HOW AND WHERE

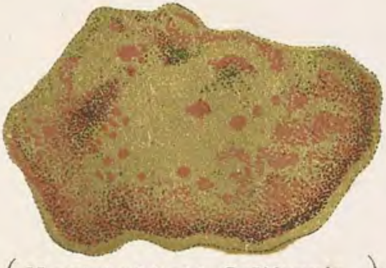
UNDERGROUND TREASURES

TO FIND THEM

PROSPECTING THE GROUND.

Underground Treasures:

How and Where to Find Them.



(Nugget of Gold - California.)

By JAMES ORTON, A. M.

PHILADELPHIA:
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UNDERGROUND TREASURES:

HOW AND WHERE TO FIND THEM.

A KEY

FOR THE READY DETERMINATION OF ALL THE USEFUL MINERALS WITHIN THE UNITED STATES.

BY JAMES ORTON, A.M.,
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A NEW EDITION WITH AN APPENDIX

ON ORE DEPOSITS AND TESTING MINERALS WITH THE BLOW-PIPE.

ILLUSTRATED.

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NOTE.

THIS little work was not written for mineralogists, but expressly for the landholder, the farmer, the mechanic, the miner, the laborer, even the most unscientific. It is designed to enable such to discover for themselves, minerals and ores of use in the arts, and thus develop the resources and ascertain the value of any particular farm or region. It may save the owner from ruinous bargains, and may reveal a mine of mineral wealth, more sure and more profitable than any bank.

Still further, to enhance the value and popularity of the book, it has by the present editor, been deemed advisable to add an Appendix on Ore Deposits and Testing Minerals by the Blow-pipe.

W. T. B.

PHILADELPHIA, 1901.

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INSCRIBED

TO

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UNITED STATES

COMMISSIONER OF MINING STATISTICS;

EDITOR OF THE

ENGINEERING AND MINING JOURNAL;

AUTHOR OF

"The Mines of the West," etc.

Underground Treasures.

List of Illustrations.

A KEY

FOR THE READY DETERMINATION OF ALL THE
USEFUL MINERALS WITHIN THE
UNITED STATES.

CHAPTER I.

INTRODUCTION.

MONEY IN THE ROCKS—THE UNDERGROUND WEALTH OF OUR COUNTRY—VALUABLE MINERALS DISGUISED—HOW GREAT FORTUNES ARE MISSED—NUMBER OF MINERALS IN THE UNITED STATES—OBJECT OF THIS WORK AND HOW TO USE IT—THE BEST MINERAL REGIONS.

MINERALS head the list of the sources of our nation's wealth. Gold, iron, coal and marble have not only contributed largely to the enterprise and opulence of America, but at this very moment they exert a commanding influence in political circles. No one can prophesy the greatness of the commercial power which is sure to rise on their foundations.

No other country can boast of such

vast and valuable mineral deposits. Yet our country is not half developed. Treasures lie undiscovered in our mountains and under our farms,—gems of "purest ray serene" and still more precious metals. Some will be accidentally brought to light; but the majority are so disguised that their real nature is not seen. How unpromising are the best ores of iron, zinc and silver and the rarest gems! Then, again, there is "mimicry" in the mineral kingdom; worthless stones are often good imitations of the valuable, and fortunes have been sunk in mining pyrites for gold, mica for silver and slate for coal. But if we wait for mineralogists to develop our mineral resources, we must wait a millenium, our country is so vast and scientific laborers so few. Fortunately, however, nature has stamped upon each mineral some peculiar feature or assemblage of characters which enable any one with average common sense to distinguish those which are of value in the arts.

The object of this work is to point out those distinctions so clearly and in popular language that those who do not claim to be scientific may determine specimens for themselves; in other words, to furnish *a key for the ready determination of all the useful minerals within the United States*[*]

Two hundred and forty-four mineral species have been found within the bounds of the Union. Of these only one-third are of any use to the practical man. These eighty have certain general characters in common, but always some specific differences. The object is to divide them into groups, as the botanist divides the plants, and then to separate the individuals by some properties or features peculiar to each. Only those minerals are mentioned which are useful: any specimen, therefore, which does not fit any of the descriptions given, may be considered of no special

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[*] The useful rocks, as granite, slate, sandstone, water-lime, etc., are not included. By "granite region" is meant one having rocks like New England, and therefore unlike Western New York or Illinois.

value. By the term "color," is meant the color of a fresh fracture, for the exposed surface often misrepresents the true aspect. Exact color is not meant, but "red" stands for reddish, "yellow" for yellowish, "white" for a light gray up to the perfectly transparent. "Magnetic" means that the specimen disturbs the needle of a compass, or that a magnet will take up fine particles. A mineral is "opaque" if the light will not pass through either the edges or a thin fragment. A "translucent" mineral is either clear as crystal or only allows light to pass dimly through a thin portion. "Effervescence" is the bubbling produced by the escape of a gas, as in soda-water. "Gravity" is the weight compared with that of an equal bulk of water. In the majority of cases the specimen can be determined without it; but there may be several doubtful cases which can be settled only by obtaining the gravity. This is done by first weighing a fragment of the mineral in a small apothecary or jeweler's balance, reckoning it in grains. Then by a thread suspend it below one of the scales in a tumbler of water, taking care that the specimen is covered with water and does not touch the sides. Subtract the weight in grains as it hangs in the water from the first weight, and divide the first weight by the difference: the result is the gravity. Five per cent. should be allowed for impurities. Where exactness is not required, the gravity of a specimen may be judged by comparing it with well-known substances. Thus,

