometimes bluish-green. Compact, of a fine earthy texture, with a smooth feel. H.=2—2.5. Floats on water. Contains 60.8 per cent. of silica; 27.1 per cent. of magnesia; and 12.1 per cent. of water. B.B. infusible, gives much water, and a pink color, with cobalt solution. Occurs in masses in stratified earth deposits. Used for pipe-bowls.

MANGANESE SPAR. FOWLERITE.

Color, reddish (usually deep flesh-red), also brown, greenish, or yellowish, sometimes black on surface. Streak, uncolored. Lustre, stony; transparent to opaque. H.=5.5—6.5. G.=3.4—3.7. Contains 45.9 per cent. of silica; and 54.1 per cent. of manganese protoxide. B.B. becomes dark brown, and with borax, bead is deep violet when hot, and reddish brown when cold. Looks like feldspar, but is heavier. Used in making a violet colored glass, and a colored glaze on stoneware. Takes a high polish, and makes a handsome ornamental stone.

FLUORSPAR. FLUORITE.

Occurs commonly in crystals, or compact. In bright colors, resembles some gems, but is distinguished by its easy cleavage and softness. Colors are white, or light green, purple or clear yellow, also rarely rose-red or sky-blue. Transparent or translucent. H.=4. G.=3—3.25. Brittle. Consists of 48.7 per cent. of Fluorine; and 51.3 per cent. of calcium. B.B. decrepitates and fuses to an enamel.

When massive receives a high polish, and is made into vases, candlesticks, etc., and sold under the name of DERBYSHIRE SPAR. Hydrofluoric acid, with which glass is etched, is obtained from fluorspar; also used as a flux for copper and other ores, hence the name fluor.

CALCIUM.

APATITE. **PHOSPHATE OF LIME.**

Hexagonal. Commonly in six-sided prisms. Color, green of various shades, sometimes yellow, blue, and reddish or brownish. Streak, always white. Generally occurs in crystals, but sometimes massive. H.=5. G.=3—3.25. Brittle. Lustre, stony. 10 cubic feet weigh one ton. B.B. moistened with sulphuric acid tinges the flame bluish-green, without the acid, reddish-yellow. Occurs in pyroxene; crystalline limestone; hornblende gneiss; and mica schist.

Used extensively as a fertilizer. Distinguished from feldspar by trial of hardness.

GYPSUM. **LAND PLASTER.**

This is a hydrous sulphate of Lime. It is used on land, for agricultural purposes, and as a plaster for walls. H.=1.5—2. G.=2.33. B.B. becomes white at once and exfoliates, then fuses. When pure white it is called—ALABASTER; when transparent—SELENITE; when fibrous—SATIN SPAR; when burned and ground it is PLASTER OF PARIS. Found in thick seams in limestone and clay beds.

MARBLE.

Crystalline limestone, or dolomite, susceptible of a fine polish, is marble. Colors are: white, pink, red, mottled, yellow, bronze, and black. Massive. Serpentine is sometimes called marble.

LITHOGRAPHIC LIMESTONE.

Is a compact, fine grained limestone. If free from grit, and other impurities, makes a valuable quarry.

HYDRAULIC LIMESTONE.

An impure limestone, containing silica and alumina, which on being burned affords a cement which will *set under water*. Contains 15 to 25 per cent. of clay.

BARIUM.

BARITE. HEAVY SPAR.

Color, white, and yellowish, or reddish. Transparent or translucent. Lustre, vitreous or pearly. H.=2.5—3.5. G.=4.3—4.7. B.B. fuses, and imparts a green tinge to flame. After fusion with soda, stains silver coin black. When ground, is used to adulterate white lead. Found in veins, generally with lead, as part of the gangue. 7.1 cubic feet weigh one ton.

CELESTITE. STRONTIUM SULPHATE.

Trimetric. In rhombic crystals, with distinct cleavage. Color, clear white, tinged with blue, or reddish. Lustre, vitreous. Brittle. Nearly transparent. H.=3—3.5. G.=3.9—4. B. B. decrepitates, tinging flame bright red, and fuses.

With soda blackens silver coin. Contains 56.4 per cent. of strontia which is used to obtain the red color in fireworks. Found in sandstone and limestone rocks. Is sometimes fibrous.

SODIUM.

ROCK SALT. **CHLORIDE OF SODIUM.**

Colorless, or colored (by accidental impurities, such as iron,) red, brown, pale blue, yellow, or green. Streak, white. H.=2—2.5. G.=2—2.25. Tastes strongly saline. Contains 39.30 per cent. of sodium; and 60.66 per cent. of chlorine, but most samples contain clay, and a little lime and magnesia. B.B. flies to pieces, and melts into a bead which colors the flame yellow. It is obtained by sinking wells, from which the brine is pumped and evaporated in large pans, or by mining, the same as for any other ore.

THORIUM.

MONAZITE.

This mineral is a phosphate containing cerium, lanthanum, yttrium, didymium and THORIUM, which latter is now used in making an improved gaslight. Color, brown to brownish-red. Subtransparent to nearly opaque. Lustre, vitreous to resinous. Brittle. H.=5. G.=4.8—5.1. Occurs in crystals. It is mined, the same as placer gold, from sand or gravel beds. B.B. colors the flame green when moistened with sulphuric acid.

TALC.

STEATITE. **SOAPSTONE.**

Trimetric. Foliated or massive. Color, light green or shining white. Sometimes dark green. H.=1.15. G.=2.5—2.8. A silicate of magnesia. It is easily cut. The greenish colored massive variety of talc.

POTSTONE: is impure soapstone of dark color and slaty structure. FRENCH CHALK is a milk-white kind. Soft and greasy to the touch. B.B. infusible.

FOLIATED TALC.—Pure foliated talc of white, or greenish-white color.

Soapstone is cut with a saw, and turned in a lathe, without difficulty. Used for gas-jets, and for various purposes. Takes a fine polish after being heated. Also used to adulterate soap; as a face powder; and as a filling for paper.

AMPHIBOLE.

HORNBLENDE.

Occurs generally as a massive rock, but occasionally in fibrous form, as:

ASBESTOS.—Color, green or white. Fibrous. A hydrous silicate of magnesia. May be spun into fine threads, by separating the fibres into a silky mass, and then twisting it, with the fingers. Used to cover steam-pipes, etc., in the form of rough cloth, and for many purposes requiring an incombustible material. Occurs in seams from half an inch to several inches in width, running parallel, or crossing one another, the width of each seam making the length of the fibre.

ACTINOLITE.—The long-bladed greenish variety. Used for fireproof material, chiefly roofing, with tar, or asphalt.

MICA.

MUSCOVITE. **COMMON MICA.**

Monoclinic. In crystals, splitting easily into sheets, or in scales. Color, white, green, brown to black. Transparent, tough and elastic. H.=2—2.5. G.=2.7.—3. This mineral is extensively used in sheets, and ground. In sheets it is used for stoves, standing a great heat; and for insulating purposes in electrical plants. Ground; it is used as a lubricant, and in making ornamental and fire-proof paint. The pure white in large sheets (3 x 3 and upward) is most valuable, but the amber is as good value for electrical purposes. When spotted it is of little or no value. B.B. whitens, but does not fuse except on thin edges. Light colored micas are mostly Muscovite; black, Biotite.

LITHIA MICA. **LEPIDOLITE.**

Color, rose-red, and lilac to white. In small plates, and aggregations of scales. Contains 2 to 5 per cent. of the metal Lithium.

LITHIUM.—Is a soft, whitish, metal, of very light specific gravity, and considerable tenacity. It is very fusible. Used in an alloy with tin, and lead, as a solder. Lithia is also found as a phosphate, in:

TRIPHYLITE.—A mineral having H.=5. G.= 3.50. Streak, grayish-white, and lustre, sub-resinous. B.B. any mineral containing lithia colors the flame a beautiful deep crimson.

SULPHUR.