The gravity of anthracite coal is about	1.5
The gravity of brick is about	1.8
The gravity of clay is about	2 0
The gravity of marble and glass is about	2 5
The gravity of slate is about	2 8
The gravity of cast iron is about	7.0
The gravity of copper is about	9 0
The gravity of lead is about	11.0

If the gravity of a mineral is 1.5, a cubic inch of it will weigh about 3-4 ounce; if 2., 1 oz.; if 2.5, 1 1-4 oz.; if 3., 1 1-2 oz.; if 4., 2 oz.; if 5, 2 1-2 oz., etc.

There is no section of our country that may not reward a diligent search for precious or useful minerals The rocks, however, between the Alleghanies and the Atlantic and between the Rocky Mountains and the Pacific furnish the greater variety and abundance. Here are found the best ores Gold and silver seem to abound more on the western than eastern sides of both mountain-chains. A trap-region, like the shore of Lake Superior and the Connecticut River Valley, is likely to be a good locality for copper and iron. The Mississippi Valley, or the region of Bituminous Coal, furnishes chiefly iron and lead; gold, silver and copper are seldom found. In general, where the layers of rock lie level and contain fossil shells, it is a locality good only for soft coal, (New York excepted), iron ore, gypsum and salt. The regions of granite, slate, limestone, marble, etc., offer the greatest inducement to search for useful minerals.

CHAPTER II.

DIRECTIONS FOR DETERMINING SPECIMENS BY THE KEY.

HOW TO TEST MINERALS WITH THE SIMPLEST MEANS — PROSPECTING WITH A JACK-KNIFE AND COMMON SENSE — USE OF THE KEY — HOW TO TELL PYRITES FROM GOLD AND QUARTZ FROM DIAMOND—ALL THE USEFUL MINERALS GROUPED ACCORDING TO HARDNESS AND COLOR.

FIRST see whether it will scratch common window-glass. If it will make the least mark, it belongs to division A; if not, it is to be found in group B. Next notice whether the light will shine through it: if it does not pass through even the edges or a thin splinter, it is opaque; if any light is allowed to pass, it is translucent. With a knife see if it is harder or softer than pure white marble; then, noting its color, compare it with the descriptions of minerals referred to by the numbers. If it agree with none, it may be considered of no use in the arts. To make doubly sure, get the gravity as described on page 12.

Examples: Suppose we have an unknown mineral in hand: We first try to scratch glass with it and find it impossible. It therefore belongs to section B. Next we find it is opaque and yellow, and evidently heavier and harder than marble. It must be one of two: 44 attracts the compass-needle, and this will not; it is consequently 26 or *Copper Pyrites*, if it agree with the description. If not, it is something of no great value.

You have found what you think is a diamond. Does the specimen scratch glass? Yes, easily, and is brittle. Can you see through it? You say it is clear as glass. Look now under section A, "translucent" series, number 6 (for it is colorless), and decide which of the four it is. The first one (27), is diamond; but do not let your wishes *make* it agree. Turning to the description, you read that it can not be scratched with a file or worn down on a grindstone. This decides against it. Besides, the gravity (2.5) is too little. With the next (57) it agrees perfectly, and you need not go further. Should the specimen, however, agree very well with rock crystal, only that its gravity (3.5) is too great, then it is topaz.

☞ All minerals that scratch glass are brittle, and all (save 32 and 46) are infusible or melt with great difficulty.

☞ The following minerals will burn, evaporate or melt without a flux in an ordinary fire: Nos. 2, 4, 5, 7, 10, 13, 14, 16, 18, 19, 21, 23, 24, 26, 29, 33, 35, 37, 44, 53, 55, 62, 63, 70, 71, 75. All but the following are heavier than marble: 2, 4, 6, 7, 10, 14, 16, 34, 36, 40, 47, 48, 56, 60, 61, 69, 71. Nos 2, 50 and 58 alone dissolve in water.

☞ In determining color, be sure you have a fresh surface, for the outside is often deceptive. By "blow-pipe" is meant the tapering tube used by watch-makers.

A.

WILL SCRATCH GLASS.

I. OPAQUE.

(1) Black: 12, 20, 28, 30, 42, 43, 51, 54, 67, 72.
(2) Brown: 12, 28, 42, 59, 72, 77.
(3) Red: 39, 46, 54, 59, 67.
(4) Yellow: 38, 72, 77.
(5) Gray: 22, 28, 72.
(6) White: 64.

II. TRANSLUCENT.

(1) Brown: 32, 59, 72, 77.
(2) Red: 17, 32, 46, 59, 68, 73, 74.
(3) Yellow: 32, 59, 72, 73, 77.
(4) Green: 74, 77.
(5) Violet-blue: 3.
(6) White: 27, 57, 73, 77.
(7) Banded or clouded: 1.

B.

WILL NOT SCRATCH GLASS.

I. OPAQUE.

Harder than white marble.*	Softer than white marble.
(1) Black: 11, 35, 47.	4, 7, 10, 12, 13, 14, 16, 24, 34, 37, 49, 51, 55, 56, 76.
(2) Brown: 66, 75.	12, 14, 21.
(3) Red: 44, 53, 75.	21, 23, 41, 55.
(4) Yellow: 26, 44.	12, 33, 56.
(5) Green: 45.	60, 61.
(6) Gray: 35, 66.	5, 24, 31, 34, 36, 49, 56, 63, 69.
(7) White: 6, 9, 11.	36, 40, 56, 62.

II. TRANSLUCENT.

(1) Black: 11.	55.
(2) Brown: 9, 11, 65, 66.	48.
(3) Red: 9, 11, 18, 53, 78.	36, 55.
(4) Yellow: 9, 11, 15, 29, 47, 78.	48, 71.
(5) Green: 29, 45, 65, 70.	48, 60, 61.
(6) Blue: 8, 18, 29, 47.	
(7) Gray: 19, 47, 65, 66.	37, 69.
(8) White: 18, 47.	2.
(9) Mottled or Banded: 47.	

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* That is, they are not so easily cut with a knife; they do not necessarily scratch marble.

CHAPTER III.

DESCRIPTIVE LIST OF USEFUL MINERALS.

THE GEMS—PRECIOUS METALS—VALUABLE ORES AND USEFUL MINERALS OF THE UNITED STATES FROM AGATE TO ZINC — THEIR DISTINGUISHING CHARACTERS, USES AND LOCALITIES — A MINERALOGY FOR MINERS.

1.—AGATE.

THIS stone is a mixture of several kinds of quartz, mainly the white, red, brown and black, disposed in layers or clouds. The layers are zigzag, circular or in straight bands (onyx). Occurs in irregular rounded masses ; not very translucent ; not altered by heat or acids ; cannot be cut with a knife nor split into plates ; takes a high polish ; lustre glassy ; gravity 2.5.

VALUE —Used for jewelry and ornamental work, mortars, vases, knife-handles, burnishers, etc. The colors are deepened by boiling in oil and then in sulphuric acid.

LOCALITIES. — Found in granite and trap regions, generally by the shores of rivers, lakes and the sea; as, north-west shore of Lake Superior; Missouri, Columbia, Colorado and Connecticut Rivers; Crescent City, Cal.; Hancock County, Ga.; near Tampa Bay, Fla; Fulton, Penn.; Yellowstone Lake, Wy.*

2.—ALUM.

Occurs in mealy or solid crusts, often fibrous; dissolves in water; tastes sweetish-astringent; melts and froths up when heated.

VALUE.—Extensively used in dyeing and calico-printing, candle-making, dressing skins, clarifying liquors and in pharmacy.

LOCALITIES.—Found incrusting and impregnating dark slaty rocks, with yellow

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* Only the best known localities in the United States are given. For these we are indebted mainly to Professor Dana's great work on Mineralogy.

streaks. Cape Sable, Md ; Cleveland County, N. C. ; coal slates on Ohio River, and in caves in Sevier, De Kalb, Coffee and Franklin Counties, Tenn. ; also Esmeralda and Storey Counties, Nev.

3.—AMETHYST.

Same as *Rock Crystal*, but colored purple or bluish violet. Generally in clustered crystals.

VALUE.—When clear and finely colored, it is a favorite gem.

LOCALITIES.—Usually found with agate. Keweenaw Point, Pic Bay and Gargontwa on Lake Superior ; Bristol, R. I ; Surry, N. H. ; East Bradford, Aston, Chester, Thornbury, Edgemont, Sadsbury, Birmingham, Middletown and Providence, Penn. ; Greensboro, N. C.

4.—ANTHRACITE.

Occurs massive ; compact ; high lustre ; brittle ; breaks with a curved surface ; will not scratch marble ; burns, but not readily, with a pale blue flame and little smoke ;

will not form coke by roasting; gravity 1.4 to 1.8.

VALUE.—Used for fuel and sometimes cut into inkstands, etc.

LOCALITIES.—Found in beds between slates and sandstones, and east of the Alleghany range only, as Eastern Pennsylvania; Portsmouth, R. I.; Mansfield, Mass.; North Carolina. No workable beds will be found in New York.

The rocks in anthracite regions are tilted, bent and broken, never level to any great extent. Impressions of leaves are good indications.

5.—ANTIMONY ORE.

Occurs fibrous or granular; color lead gray, often tarnished; shining lustre, brittle; but thin pieces can be cut off with a knife; melts in a candle, at a high heat passing off in vapor; gravity 4.5.