This acid is found as the mineralizing agent of many metallic ores, and is chiefly obtained for commercial purposes from:

NATIVE SULPHUR.—Color and streak, sulphur-yellow, or sometimes orange-yellow. Lustre, resinous. Transparent to translucent. Brittle. H.= 1.5 to 2.5. G.=2.07. Burns with a blue flame and sulphurous odor. Pure sulphur, or contaminated with clay, or pitch. Found in beds of gypsum, or the vicinity of volcanoes, active or extinct. Purified, it is the sulphur of commerce, which is also obtained largely from copper and iron pyrites, from which ores

SULPHURIC ACID.—is also manufactured (the non-magnetic ores being preferred for this purpose), making veins of these ores valuable. It is known as Oil of Vitriol. The uses of sulphur for gunpowder, blacking, and medicine are well known.

PHOSPHOROUS.

This is also an acid, frequently found combined with lime, forming the valuable mineral APATITE; also with copper, lead, etc., and is very injurious in iron ores. B.B. may be detected by moistening the assay with sulphuric acid, when the flame is tinged green. It is a white, waxy substance, when refined, and very poisonous. Used in the arts; for making matches, and various other purposes.

ARSENIC.

This is a common acid in connection with ores of economic value, and occurs:

NATIVE.—with silver, and lead ores. Color, and streak, tin-white, usually tarnished gray. Brittle. H.=3.5. G.=5.65—5.95. B.B. volatilizes before fusing, with the odor of garlic. and burns with pale blue flame. Also occurs combined with sulphur, as:

REALGAR.—of red color. H.=1.5—2. G.=3.4—3.6 containing 29.9% of sulphur.

ORPIMENT.—Bright golden-yellow. H.=1.5—2. G.=3.4—3.5. having 39% of sulphur.

Obtained chiefly from mispickel, (Arsenopyrite) for commercial purposes.—Very poisonous.

It is an unwelcome ingredient in many gold, silver, and other ores, making their treatment very difficult, and often unprofitable.

COAL.

ANTHRACITE. **STONE COAL.**

Color, black with high lustre. Opaque. Brittle and sectile. H.=0.5—2.5. G.=1.2—1.80. Carbon, with some oxygen, and hydrogen, and often more or less clay or slate. The seams run from an inch to forty feet in thickness. Believed to be of vegetable origin. Never found commercially in crystalline rocks, but is mostly confined to the upper rocks, known as Carboniferous.

BITUMINOUS. **SOFT COAL.**

Color, black. G.=not more than 1.5. Softer than anthracite. Used to make coke and gas, and varies much in the amount of tar, gas, or oil it yields.

BROWN COAL. **LIGNITE.**

Color, brownish-black. Like bituminous coal in appearance but, contains 15 to 20 per cent. of oxygen. Sometimes shows the structure of the wood from which it was formed. It will not make coke.

JET.—is a variety of coal, but is hard, of a dead black color, taking a fine polish, and much used in jewelry.

Large quantities of different colored dyes are obtained from coal. It is said, that dye from one pound of coal will color 5,000 yards of cotton cloth.

NATURAL GAS.

Gas can be found only in stratified rocks, generally in what is called Trenton Limestone, and the gas rock must be covered by considerable thickness of a close impermeable capping, of some other rock, or clay, or no body of gas of any extent will be met with, while however abundant, the supply is but temporary and will eventually be exhausted in each locality. No surface indications are found, except small gasflows which indicate that the gas, escaping as formed, does not exist in the locality in commercial quantity.

PETROLEUM.

MINERAL OIL.

The crude oil is found like natural gas; only in the higher rocks. It cannot be found in metamorphic rocks or any crystalline formation. The common coal oil of commerce, is the volatile product of the distillation of Petroleum, the lubricating oils, are the heavy oils left behind, and afterwards more or less purified, and perhaps 10% (or 1 lb. to the gallon) of Paraffin wax,—is the residue of value. This wax is the

OZOKERITE—of commerce; originally found in a natural state.

ASPHALT.—is mineral Pitch, used for roofing and street paving. Color, black to blackish-brown. H.=(when solid) 1—2. G.=1—2. melts at 90° F. and is very inflammable.

PEAT.

This substance is not a mineral, but simply vegetable matter in a state of decomposition.

Color brown to black. Spongy. G.=0.5—1. When dried contains 15% to 25% of water. It is found in beds, or in bogs. It forms a valuable fuel when dried and strongly compressed, fit for locomotives, or to smelt iron ores.

SILICATE COTTON.

MINERAL WOOL—so called is not a natural, but an artificial product. It is made by converting scoria and certain slags, while in a melted condition into a fibrous state, and is really glass in its nature, but fibrous, soft and inelastic. Used as a preventive of fire and frost, and to deaden sound; in buildings.

URANIUM.

The oxides are used in painting porcelain, giving a fine orange color in the enameling fire, and a black color when baked. The chief ore is:

URANINITE. **PITCHBLENDE.**

Color, grayish to brownish or velvet-black. Lustre, submetallic or dull. Streak, black. Opaque. H.=5.5. G.=6.47. Contains 75 to 87 per cent. of uranium oxides, with silica, lead, iron, and other impurities. B.B. infusible alone. Dissolves slowly in nitric acid when powdered.

NATURAL PAINTS.

Natural paints, are those minerals which when powdered and mixed with oil, will adhere to a smooth surface, and in drying form an impermeable skin, or covering.

RED IRON paint; is powdered hematite iron ore mixed with oil.

YELLOW IRON paint; is made from the brown iron ore.

BLACK IRON paint; is made from magnetite.

UMBER; by mixing the iron paints, with powdered oxide of manganese.

RED COPPER paint; is powdered red oxide of copper.

GREEN COPPER paint; is powdered silicate of copper.

ZINC WHITE; is oxide of zinc, artificially made, by large costly plants.

WHITE LEAD; is carbonate of lead, also artificially prepared, the natural ores not being pure enough. This also is a costly process.

RED LEAD; is oxide of lead, and has to be carefully made by experts.

VERMILLION; is the natural ore of mercury.

SLATE colored paints, are made from powdered, fine-grained slates, ground in oil.

GRAPHITE makes a fine shiny, fireproof paint.

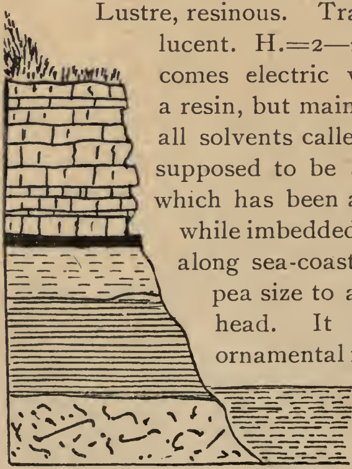
THE OCHRES; are fine clays, with brown or red iron in them, which have been naturally washed, and ground, and sifted, to an extent that cannot be profitably imitated by art.

TRIPOLITE.

INFUSORIAL EARTH.—This polishing earth is formed from very minute siliceous shells, and besides its use for polishing metals, is mixed with nitro-glycerine to make Dynamite, the powerful explosive used extensively in all heavy rock cutting.

AMBER.

MINERAL RESIN.—Is yellow in color to whitish. Lustre, resinous. Transparent to translucent. H.=2—2.5. G.=1.18. Becomes electric when rubbed. Is a resin, but mainly one that resists all solvents called Succinite. It is supposed to be a vegetable resin, which has been altered by sulphur while imbedded. Generally found along sea-coasts, in masses from pea size to as large as a man's head. It is used to make ornamental necklaces of beads, mouthpieces for pipes, cigar holders, etc.



PRECIOUS STONES.

Stones of the most valuable kinds—EMERALDS, SAPPHIRES, RUBIES, GARNETS, OPALS, and perhaps DIAMONDS, will yet be found in many sections in America, where they have not hitherto been discovered, or their existence even suspected. The fact is, that very few prospectors know anything at all about precious stones or crystals, and in most cases are not aware that Crystals or handsome specimens of minerals, have a value entirely apart from that due them as the source of the metals.

Very few people have any idea of the beauty brought out, by polishing even very common stones or pebbles.

In an idle hour on the bank of stream or lake, amuse yourself by trying the *hardness*, of any clear pebbles, or crystals you may find there. When you come across one that is not scratched by the corundum in your case, which represents number nine in the scale of hardness, or one which being scratched by number nine, will also scratch it in turn, put it in your pocket, and send it by mail to a Lapidary or dealer in mineral specimens.