VALUE.—The source of the antimony of commerce, containing seventy per cent.

LOCALITIES.—Found associated with *Silver*, *Spathic Iron*, *Blende*, *Baryta* and

Quartz. Carmel, Me.; Lyme, N. H.; Soldier's Delight, Md.; Aurora, Nev.; San Amedio Cañon and Tulare County, Cal.

6 —ASBESTUS.

Occurs finely fibrous, flax-like; flexible, not elastic; silky lustre, sometimes greenish; gravity 3.

VALUE. — Used for lining safes and steam-packing, and for making incombustible cloth, lamp-wicks, etc.

LOCALITIES.—Found in granite-regions east of the Alleghanies; often with *Serpentine.* Brighton, Dedham, Newbury, Pelham and Sheffield, Mass.; Milford, West Farms, Winchester and Wilton, Conn.; Chester, Mt. Holly and Cavendish, Vt.; Patterson, Phillipstown, Monroe and Staten Island, N. Y.; Brunswick, N. J.; East Nottingham, Goshen and Aston, Penn; Bare Hills and Cooptown, Md.; Barnet's Mills, Va.

7.—ASPHALTUM.

Occurs massive; brittle; breaking with high lustre like hardened tar, and with curved surface; melts and burns readily with flame and smoke; gravity 1.2, sometimes floats on water.

VALUE.—Used for cements and varnishes.

LOCALITIES.—Found generally near the surface. Near the coast of Santa Barbara, Cal.; West Virginia, twenty miles south of Parkersburg.

8.—AZURITE.

Occurs in crystals and masses with glassy lustre, or earthy and dull; brittle; crackles and blackens, and finally fuses by heat; dissolves with effervescence in nitric acid; gravity 3.5.

VALUE.—A valuable ore of copper, containing sixty per cent.

LOCALITIES.—Found chiefly in lead and copper mines. Perkiomen lead mine, Cornwall, Phoenixville and Nicholson's Gap, Pa; near New Brunswick, N. J.; near Mineral Point, Wis.; Polk County, Tenn.; Calaveras and Mariposa Counties, Cal.; near Virginia City, Mont.

9.—BARYTA, OR HEAVY SPAR.

Occurs in crystals, plates and masses; powder white; brittle; crackles when strongly heated; not dissolved in acids; easily distinguished by its weight; gravity 4.5, or twice as heavy as *Gypsum*.

VALUE.—Used extensively as white paint and in pottery.

LOCALITIES.—Found in mining districts, often with lead, copper and iron ores, and in limestone. Piermont, N. H.; Hatfield, Southampton and Leverett, Mass.; Cheshire and Berlin, Conn.; Pillar Point, Rossie, Carlisle, Scoharie, De Kalb, Gouverneur, N. Y.; Fauquier and Buckingham Counties, Va.; Union, Gaston and Orange Counties, N. C.; near Paris, and in Anderson, Fayette, Mercer and Owen Counties, Ky.; on Brown's Creek and Haysboro, Tenn.; Bainbridge, O.; Scales Mound, Ill; Prince Vein, Lake Superior; Mine-a-Barton, Mo.; near Fort Wallace, N. M.; Ingo County, Cal.

10.—BITUMINOUS COAL.

Occurs in masses, beds or seams; softer and duller than *Anthracite;* often a bright pitchy lustre; brittle, showing a slaty or jointed structure rather than curved surface; powder black; burns readily with yellow flame; by roasting forms coke; gravity 1.5 or less.

VALUE.—Used for fuel and the production of gas, coke, carbolic acid and aniline.

LOCALITIES.—Found west of Harrisburg, Pa., in rocks (slates and sandstones) less disturbed than in the *Anthracite* region. Western Pennsylvania; South-east Ohio; West Virginia; Eastern Kentucky and Tennessee to Tuscaloosa; North-west Kentucky; Illinois; Iowa; Missouri; Kansas; Arkansas; Northern Texas; Central Michigan; Owyhee County, Idaho; Deer Lodge and Gallatin Counties and sixty miles north-east of Bannock, Mont.

11.—BLENDE.

Occurs in crystals and masses; waxy lustre, but not always very apparent; usual color, rosin-yellow to dark brown; brittle; the powder, which is whitish to reddish-brown, dissolves in muriatic acid giving off the odor of rotten eggs; by roasting gives off sulphur-fumes; infusible alone, but on charcoal at a high heat gives off white fumes; gravity 4.

VALUE.—An ore of zinc (containing sixty-six per cent.) and a source of white vitriol. Often worked for its *Silver* and *Gold.*

LOCALITIES.—Found with lead and other ores. Lubec and Bingham, Me. Eaton, Warren and Shelburne, N. H.; Sterling, Southampton and Hatfield, Mass.; Brookfield, Berlin, Roxbury and Monroe, Conn.; near Wurtzboro', Cooper's Falls, Mineral Point, Fowler, Ancram, Clinton and Spraker's Basin, N. Y.; Wheatley and Perkiomen lead-mines, Schuylkill, Shannonville and Friedensville, Pa.; Austin's lead-mine, Va.; Haysboro', Brown's Creek and Polk Counties, Tenn.; Prince Vein, Mich.; Dubuque, Ia.; Warsaw, Rosiclare and Galena, Ill.; Shullsburg, Wis.; Stillwater, Minn.

12.—Bog Iron Ore.

Occurs in masses or beds, looking much like hard brown earth; loose or porous and earthy, rather than compact and nodular; powder yellowish-brown; when strongly heated becomes black and magnetic; gravity nearly 4. An earthy yellow variety is called *Yellow Ochre.*

Value.—An important ore, yielding thirty-five per cent.

Localities.—Found in low, marshy grounds; widely distributed. Lebanon, N. H.; Berkshire and Plymouth Counties, Mass.; Columbia, St. Lawrence, Franklin and Jefferson Counties, N. Y.; New Limerick, Katahdin, Newfield, Shapleigh, Argyle, Clinton, Williamsburg and Lebanon, Me.; Darien and Martin Counties, Ind.; Monmouth County, N. J.; Somerset and Worcester Counties, Md.; Michigan, Ohio, Illinois, Wisconsin, etc.

13.—BRITTLE SILVER ORE.

Occurs in crystals and masses; metallic lustre; tarnishes yellow, gray and finally black; easily cut or broken; when heated gives off fumes of sulphur and antimony, affording a button of silver; dissolved in nitric acid, it silvers copper placed in it; gravity 6.

VALUE.—A rich ore of silver, containing over sixty per cent.

LOCALITIES.—Found in veins with other silver ores, in Nevada and Idaho.

14.—BROWN COAL.

Occurs like *Bituminous Coal*, but usually brownish-black with less lustre, and often showing a woody or slaty structure; powder always brown; contains fossil plants; gravity between 1.2 and 1.5.

VALUE.—Inferior to No. 10. Makes no coke. Can be used in the manufacture of alum.

LOCALITIES.—Found in thin veins or elliptical masses, never in extensive layers like Pennsylvania coal. Near Richmond, Va.; Deep River, N. C.; Michigan, Missouri, Texas; Evanston, Utah; Coal Creek and Bellmonte, Col.; Boreman, Dearborn River and Greenhorn Gulch, Mont.

15.—CALAMINE.

Occurs in crystals and masses; glossy lustre; harder than marble; brittle; heated it swells up, becomes opaque and emits a green light; dissolves, when powdered, in hot sulphuric acid without effervescence; gravity 3.4.

VALUE.—An ore of zinc yielding from forty to sixty per cent.

LOCALITIES.—Found in limestone rock with other ores. Friedensville, Perkiomen, Phœnixville, Lancaster and Selin's Grove, Pa.; Austin's Mines in Wythe County, Va.; Claiborne County, Tenn.; Jefferson County, Mo.

16.—CANNEL COAL.

Occurs in compact masses; dull lustre; brittle, breaking with a curved surface;

burns readily but does not melt ; does not soil the fingers ; gravity about 1.2.

Value.—Used for fuel and for making gas, oil and ornaments.

Localities.—Found in the Mississippi Valley ; Kentucky ; Lick, Ohio ; Illinois ; Moniteau County, Mo. ; Kenawha County, Va. ; Beaver County, Pa.

17.—Carnelian.

Occurs in masses or pebbles ; at first grayish, but by exposure to the sun becomes uniform flesh, red or brown, never striped,—although *Carnelian* may form one of the bands of an *Agate ;* brittle, breaking with a curved surface ; very hard ; takes a fine polish ; glassy or resinous lustre ; gravity 2.6.

Value.—Used for jewelry. When of two layers, white and red, (properly called sardonyx,) it is used for cameos.

Localities.—Same as *Agate.*

18.—Celestine.

Occurs crystallized, fibrous and massive ; color white, often faint bluish ; glassy lustre; very brittle; under the blow-pipe crackles and melts, tinging the flame red; does not dissolve in acids; gravity 4.

VALUE.—The source of nitrate of strontia, used in fire-works.

LOCALITIES.—Found in limestone, gypsum and sandstone. Rossie, Schoharie, Chaumont Bay, Depauville and Stark, N. Y.; Frankstown, Pa.; Strontian and Put-in-Bay Islands, Lake Erie; near Nashville, Tenn.; Fort Dodge, Iowa.

19.—CERUSSITE.

Occurs in crystals, in powder or masses; glassy lustre; brittle; dissolves in nitric acid with effervescence; heated strongly on charcoal crackles and fuses, giving a globule of lead; gravity 6.4.

VALUE.—A rich ore of lead yielding seventy-five per cent.

LOCALITIES.—Found in lead mines Southampton, Mass; Perkiomen, Phœnixville, Charlestown and Schuylkill, Pa; Wythe County, Va.; Washington Mine, N. C.; Valle's Diggings, Mine-la-Motte and Mine-a-Burton, Mo.; Davies and Rock Counties, Ill.; Blue Mounds, Wis.; Ingo County, Cal.