This costs almost nothing and you may one day, be surprised by the result, and find yourself well paid for your trouble. Again, when you run across a handsome cluster of Quartz, or other Crystals, do likewise. Gems are discovered by carefully examining the various stones found in panning, or washing gold gravel.

Sometimes the expenses of a long trip, may be recovered by the collecting of a few *good* crystals or unusual specimens of minerals, not of commercial value other than as Cabinet Specimens. Precious stones are sold at so much a carat, which is a conventional weight, divided into four grains, which are a little lighter than Troy grains. The term is derived from a dried bean used as a weight in Africa, for weighing gold.

An approximate idea of the *size* of the various gems, may be had by reference to their varying specific gravity in comparison with this table of the approximate size of Diamonds, which is as follows, a stone weighing

$\frac{1}{32}$	of a carat	is about	$\frac{1}{16}$	inch	in diameter
$\frac{1}{16}$	"	"	$\frac{3}{32}$	"	"
$\frac{1}{8}$	"	"	$\frac{1}{8}$	"	"
$\frac{1}{4}$	"	"	$\frac{5}{32}$	"	"
$\frac{1}{2}$	"	"	$\frac{3}{16}$	"	"
1	"	"	$\frac{1}{4}$	"	"
2	"	"	$\frac{5}{16}$	"	"

Diamonds	are	worth	from	$30	to	$150	per	carat.
Emeralds	"	"	"	$10	"	$75	"	"
Rubies	"	"	"	$8	"	$90	"	"

Precious stones when polished are worth from 10c. to $10.00.

They occur in the drift where the country rocks are eruptive. Transparency and hardness tell their value.

DIAMONDS.

Isometric. Faces of crystals often curved. Color, pure, colorless, or white (the most valuable) also yellow, orange, green, blue, brown and black. Lustre, adamantine. Transparent, unless dark colored. H.=10. G.=3.5 Pure Carbon. The hardest substance known.

The Diamond does not sparkle in the rough, as found, or until polished. The best test is the hardness, and its becoming electric, when rubbed *before polishing*, this stone always showing positive electricity. Other gems are negative unless polished. B.B. burns.

Look for *dull* grayish white pebbles, having a worn octohedral form pointed at opposite ends. Generally found in gravel diggings, but the Diamond bearing rock, in Brazil appears to be, a species of mica schist filled with quartz in grains, called Itacolumyte, while at the Kimberly mines, in South Africa, it is a magnesian conglomerate with silica as a base. The matrix; known to the miners as the "blue," consists for the first 100 feet of soft friable yellow shale, altered from a slate-blue colored crystalline rock, which pulverizes on exposure to the air. The encasing rocks of the "chimney" are first a reddish sand from 2 inches to 2 feet, then a few feet of calcareous Tufa, of recent date and still forming. Then a yellow to pinkish shale for 35 to 50 feet, succeeded by a black carbonaceous shale which extends to 260—285 feet from the surface when it gives way, to an unstratified basalt trap—depth unknown—which encircles the whole mine or mines. It is an amygdaloidal Dolerite with much agate. The "blue" contains many thin veins of calcspar, and mica, pyrite, and hornblende occur throughout, The total area is eleven acres. The "blue" is allowed to lie in the open air until pulverulent, when it is carefully washed and the stones picked out. The less valuable are used as drills, and in powder as polishing material. The Diamond is cut by abrasion with its own powder. A cutter has succeeded lately in cutting a finger ring out of one perfect stone, $\frac{5}{8}$ of an inch in diameter.

SAPPHIRES.

Rhombohedral. Usually in six-sided prisms but very irregular. Blue is the true color, but the stone occurs; red; yellow; green violet and hairbrown. Transparent or translucent. H.=9 or next the Diamond. G.=4—4.16. B.B. remains unaltered. Pure Alumina. Dark colors are called EMERY, (which occurs, granular in appearance,) and is used as a polishing powder.

Test for hardness. It scratches quartz very easily. Commonly found in gravel washings, and in mica schist, and gneiss, with crystalline limestone, as the usual matrix.

A very valuable gem, the red colored being most highly prized. One specimen weighs $18\frac{1}{4}$ pounds Troy, and is transparent, without a flaw.

TURQUOISE.

In opaque masses, without cleavage. Color, bluish-green. Lustre, waxy. H.=6. G.=2.6—2.8. B.B. becomes brown, and tinges the flame green, but does not fuse. Soluble in hydrochloric acid, and moistened with the acid tinges the flame green for a moment, owing to the copper present. Is highly valued, but closely imitated by art, though the artificial gems are much softer. Occurs in veins.

BERYL.

EMERALD.

Color, green, sometimes bluish or yellowish. Streak, uncolored. Transparent, or translucent. Brittle. H.=7.5—8. G.=2.7. The rich green is the true emerald. The bluish-green are called AQUAMARINE. Colored by chromium when pure green. Not touched by acids. B.B. infusible, but becomes clouded. One specimen weighs nearly seventeen pounds. Occurs in granite, and gneiss, but the finest crystals are found in dolomite.

TOPAZ.

Trimetric. In rhombic prisms, with perfect cleavage. Color, pale yellow, white, reddish or greenish blue. Transparent to translucent. H.=8. G.=3.5. Consists of alumina and silica. B.B. infusible. Not affected by acids. Found both in loose crystals or pebbles, and in veins in metamorphic rocks.

When used in jewelry the color is often altered by heat. Becomes electric on heating. The quartz crystals are known as False Topaz. *(See also under Quartz.)*

OPAL.

Precious Opal.—Compact or earthy. Opaque white or bluish-white, with beautiful play of colors. H.=about 6. G=about 2—. Fire Opal; has yellow, and bright fire-red reflections. Easily scratched by quartz. B.B. infusible. Composition like quartz, but usually contains two to ten per cent. of water. Some stones are good natural barometers, becoming clouded on the approach of stormy weather, and clearing, and showing brighter reflections, as the weather becomes settled.

GARNET.

Isometric. Also occurs massive, or granular. Color, deep red to cinnamon, also brown, black, green, and white. Transparent to opaque. Lustre, vitreous. H.=6.5—7.5. G.=3.1—4.3. B. B. fuses easily. When transparent, *precious;* if opaque, *common.* Of frequent occurence in mica schist and gneiss, but fine clear crystals are not common, and are highly valued. There are many varieties. Its crystalline form and fusibility distinguish it.

ZIRCON.

Dimetric. Usually in crystals, but also granular. Color, red to brown or gray, yellow, and white. Streak, uncolored. Lustre, adamantine. H.=7.5. G.=4—4.8. Transparent red specimens are called HYACINTH. Sometimes heated in a crucible, with lime, when it loses its color, and is then sold as diamond. Occurs in granite, gneiss, and some other igneous rocks. Distinguished by its square prismatic form, and great specific gravity.

QUARTZ GEMS.

Quartz is rhombohedral in crystallization, occurring usually in six-sided prisms more or less modified, also compact or granular.

Crystals are colorless or yellow, amethystine, rose, smoky, and other tints. Transparent to opaque, and sometimes the colors are banded red, green, blue, and brown to black. H.=7. G.=2.5 to 2.8. Contains nominally; 53.33 per cent. of oxygen; and 46.67 per cent. of silicon, but often contains iron, clay, and other minerals. B.B. infusible alone, but fusible with soda. The following are all varieties of quartz.

ROCK CRYSTAL.—Pure pellucid quartz. The "whitestone" of jewellers, often used for spectacles and optical instruments.

AMETHYST.—Purple, or bluish violet; of great beauty.

ROSE QUARTZ.—Pink or rose-colored. Seldom in crystals.

FALSE TOPAZ.—Light yellow, clear crystals. Often cut and sold for Topaz.

CAIRNGORM STONE.—Simply smoky Quartz.

PRASE.—Leek green, massive quartz.

AVENTURINE.—Common quartz, spangled with yellow mica.

CHALCEDONY.—Translucent, massive, with waxy lustre.

CHRYSOPRASE.—Apple-green chalcedony.

CARNELIAN.—Bright red chalcedony, of rich tint. Much used for seals.