20.—CHROMIC IRON.

Occurs in compact masses; powder dark brown; small pieces sometimes attracted by the magnet; brittle, breaking with uneven surface; with borax melts into a green globule; not acted upon by acids; little lustre; gravity 4.4.

VALUE.—Used in making the chrome pigments.

LOCALITIES. — Found in *Serpentine*. Bare Hills, Cooptown and north part of Cecil County, Md.; Nottingham, W. Goshen, Williston, Fulton, Mineral Hill, Texas and Unionville, Pa.; Jay, New Fane, Westfield and Troy, Vt.; Chester and Blanford, Mass.; Loudon County, Va.; Yancy County, N. C.; North Almaden, New Idria and Coloma, Cal.

21.—CINNABAR.

Occurs in granular or earthy masses; resembles iron-rust, but is a yellowish-red;

powder scarlet; easily cut with a knife; thrown on red-hot iron, evaporates, giving off odor of sulphur; rubbed on copper, "silvers" it; gravity 9, or about as heavy as *Copper.*

VALUE.—The source of mercury (containing eighty-four per cent.) and vermilion.

LOCALITIES.—Found in slate and limestone rocks. Centreville, Coulterville, New Idria and New Almaden, and Lake and San Luis Obispo Counties, California; Idaho.

22.—COBALT PYRITES.

Occurs crystallized and massive; does not scratch glass easily; metallic lustre; tarnish, copper-red; powder, blackish-gray; brittle; heated on charcoal gives off sulphur fumes; heated with borax gives a blue glass; gravity 5.

VALUE.—An ore of cobalt, yielding twenty per cent.

LOCALITIES.—Usually found in slate or granite rocks with *Copper Pyrites.* Mineral Hill, Md.; Mine-la-Motte, Mo.

23.—COPPER.

Occurs in irregular masses; metallic lustre; can be cut with a knife; malleable; ductile; fusible; gravity 8.8.

VALUE.—A source of copper and silver.

LOCALITIES.—Most abundant in the trap and "freestone" regions. New Brunswick, Somerville, Schuyler's and Flemington, N. J.; Whately, Mass.; Cornwall and Shannonville, Pa.; Polk County, Tenn.; Keweenaw Point, Lake Superior; Calaveras, Amador and Santa Barbara Counties, Cal.; on Gila River, Ariz.

24.—COPPER GLANCE.

Occurs crystallized and massive; color, blackish lead-gray, often tarnished blue or green; nearly as hard as marble; brittle; a splinter will melt in a candle, giving off the odor of sulphur; dissolved in nitric acid, it will coat a knife-blade with copper; metallic lustre; gravity 5.5.

VALUE.—An ore of copper, yielding seventy-five per cent.

LOCALITIES.—Found at copper-mines.

Simsbury, Bristol and Cheshire, Conn.; Schuyler's Mines, N. J.; Orange County, Va.; near Newmarket, Md.; Lake Superior copper-region; La Paz, Arizona; Washoe, Humboldt, Nye and Churchill Counties, Nev.

25.—COPPER NICKEL.

Occurs in masses; metallic lustre; color pale copper-red; tarnishes gray to black; powder pale brownish-black; brittle; on charcoal melts giving the odor of garlic; becomes green in nitric acid; gravity 7.5.

VALUE.—An ore of nickel (containing forty-four per cent.) and arsenic.

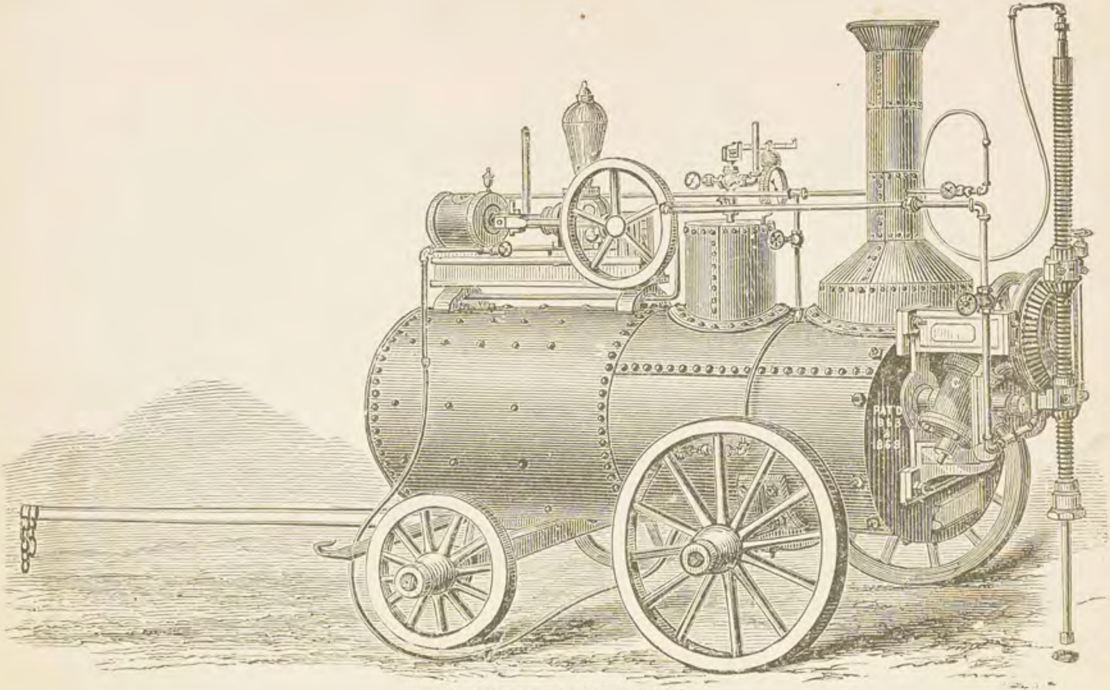
LOCALITIES.—Found in granite regions. Chatham, Conn.