SARD.—Deep brownish-red chalcedony, blood-red by transmitted light.

AGATE.—Variegated chalcedony. Beautiful when polished.

MOSS AGATE.—Contains moss-like delineations, caused by iron oxide.

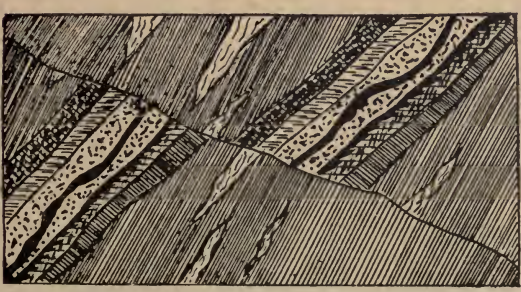
ONYX.—Agate having the colors in flat horizontal layers. Usually light brown and opaque white. It is the material used for Cameos.

CAT'S EYE.—Greenish-gray, translucent chalcedony, with a peculiar opalescence when polished with spheroidal surface, owing to inclusions of asbestos.

BLOODSTONE; or HELIOTROPE.—Deep green, with spots of red. A variety of Jasper.

SILICIFIED WOOD.—Petrified wood, quartz having replaced the wood.

FLECHES D'AMOUR.—(Love's Arrows). Quartz with rutile (or oxide of titanium) penetrating in every direction like fine hairs.



SECTION SHOWING BANDED VEIN; DISPLACED BY A FAULT.

This cut shows a vein with pay-streak which has been thrown to one side, in such a manner that if worked by a slope it would be lost altogether. A study of the formation will enable the miner to decide in which direction to go, without any lost labor.

PART VI.

PRACTICAL POINTERS.

REJECTING SAMPLES. That there are more valuable deposits of mineral passed over unrecognized, in each and every season, than are discovered, I believe to be a fact, at least as regards new mining territory. To old mining districts, where the geology, and mineralogy, have been thoroughly worked out, and where the community in general, is familiar with the only ores existing in the territory, this of course does not apply. The very first requisite to success in prospecting, is to become familiar with *all the various ores and rocks by sight*. Study each ore until you can recognize it at once.

A GOOD RULE. The average prospector is familiar with at most, the ores of but two or three metals, and will often pass by, the very thing which would yield the best return. This comes from going to work on a wrong principle. A prospector should never reject samples of veins, simply because he does not recognize the ore, as valuable. On the contrary, he should procure samples of every lode, or deposit, which he does not *know positively*, to be of no value, and submit them to a competent mineralogist for examination. This will at any rate serve one good purpose—the prospector will learn what the substance is, and thus add to his knowledge.

HOW TO SAMPLE. In selecting samples for assay, break small pieces from as many different parts of the deposit as possible. One sample however large, is of little value, as it will almost invariably be either too rich or too poor, and will therefore be misleading. Collect three to five pounds of iron, galena, gold, or silver ore, and all quartz or vein matter, thus giving the assayer some chance to properly sample, *and always retain a portion.*

COLLECTING SAMPLES. In taking samples, paint a number on each and every sample on the spot, and at the time, and enter exact particulars of each in the blank columns ruled for the purpose, at the end of this volume; where sample was got, part of vein taken from, depth, date, with other items thought of, so that if necessary, an affidavit may be made regarding any given sample, at any time in the future; and keep *duplicate samples*, which in time make a collection of value.

THE CHEMIST. When sending samples for assay to a chemist, many people expect an opinion of the ore, or some further information. As a rule no chemist will do more, than simply test for the metal or other ingredient, asked for by the sender. The chemist has no knowledge of the purpose for which the information, or analysis, is wanted, and is seldom competent to give an opinion, as to the value of the property as a mine. That is not his business, and even when a competent business man, and miner—he will not commit himself; as he is simply paid *as a chemist* for the assays made, and not for an opinion as an expert metallurgist or miner.

Every mining expert must have a knowledge of assaying—no chemist need have any knowledge of mining.

OBJECT IN ASSAYING. The owner, or anyone, interested in a mine requires, not only to know the amount of metal in the ore, but more especially the amount necessary *to make the mine pay*—that is the vital point—and that depends on the amount of metal which can be taken out of the ore, when treated on a commercial scale; on the cost of mining, and of treatment (which varies in almost every case); the cost of shipment; and many other things. A working test of a few tons of ore, taken as mined, should follow the assays, which in their proper place are valuable in proportion to the skill of the sampler.

WHERE TO PROSPECT. In choosing a route for a prospecting trip, be guided to a considerable extent by the strike of the country rock. Follow along a granite ridge; if such runs through the country; in a zig-zag fashion, continually crossing and re-crossing any contact of two formations. Linger to carefully search along either side of any fault, or disturbance, especially if caused by an eruptive dyke, and notice any sudden change in the strike of the rock, or appearance of the timber. Try all the streams and gravel bars for gold, stream tin, etc., not forgetting that dry placers (or old river beds) contain as much

This section shows an old river bed covered by a trap overflow, which forced the river to take a new course, along the line of a "fault." *A A*—Earth. *E*—New Channel. *O O*—covered gold-bearing gravel. *N N*—The formation. *F*—Fault. *S S*—Trap overflow.

metal as the present streams, and that old gravel beds, are sometimes covered by a thick capping of rock, caused by an overflow of trap or lava; and if found, follow up the course until you reach the source of the gravel, and the veins.

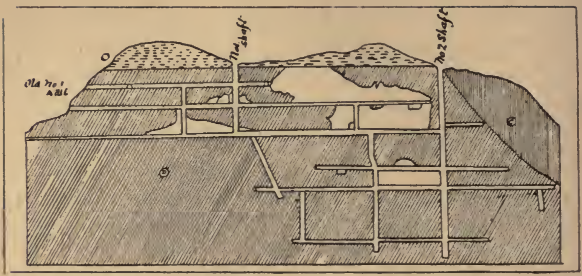
Use the pan at every opportunity, and *study all* material obtained by washing, carefully saving any unknown substance.

Many ores are found, such as lead veins, or nickeliferous pyrrhotite, by observing a peculiar red stain throughout the earth or drift, and ore is often got, where no exposure or other indication exists, save stains, and discolorations on the bare rock, or other slight results of oxidation. Lead veins, sometimes cause a series of hollows, or "sinks," running in a straight line.

The above section shows a common occurrence of Galena Veins. OO—Surface Clay. NN—Limestone. M—main bodies of ore. C—a Pocket. S—the Lode.

HOW TO OPEN. After coming across a vein, first follow the outcrop, on the strike, as far as possible, and where it can be traced for a distance, spend some time in choosing the most favorable places for opening; where the outcropping appears widest, and the ore most abundant. Begin by making shallow cuts across the vein, at these places, and after selecting the points which look the most likely, and where the vein seems to carry the greatest quantity of metal, sink small shafts to the depth of about eight or ten feet. Then have assays made; and if satisfactory, continue the shafts until a sufficient depth is reached to admit of cross-cutting. This being done; and the results being favorable, and further sinking and stripping showing ore to exist in quantity; the property will be ready for examination *as a prospect*, by experts on behalf of capitalists; or on behalf of the owners; to obtain an authoritative report, to place the property on the market in good form; or lay out the mine, to the best advantage.

Do not consider the money spent in preparing the prospect for the market, as an expense to be avoided. It is necessary to show capital the best possible evidence of value, as an inducement to inspect the goods offered, and then the sale will depend on the property being shown to advantage, by developing as much ore as possible, stripping the vein on the surface, etc., in strict conformity with the report and plans shown to the investor, and on which the expense of the examination was undertaken.



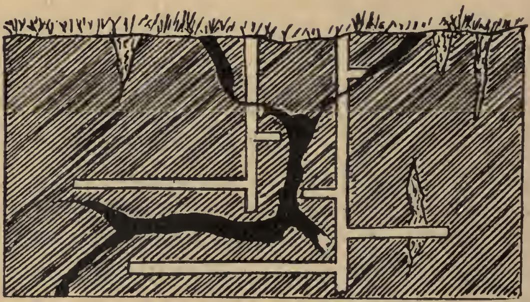
BEAVER SILVER MINE, PORT ARTHUR, CANADA.

SCALE: 400 feet = 1 inch.

This cut shows a successful Silver Mine, and also how a mine should be laid out. O—Trap. D—Slates. C—Earth.

PROSPECTING WORK. In sinking prospect shafts, or in doing any other work of a prospecting character, do not put any money into plant, machinery, or buildings, until absolutely necessary. Do the work *as long as possible* by hand labor. Ordinarily a shaft may be put down the first forty or fifty feet, with the aid of a common windlass, (which should be provided with a good brake) and the second fifty feet a horse-whim, will do all the hoisting, unless the shaft be very wet—in which case a light steam hoist, with pump attached; is the most economical. Steam or air drills should not be purchased, until the mine is a proved producer, unless deep working and extensive exploring underground is for other reasons decided upon.

The main essential to success in prospecting, even more than in other lines of business, is steady perseverance, backed by common sense. Nevertheless success does not often come, without a close study of how rocks are formed, how the ores were deposited, and how they came in the positions we now find them. It has occasionally happened, and doubtless will occasionally happen, that a man born under a lucky star, will by sheer good fortune, stumble on a rich mine, while it may be considered certain, that the same steady application, as would be shown in any other calling, will ensure much larger rewards when devoted to mining; and this applies equally to those, who, engaged in different business, have opportunities to secure interests in discoveries made by others; nevertheless, it should always be remembered, that one find in several only, is valuable, and one or two disappointments need not discourage further attempts. Economy should be the watchword in all prospecting work, but there is no economy in working with poor tools, or men, no matter how cheaply they may be bought. This applies, perhaps with greater force, to the development of new enterprises. More experience, more general knowledge, sound judgment and foresight, are requisite *before* the conditions and difficulties to be overcome, are fully known, than afterwards; when good management alone is needed. It is very easy to make errors in laying out a mine, which it often costs large sums to rectify.



"HARD LUCK" MINE. MORAL: Use a Core Drill.

THE PROSPECTOR'S "KIT."

A good pocket lens, -	$ 2.00
A dipneedle, -	10.00
A good compass, (one showing dip is the best)	2.50
A set of $\frac{3}{4}$ in. steel, one of 12 in., two of 18 in. and one of 36 in., - -	3.00
A 6 lb. striking hammer, - - -	1.50
A good light shovel and pick, - -	2.50
A light axe, - - - - - -	1.25
A small prospecting pick, with handle divided into inches and half inches, -	1.50
A miner's pan, of wood or iron, - -	2.00
A few pounds of dynamite, (Eclipse) with fuse, etc., - - - - -	3.00
A jack-knife, with one blade magnetized,	1.00

A case of small samples of ores for comparison, - - - - - -	10.00
A scale for trying hardness, - - -	2.00
A vial of mercury, and small steel pestle and mortar, - - - - -	4.00
A tube of vermillion, for numbering samples, and brush, - - - - - -	.50
A small bottle of nitric, and one of hydrochloric acid, - - - - -	1.00
A number of small cotton or other bags to carry samples of crystals, etc., in, to keep them from abrasion, - -	.25
And last, but not least, a simple blowpipe outfit, - - - - - -	5.00

Archibald Geikie says: "A knowledge of rocks can never be gained from instructions given in books, but must be acquired from actual handling of the rocks themselves."

PROSPECTORS' SAMPLES. I would advise every prospector to buy from a dealer in mineral samples, a set of the minerals comprising the scale of hardness, also a prospector's case of samples of ores for comparison, most of which may be very small pieces. Nothing else can take the place of a known sample of the mineral, which can also be compared with samples of the vein on the spot, while the cost of a representative case of ores, is but trifling, being from ten to fifteen dollars for case of about one hundred specimens, covering both ores and rocks pretty fully, and this should be made the nucleus of a private collection, which in time may be valuable, if the record of each specimen be faithfully kept.

MEANS OF ACCESS. Every mile between a railway, or point accessible to large vessels, and a discovery of mineral means a reduction in the value of the property, and an added difficulty in finding a purchaser, and effecting a sale. This is too frequently lost sight of in selecting a field. It costs from $5,000 to $10,000 per mile in the average mining country, to build a railroad, therefore, unless there be strong reasons to the contrary, try and make your "search" or venture, as near one means of access or the other as possible, and you will save much vexatious delay, and disappointment, while the chances of success will not be lessened.

SELLING A PROSPECT. Mining properties are usually sold outright, or leased on royalty. In the former case it is usual to give an option at a fixed price, for a certain definite period, during which time the purchaser is allowed to make the fullest investigation, and if on a prospect, to develop the property at his own expense, and to remove such an amount of ore as to allow a thorough test to be made. In the case of a lease, the lessor agrees to mine a minimum amount of ore during each year, and to pay a certain sum, or royalty, for each ton mined. An option to purchase for a fixed sum, is sometimes made a condition in the lease. Occasionally an owner will arrange to allow a plant to be erected and the mine worked, under proper conditions, on receiving a fixed percentage of the gross output.

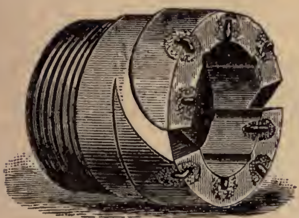
HOW TO DESCRIBE. In describing a find to possible purchasers, be careful to have any margin between the description and the facts, in favor of the property; never say the show is "about half an acre wide," or "a rifle shot long." It depends on who loads the rifle. It is just as easy to measure the outcrop, if only by pacing it, and to describe it as so many feet, or so many paces. The description should state: the title; the kind of country; the supply of timber and water; the geology, as well as possible; the trail, and means of approach; and the surface show; giving the dip; and strike; the facilities for working; and sites for buildings; the assays; and should be accompanied by *average* samples. Where possible the amount of ore "in sight" should be stated. The term "in sight" being used when an ore body is developed, by shafts, undercuttings, etc., to allow of measurement. Never cause a customer disappointment by describing a *prospect* as a *mine*.

SECURING CAPITAL. In these days of concentration, when all mines are carried on, with the use of expensive machinery, and costly plant, on a large scale, necessitating the employment of large capital, a connection with some one in touch with monied men, is absolutely necessary, to enable a prospector or owner of a prospect, to realize on the property.

There is only one way to obtain such a connection, and be assured of fair treatment, that is: by convincing the capitalist, or his representative, that the vendor is a man of his word, and not in the habit of exaggerating or misstating plain facts, that when he say a foot, he means twelve inches, and not six inches. The aim of a prospector or vendor of a prospect, should be to place it before buyers in the best possible shape to induce investigation. An authoritative report by a well known unbiassed outsider, is the quickest way to reach this end.

CORE DRILLS. Sometimes, in exploiting a vein, or other deposit of mineral, the Core Drill offers certain advantages over shafts, or tunnels, and drifts.

In exploring small, or irregular veins the work of the Core Drill is not reliable. When the conditions allow it fair play, it is the most economical method of testing an ore body, saving time, and expense in underground work, and boring smooth, straight holes, in any direction, from vertical to horizontal. Drills are made of varying capacity, being driven by hand, steam, or horse power, and drilling from 500 to 4,000 feet in depth.



This Drill consists of, a hollow circular bit, set both on inside and outside edge, with inferior diamonds, which do the cutting, as the drill revolves. A continuous core remains in the tube, which is broken off and drawn up, a section at a time; thus giving an actual sample of the strata passed through, at any and every depth.

A new core drill is being successfully used in California, which does not require diamonds. It consists of different lengths of iron pipe (like gas pipe) screwed together, and revolved at great speed under pressure, small chilled steel shot being fed into the hole at the top. These become imbedded in the soft iron of the pipe, forming a rough rasp, which wears the hardest rock. It will bore either a perpendicular hole, or one on the incline, following the dip of the ore and is said to be a very economical prospecting tool.

The safest, and generally speaking, the most satisfactory way, is to contract with an experienced driller, for the work required, at a certain price per foot.

DRILLING.