26.—COPPER PYRITES.

Occurs in crystals and masses; color brass-yellow; tarnishes green; metallic lustre when freshly broken; can be cut with a knife; brittle; powder greenish black; on charcoal melts giving off sulphur fumes; dissolves in nitric acid, making a green liquid; gravity 4.2.

VALUE.—If of a fine yellow hue, it is a valuable copper ore (yielding from twelve to forty per cent.) and source of blue vitriol.

LOCALITIES.—Found in mountainous or granite regions with other ores. Lubec and Dexter, Me.; Franconia, Unity, Warren, Eaton, Lyme, Haverhill and Shelburne, N. H.; Corinth, Waterbury and Strafford, Vt.; Southampton, Turner's Falls, Hatfield and Sterling, Mass.; Bristol and Middletown, Conn.; Ancram, Rossie, Wurtzboro' and Ellenville, N. Y.; Phœnixville and Pottstown, Pa.; Bare Hills, Catoctin Mountains, near Newmarket and Finksbury, Md.; Phœnix and Walton Mines, Va.; Greensboro, Charlotte and Phœnix Mines, N. C.; Hiwassee Mines, Tenn; Cherokee, Rabun and Habersham Counties, Ga.; Presque Island, Lake Superior; Mineral Point, Wis.; Union, Keystone, Empire and other mines, Calaveras County, La Victoire and Haskell claims in Mariposa County, Amador and Plumas Counties, Cal.; near Virginia City, Mont.



PROSPECTING DIAMOND DRILL.

27.—DIAMOND.

Occurs in crystals and irregular angular masses; cannot be scratched by any other mineral or the file; brilliant lustre; feels cold to the touch; when rubbed on the sleeve exhibits electricity for hours; retains the breath but a short time; often tinged yellow, red, or green; gravity 3.5.

VALUE.—Used for jewelry, lenses and for cutting glass.

LOCALITIES.—Found in gold-regions, in river-washings of sand and pebbles; usually with coarse gold, but deeper down. Rutherford, Cabarras, Franklin and Lincoln Counties, N. C.; Hall County, Ga.; Manchester, Va.; Cherokee Ravine, N. San Juan, French Canal, Forrest Hill, Placerville and Fiddletown, Cal.

28.—EMERY.

Occurs in granular masses, sometimes with bluish crystals; looks like fine grained iron ore; breaks with uneven surface; scratches quartz easily; very tough; brittle; gravity 4.

VALUE.—Used extensively as a cutting and polishing material.

LOCALITIES.—Found generally in limestone or granite with *Magnetic Iron Ore.* Chester, Mass.; Newlin and Unionville, Penn.; Macon and Guilford Counties, N. C.

29.—FLUOR SPAR.

Occurs in square crystals and in masses; glassy lustre; powder white; brittle; crackles when heated and then shines in the dark; does not effervesce with acids; is not scratched by marble; gravity 3.

VALUE.—Used as flux in glass and iron works.

LOCALITIES.—Found in limestone, granite, slate, etc., often at lead-mines. Blue Hill Bay, Me.; Westmoreland, N. H.; Putney, Vt.; Southampton, Mass.; Trumbull, Plymouth, Middletown and Willimantic, Conn.; Muscolonge Lake, Rossie and Johnsburg, N. Y; near Franklin, N. J.; near Woodstock and Shepardstown, Va.; Smith County, Tenn.; Mercer County, Ky.; Gallatin County, along the Ohio, Ill. Castle Dome District, Ariz.

30.—FRANKLINITE.

Occurs crystallized and in masses; generally made of coarse grains; brittle; powder dark reddish-brown; heated with soda turns bluish-green; dissolves in muriatic acid; gravity 5.

VALUE.—An ore of zinc.

LOCALITIES.—Found in limestone with *Garnet* and *Zincite.* Hamburg and Stirling Hill, N. J.

31.—GALENA.