SELLING ORES. In many cases, when capital is not conveniently obtained, and where it is necessary that a property be developed, before being offered for sale; it is a matter of moment to sell any ore which may be mined, in the course of such development. It sometimes happens that sufficient ore can be obtained, to pay for the necessary expense incurred. This is a matter requiring considerable judgment and discretion, to decide, before entering on the work, depending on a return from the ore. Ore *can* be sold by the single carload, or by the ton, but at the minimum price. A hint as to the data required, by purchasers of ore, may not be out of place. Ores, and mattes, are usually sold at a price per unit, a minimum percentage of metal being usually fixed, below which grading the ore must not run. Send samples which will fairly represent the ore pile, taking care that the average will not be too high, *and a complete analysis of the ore.* State as nearly as possible, how much ore you will be able to ship, confining the amount to what you have available at the time, and a purchaser may be found, who will advance a part of the value on the bills of lading (often a consideration to the shipper) for gold, silver, copper, lead and some other ores.

BEGINNING TO MINE. After sufficient work has been done, to absolutely prove that a paying deposit exists, *and not till then*, should mining begin. The exploration should expose sufficient ore, to pay for all plant and development work, and a profit, which usually means a couple of years supply, for the necessary reduction works. Further development should be pushed so as to keep this reserve, constantly ahead. The ore should be thoroughly tested, to guarantee the above value, by *working* tests, at the nearest refining works, before deciding on a process of treatment. A mining enterprise conducted in this way, involves no further risk, than the loss of the expenses of preliminary investigation, provided it receives the same careful management, and honest supervision, as all business ventures demand.

SELECTING THE TREATMENT. Selecting the *wrong process* for treating a given ore, is possibly, one of the greatest causes of failure, in starting a new mining enterprise. This is an art in itself. Take for example gold ores. One ore is suited best by free-milling; another requires free-milling and concentration; the next concentration only, followed by smelting, or perhaps chlorination; a fourth works best by smelting direct. Some ores need fine grinding; and on others, coarse grinding is more economical, while occasionally it pays best, to lose as much as one-third of the gold in the tailings. The cost of mining gold varies from twentv-five cents to eighty cents for each dollar obtained, in large mills, working under different local conditions.

This point can be decided at little cost by one having the special knowledge and ability in this direction, and no company should decide on the purchase of plant or the use of a process, until the best advice in the market is had on this point. Not a dollar should be spent on experimenting with new ideas or costly plant, which although thoroughly tested at some other mine, may not suit the ores under consideration. If a company be formed and money invested in a mining venture, it should be used for *mining* only, and the diverting of funds to any other purpose should be strictly tabooed.

MINING RISKS. The risk should be confined to the natural, legitimate, and unavoidable hazard, incidental to mining, as to every other business. The popular idea, that mining is in itself, more risky, and speculative, than other lines of enterprise, is a fallacy. The farmer takes greater chances on every crop he plants. If the season be too dry or too wet, or the grasshoppers too numerous; he gets no return. If the weather be propitious, it is equally so all round, and the extra crops make low prices, and thus his profit goes. The legitimate miner takes one risk only—that of proving his mine. He takes no heed of the weather, and his crop is metal, and metal is money. What has brought mining into disrepute, is incompetence, and dishonesty. Mining requires special skill, adaptability and experience, on the part of those actually operating, and that the general public is not familiar with the business gives unusual opportunity to the unscrupulous, but the day of "salted" mines is passing. The profession of Mining Engineering is occupied by men of knowledge, ability, and probity, and the "crook," and the man who used a pretended familiarity with "Science" to foist his bogus claims to a knowledge of mining, on an innocent public, are rapidly being "frozen out," as the ignorance of the business public regarding mining is dispelled.

Neither should a man undertake to mine himself, or under his own supervision, unless he is competent and experienced, and so in selecting a manager. The manager should have a record as being skilful and economical, and must in addition be an all round business man. Such a man gets a good price for his services, and in mining the owner or owners can afford to pay it, and cannot afford to employ "cheap" men, or machines.

MINING STOCKS. There is one peculiar feature, connected with the business of mining investment. Go to a business man and show him any other enterprise in which, with a medium amount of risk, he is assured of a profit of twenty or thirty per cent., and he will immediately give it his most serious consideration. Ask the same man to invest in a mining venture, and show him a profit of fifty per cent. per annum. In almost every case, he will look for more, and also expect the return of his entire capital, in addition, within a very short time, and further; that same man, even though he be known as one of the most cautious, and conservative, of investors, will buy stock in a mine he knows nothing about, at ten or twenty cents on the dollar, without even asking what amount the mine is capitalized at: after investing possibly thousands of dollars, he will not go a day's journey to inspect the property and see where his money is being put, or send anyone else to examine into the matter on his private account. As often as not, he has no personal acquaintance with the men he entrusts with his money, and does not even look up their record or standing. Apply the same methods, figuratively, to another business; and it will be seen at once, why so many mines, which might be worked to pay handsome dividends, on a capital of say one hundred thousand dollars—are "stocked" for millions, and not worked at all. An unscrupulous company buys a good mine, and expends perhaps, fifty thousand dollars, on purchase, development, and "floating" same. They capitalize the thing, at perhaps three million dollars, and offer stock, at say, twenty cents a dollar share. They need only sell half a million shares, to make 100 per cent. *profit, and still own five sixth's interest in the mine.* No other business, but railroad manipulation, or "sugar" trusts, can show such profits. *No legitimate business* can be expected of such a company, and apparently the business public is to blame, because, they will treat mining investments, in a manner directly the opposite, of that accorded to any other offered.

On the other hand, it is not intended to depreciate, the popular method of obtaining capital for opening and developing mines. On the contrary, the advantages of joint stock companies over individual efforts, are many. Operations can be carried on, on a much larger scale, and thus, better economic results may be obtained, while the benefits are distributed amongst the many, instead of going to a few, to the advantage of the community at large. When failure is incurred, the loss also, is borne better when each member has but a small individual interest. Given the same cautious investigation and careful scrutiny *before investing*, mining stocks are shown, by statistics extending over long periods, to pay better and more constant dividends, than those of any other class, and investments in development mining stock, in honest and legitimate mining concerns, are likely to prove more profitable than shares in companies organized to operate in any other direction.

USEFUL TABLES.

MEASURES OF ORES, EARTH, ETC.

13 cubic feet of ordinary gold, or silver ore in mine, equal	1 short ton
20 cubic feet of broken quartz, equal	1 " "
18 cubic feet of gravel in bank, "	1 " "
27 cubic feet of gravel, when dry, "	1 " "
25 cubic feet of sand, equal	1 " "
14 cubic feet of chalk, equal	1 " "
18 cubic feet of marl, equal	1 " "
18 cubic feet of earth, in bank, equal	1 " "
27 cubic feet of earth, when dry, "	1 " "
17 cubic feet of clay, equal	1 " "
44.8 cubic feet of bituminous coal, broken, equal	1 long ton
42.3 cubic feet of anthracite, broken, equal	1 " "
123 cubic feet of charcoal, equal	1 " "
70.9 cubic feet of coke, equal	1 " "

The number of cubic feet of ore in a ton, is got by ascertaining the specific gravity; water being taken as the standard. One cubic foot of water weighs 62½ lbs. therefore, 32 cubic feet weigh one ton (2,000 lbs.) The specific gravity of iron ore is, say 4—therefore; 8 cubic feet equal one ton, or in other words, one fourth of 32, the bulk of water.

RELATIVE WEIGHT OF METALS.

Cast Iron being the Unit.

Cast Iron	1,000
Wrought Iron	1,072
Copper Rolled	1,226
Tin	1,015
Zinc	947
Brass	1,170
Steel	1,086
Lead	1,574
Gold	2,702
Silver	1,448
Mercury	1,880

WEIGHTS AND VOLUMES OF ORDINARY METALS.

Metals	Cubic Feet Lbs.
Brass	488.75
" in sheets	512.6
" in wire	524.16
Copper, cast	543.625
" plates	547.25
Iron, cast	450.437
" plates	486.75
" wrought bars	481.5
Lead, cast	709.5
" rolled	711.75
Mercury (60 degrees)	848.7487
Steel-plates	487.75
" soft	489.562

Tin	455.687
Zinc, cast	488.812
" rolled	440.437

WATER REQUIRED FOR QUARTZ MILLING.

For boiler; 7¼ gallons per H.P. per hour. For each stamp; 72 gallons per hour. For each pan; 120 gallons per hour. For each settler; 60 gallons per hour. If the water be run into settling tanks it may be used again, less considerable loss; say about twenty-five per cent.

A MINER'S INCH

will discharge 2.250 cubic feet of water; equal to about 17,000 gallons in 24 hours. A gallon of water weighs (U.S. standard) 8⅓ pounds, and contains 231 cubic inches.

TO CALCULATE THE WATER POWER TO BE GOT FROM A STREAM:

multiply the depth by the width, and this by the rate per minute, (which can be found by floating chips, a measured distance, and timing them.) This gives the number of cubic feet, or volume per minute, Multiply the volume by 62½ (the weight of one cubic foot), and multiply this by the height of fall. Divide the total result by 33,000 (pounds) and the result, is the horse power of a turbine wheel. In practise only 80 per cent. of this power may be relied on. A horse power, is a power which will raise 33,000 pounds, one foot, in one minute.

TO TEMPER METAL.

To temper drill steel—cool down to 430 degrees to 450 degrees, which is respectively; a faint yellow; and a pale straw color.

To temper knives for wood, soft metals, etc.—cool down to 510 degrees to 537 degrees. A brown, with purple spots—a purple.

To temper axes, cold chisels, etc.—cool down to 550 to 560 degrees. Dark blue to bright blue.

To temper saws, springs, etc.—cool down to 600. Grayish blue, nearly black.

In steel heated higher than this, the effect of the hardening process is lost. A handful of salt in the water vessel, will aid in obtaining a hard temper.

TO SOLDER OR WELD, USE:

For iron or steel; borax or sal-ammoniac. For tinned iron; resin, or chloride of zinc. For copper and brass; sal-ammoniac, or chloride of zinc. For zinc; chloride of zinc. For lead; tallow or resin. For lead and tin pipes; resin and sweet oil.

TO CASE HARDEN.

Heat the article, after polishing, to a bright red, rub with prussiate of potash, allow to cool to dull red, and immerse in water.

CEMENT FOR CAST IRON.

Two ounces sal-ammoniac, one ounce Sulphur, and 16 ounces cast-iron filings. Mix well in a mortar, and keep dry. When using, take one part of this powder to 20 parts clear iron filings, make into stiff paste with water, and it is ready for use.

CEMENT FOR FACE JOINTS.

Equal parts red and white lead, with linseed oil.

TABLE OF MELTING POINT OF METALS.

Water boils at 212 degrees F.

Ice becomes fluid at 32 degrees F.

Mercury	38.2	degrees	F.
Sulphur	230	"	"
Tin	446	"	"
Bismuth	480	"	"
Lead	612	"	"
Zinc	680	"	"
Antimony	842	"	"
Bronze	1652	"	"
Silver	1873	"	"
Copper	1996	"	"
Gold	2012—2282	"	"
Cast Iron	2786	"	"
Steel	2372—2552	"	"
Bar Iron	2732—3012	"	"
Platinum	4532	"	"
Glass	2377	"	"

ALLOYS IN COMMON USE.

Babbit Metal—Tin, 89; Copper, 3.7; Antimony, 7.3.
Yellow Brass—Copper, 66; Zinc, 34.
Gun Metal, Valves, etc.—Copper, 90; Tin, 10.
White Brass—Copper, 10; Zinc, 80; Tin, 10.
German Silver—Copper, 33.3; Zinc, 33.4; Nickel, 33.3.
Church Bells—Copper, 80; Zinc, 5.6; Tin, 10.1; Lead, 4.3.
Gongs—Copper, 81.6; Tin, 18.4.
Lathe Bushes—Copper 80; Tin, 20.
Bearings—Copper, 87.5; Tin, 12.5.
Muntz Metal—Copper, 60; Zinc, 40.
Sheathing Plates—Copper, 56; Zinc, 44.

WEIGHT AND VALUE OF WOOD AS FUEL.

Cord air-dried Hickory, or Hard Maple; weighs 4,500 lbs., and is equal to 2,000 lbs. coal.

Cord air dried White Oak, weighs 3850 lbs., and is equal to 1715 lbs. of coal.

Cord air-dried Beech, Red or Black Oak, weighs 3250 lbs., and is equal to 1450 lbs. of coal.

Cord air-dried Poplar, Chestnut, or Elm, weighs 2350 lbs., and is equal to 1050 lbs. of coal.

Cord air-dried average Pine, weighs about 2,000 lbs., and is equal to 925 lbs. of coal.

We may assume from the above; that 2¼ lbs. of dry wood, is about equal to one pound of soft coal, no matter whether the wood be pine or maple, so long as it is dry. A good boiler should evaporate 7 to 10 lbs. of water per lb. of good coal. In practice, only 75 per cent. of this is attained.

APPROXIMATE COST OF MINING AND TREATING DIFFERENT ORES.

Varying with Local Conditions.

				PER TON.
Gold and Silver ore, to mine,	from	$1.00	to	$5.00
Freemilling	"	1.00	"	2.00
Concentration	"	.50	"	3.00
Treatment of concentrates,	"	3.00	"	15.00
Roasting-milling	"	8.00	"	15.00
Chlorination	"	3.00	"	12.00
Smelting to matte	"	5.00	"	30.00
Copper ore costs to mine	"	.50	"	2.50
Smelting to matte	"	3.00	"	6.00
Smelting to black copper	"	7.00	"	10.00
Nickel-copper ores:				
Smelting to matte	"	2.50	"	5.00
Refining matte	"	100.00	"	200.00
Silver-lead ores:				
Smelting to base bullion	"	5.00	"	10.00
Iron ores cost to mine	"	.25	"	1.50
Smelting to pig, per ton of iron,	"	10.00	"	14.00

A breaker with capacity of say 20 tons per diem, (crushing to nut size) costs about $250, and requires about 4 H.P.

A mill or pulverizer, crushing 20 tons per day, costs about $1,500, and requires about 8 H.P.

A concentrating plant, treating about 20 tons per day, costs about $2,000, and uses about 2 H.P.

An amalgamator, treating about 20 tons per day, will cost about $1,500.

A small prospecting plant, complete for free-milling gold ore, will cost about $500.

Three men drilling ten hours by hand, will make 15 to 16 feet on an average.

A steam drill will make an average of about 45 feet; an air drill, 50 to 55 feet per day.

GLOSSARY OF MINING TERMS.

Adit.—A tunnel into a hill.

Aerolites.—Masses of metallic, or stony matter which have fallen on the earth from other planets.

Albite.—Soda Feldspar. Triclinic.

Alkaline.—Containing an alkali; as soda, or potash.

Alliaceous.—The odor of garlic; given off by mispickel.

Alluvium.—Gravel diggings. Drift.

Alloy.—A compound of metals.

Amalgam.—Mercury combined with gold or other metals.

Amorphous.—Without form.

Anorthite.—Lime Feldspar.

Arastra.—A Mexican mill for grinding ore, by dragging large stones around in a circular pit, stone lined, and having quicksilver in the bottom with the ore.

Arenaceous.—Sandy; applied to rocks.

Argentiferous.—Silver-bearing.

Argillaceous.—Containing clay. The odor of wet clay.

Artesian Wells.—Are holes bored through solid strata, and often overflow.

Assaying.—Smelting samples to test the ore.

Auriferous.—Gold-bearing.
Azoic.—Without life.

Back.—The ground between a drift and the surface.
Battery.—A set of stamps.
Bed.—A layer of rock.
Bedrock.—The solid rock under a clay or gravel bed.
Belt.—A range of metal-bearing rocks.
Bituminous.—Carrying mineral pitch.
Bitter Spar.—Crystal Dolomite.
Black-Jack.—Dark zinc blende.
Blacksand.—The last dirt left in panning gold. Magnetic iron sand.
Boulder.—Any rounded loose rock.
Brace.—The collar at the mouth of a shaft.
Breast.—The face, or front, at which a miner works.
Buddle.—The tub used to wash slimes.
Bunch.—A rich pocket of ore.

Cage.—The lift in a mine.
Cam.—The curved pin which raises the stamp in a mill.
Calcareous.—Containing Carbonate of Lime.
Calcining.—Burning, or roasting ores.
Canon.—A deep ravine or gorge, with precipitous sides.
Caprock.—Any rock which covers an ore bed.

Carbonate.—Applied to oxides, when carbonic acid is united.

Casing.—The sheathing, or parting between the wall, and vein.

Chlorides.—Combinations of chlorine with metals.

Choke-damp.—Carbonic acid gas.

Chute.—An incline having depth without horizontal length.

Coke.—The residue after the bitumen is driven out of coal.

Clastic.—Fragmental. When a rock is composed of pieces.

Cleavage.—The property of splitting in one direction.

Color.—Any show, or speck of gold in the pan.

Contact Veins.—Veins running between two formations.

Cradle.—A wooden trough on rockers, for washing gold.

Creep.—The sinking of rock from stoping ore.

Cross Course.—Any vein crossing the one worked.

Cross Cut.—A level run across the vein.

Cupriferous.—Copper-bearing.

Dead Work.—Removing dead ground, viz.; barren rock; to get at the ore.

Dip.—The angle at which a vein lies from the horizon.

Divide.—Any continuous range of mountains from which the streams flow in opposite directions.

The Rocky Mountains are called The Great Divide.

Drift.—Loose Rock. A level run on the strike underground.

Druse.—A cavity lined with crystals.

Dump.—The waste pile.

Dunes.—Heaps of sand blown up by the wind.

Dyke.—Any igneous rock which has filled a fissure in a straight line, and stands above the level.

Erosion.—The act of being gradually worn away. Thus valleys are made by running water.

Face.—The end of a drift or level.

Fault.—Where the strata has been shoved to one side, or up, or down.

Feeder.—A small vein leading to a larger one.

Feldspar.—A constituent of many rocks. There are many kinds composed of silicates of aluminum, and of alkalies, and lime.—Hardness=6.

Ferruginous.—Relating to iron.

Fire Damp.—Carburetted hydrogen gas.

Fissure Veins.—Veins filling a rent in solid rock.

Float.—Loose ore or rock that has been misplaced.

Floor.—The bottom.

Flour-Gold.—Gold in a very fine state of division.

Flume.—A sluice-way for water.

Flux.—Anything mixed with ore, to produce slags.

Footwall.—The lower wall of a vein.

Formation.—The form, or structure of the country rock.

Freestone.—Sandstone easily dressed.

Fusion.—The state of melting.

Gad.—A pointed iron wedge, used for splitting rock. (Cornish.)

Galena.—A lead ore, the sulphide.

Gallery.—A level from which the ore has been stoped.

Gangue.—The vein matter, or matrix, holding the ore.

Geodes.—Rounded hollow nodules of rock, generally containing crystals.

Glance.—A term formerly used to specify bright shining ores.

Gossan.—The decomposed matter on or in an ore deposit, composed of iron oxide.

Grassroots.—The surface above a mine.

Hackly.—Having a surface of rough points when broken.

Hade.—The slope of a vein, usually applied to a fault.

Hanging Wall.—The wall on the upper side of a vein.

Horse.—A mass of rock in a vein.

Hydraulic Cement.—Sets under water. Made from limestone containing alumina, magnesia, and silica.

Hydraulic Mining.—Mining placer gold with a stream of water under pressure.

Igneous.—Applied to all rocks cooled from a state of fusion.

In situ.—In fixed place.

Jamb.—Any thick rock which cuts off the vein.

Jigging.—A method of sorting ore, by shaking in a sieve in water.

Kies.—The sulphides separated from the rock matter.

Kibble.—An ore bucket.

Lapidary.—One who works in gems; also applied to dealers.

Lead.—A dry river bed yielding ore.

Lean.—Poor in metal.

Litharge.—An oxide of lead, used in assaying.

Lithology.—The study of rocks. Geology applies to formations of the Earth.

Lode.—A regular vein carrying metal.

Loam.—A mixture of sand and clay.

Long Tom.—A wooden trough for washing gravel.

Magma.—The liquid matter within the earth, the source of igneous rocks.

Massive.—Not stratified. Without cleavage.

Matrix.—The body or "paste" of any rock enclosing fragments.

Metamorphic.—Changed in form and structure.

Mine.—A deposit of ore, which has been worked sufficiently to prove its commercial value.

Mineral.—Any substance taken from the earth. In mining, any ore containing metal in commercial quantities.

Muffle.—An oxidizing furnace.

Native.—As applied in mineralogy, means metal found pure, or refined by nature.

Nugget.—Any lump of native metal.

Open Cast.—Any working not underground.

Ore.—Applied to any mineral of commercial value, when mined.

Outcrop.—The exposure of rock on the surface.

Outlier.—Any portion of a group of rocks, lying in a detached position, or out from the main body.

Oxide.—A compound of oxygen with other elements.

Parting.—A thin stratum, or layer, which separates two formations; also called a selvage.

Peat.—Solid vegetable matter in a bog.

Petrify.—To become stone.

Phosphates.—Phosphoric acid combinations.

Pinched.—When a vein is contracted.

Placers.—Gravel diggings on bed rock.

Prill.—A good sized piece of pure ore.

Prospect.—A vein or other deposit not yet proved to be a mine.

Pulverize.—To reduce to powder or dust.

Pumice.—A light, porous lava.

Quartz.—Silica. Forming rock, and a common mineral in most rocks.

Range.—A mineral-bearing belt of rocks.

Reef.—A ridge; in mining a vein which outcrops along a range of hills.

Riffles.—Bars laid across the bottom of a sluice-box, to catch the heavy sands and coarse gold.

Rock.—The stony portion of the earth's crust.

Rocker.—A cradle for washing gravel.

Royalty.—A duty on the product of a mine.

Sampling Works.—Small plants for testing ores on a working scale.

Selvage.—The sheathing between wall and vein.

Silica.—Silex or Quartz.

Siliceous.—Quartz-bearing.

Shaft.—The vertical opening to any underground workings.

Shale.—Fissile argillaceous rock. Generally soft.

Shift.—The time one set of men work.

Slag.—The scoria or waste from a furnace.

Slickensides.—Smoothed surfaces on the walls of a vein.

Slope.—An inclined opening to a mine.

Stockwerke.—A number of veins running together with the enclosing rock mineralized.

Stope.—To remove the ore.

Stoping Ground.—The ore blocked out ready to remove.

Stratified.—Showing more or less distinct and separate layer or strata.

Streak.—The color of a mineral when scratched.

Streak Powder.—The powder obtained by filing a piece of mineral.

Strike.—The horizontal course of vein or formation.

Stringer.—A small vein leading to the main vein.

Stripping.—Uncovering an ore-body on the surface.

Stull.—The platform used in overhead stoping.

Sulphureous.—The odor of burning sulphur.

Sulphurets.—Metals combined with sulphur.

Sump.—A well in a mine to collect the water.

Swab.—The stick used to clean out blast holes.

Swamp-Ore.—Bog iron is sometimes called swamp-ore, when found in low, wet ground.

Synclinical.—The trough formed by the downward inclination of the strata from each side. The *Anticlinal* being the ridge formed when the strata dips in opposite directions.

Tallings.—The waste material from a mill.

Tamp.—To hammer loose earth into a blast hole.

Trap.—Any volcanic rock.

Tufa.—Any open porous rock.

Tunnel.—A level into a hill.

Unctuous.—Having a greasy feel, like soapstone.

Underlie.—The angle of a vein from the perpendicular.

Upthrow.—An upward displacement of the side of a fault.

Veinstone.—The mineral in a vein which holds the ore.

Vitreous.—The lustre of broken glass.

Vug.—A cavity in a vein.

Weathered.—Changed by exposure to the weather.

Whim.—A large drum for hoisting by horse-power.

Whin.—The Scotch name for hornstone.

Winze.—An opening from one level to another underground.

Zone.—Used to specify a certain geological position, of a strata or layer of rock.

INDEX.

Samples Collected by ______________ of ______________ from 189 to 194

No.	Kind of Ore.	LOCALITY.	ASSAYS.	Assayed by

Samples Collected by .... of .... from 189   to 19

No.	Kind of Ore.	LOCALITY.	ASSAYS.	Assayed by

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