Occurs in crystals and masses; brilliant lustre; brittle; easily broken; powder, when finely rubbed is black; can be cut with a knife; heated it gives off sulphur and melts; dissolves in nitric acid leaving a white powder at the bottom; gravity 7.5—or a little heavier than cast-iron.

VALUE.—The main source of lead (yielding eighty per cent), and also smelted for the silver it contains. Used also in glazing stone-ware.

LOCALITIES.—Generally found in limestone with *Iron Pyrites*, zinc-ore, etc. That found in slate is richest in silver. Abounds in Missouri, Illinois, Iowa, Wisconsin and Arkansas ; Rossie, Wurtzboro, Ancram, Macomb and Ellenville, N. Y ; Lubec, Blue Hill Bay, Bingham and Parsonsville, Me. ; Eaton, Shelburne, Haverill, Warren and Bath, N. H. ; Thetford, Vt. ; Southampton, Leverett and Sterling, Mass. ; Middletown and Roxbury, Conn. ; Phœnixville, Charlestown, Schuylkill, Pequea Valley and Shannonville, Pa. ; Austin's and Walton's Mines, Va ; Cabarras County, N. C. ; Brown's Creek and Haysboro, Tenn. ; Chocolate River, Mich. ; Ingo County, Cal. ; on Walker's River and Steamboat Springs, Nev. ; Castle Dome and Eureka, Ariz. ; Clear Creek County, Col. ; Virginia City and Red Bluff Lode, Mont. ; Cache Valley, Utah.

32.—GARNET.

Occurs in crystals with four-sided faces, often nearly round ; deep red, which grows darker by heat; rarely yellow; also in brown masses; melts at a high heat; brittle; not scratched by a knife; glassy lustre; gravity 4.

VALUE.—The clear deep red and yellow varieties are used for jewelry; the massive brown is ground for "emery."

LOCALITIES.—Found in slate and granite rocks. Bethel, Parsonsfield, Phippsburg, Windham, Brunswick and Ranford, Me.; Hanover, Franconia, Haverhill, Warren, Unity, Lisbon and Grafton, N. H.; New Fane, Cabot and Cavendish, Vt.; Carlisle, Boxborough, Brookfield, Brimfield, Newbury, Bedford, Chesterfield and Barre, Mass.; Reading, Monroe, Haddam and Middletown, Conn.; Rogers' Rock, Crown Point, Willsboro, Middletown, Amity, and near Yonkers, N. Y.; Franklin, N. J.; Pennsbury, Warwick, Aston, Knauertown, Chester, Leiperville and Mineral Hill, Pa.; Dickson's Quarry, Del.; Hope Valley, Cal.; near Virginia City, on Yellowstone and Madison Rivers, Mont.

33.—GOLD.

Occurs in scales, grains and nuggets, or disseminated through cellular quartz; metallic lustre; without tarnish; can be cut and hammered into thin plates; not dissolved by nitric acid; gravity 19, when pure and of a rich gold yellow color. The pale or brass yellow specimens are much lighter, the gravity being as low as 13. A grayish yellow gold, occurring in small, flat grains has a gravity of about 16.

LOCALITIES.—Found in veins of quartz running through greenish or grayish slates, the quartz at the surface being generally full of cavities and rusted, and the slates below the surface often containing little cubic crystals of *Iron Pyrites:* also in the valleys traversed by mountain-streams and in the river sands and gravel below. *Iron* and *Copper Pyrites*, *Galena* and *Blende* frequently contain gold. Masses of quartz and pyrites from the gold-regions, which make no show of gold, sometimes pay well; the value of such specimens can be

WASHING AURIFEROUS SANDS.

determined only by an assayer. Eastern range of Appalachians, as Habersham, Rabun, Clark, Hall, Lumpkin and Lincoln Counties, Ga.; Abbeville, Chesterfield, Union, Lancaster and Pickens Counties, S. C.; Montgomery, Cabarras, Mechlenburg, Burke and Lincoln Counties, N. C.; Spotsylvania, Buckingham, Fauquier, Stafford, Culpepper, Orange, Goochland and Louisa Counties, Va.; Dedham, Mass.; Bridgewater, Vt.; Canaan and Lisbon, N. H.; on Sandy River and Madrid, Me. Numberless points along the higher Rocky Mountains and western slope of Sierra Nevada, as near Santa Fe, Cerillos and Avo, New Mex.; San Francisco, Wauba and Yuma District, Ariz.; between Long's Peak and Pike's Peak, Col.; Comstock Lode, Nev.; Owyhee, Boise and Flint Districts and Poorman Lode, Idaho; Emigrant and Alder Gulches, Red Bluff and near Jefferson River, Mont.; Josephine District, Powder, Burnt, and John Day Rivers, western slope of Cascade Mountains, and southern coast, Oregon; Tularè, Fresno, Mariposa, Tuolumne, Calaveras, El Dorado, Placer, Nevada, Yuba, Sierra, Butte, Plumas, Shasta, Siskiyou Amador and Del Norte Counties, Cal. Rare in the coal-regions and Mississippi Valley.

34.—GRAPHITE.

Occurs in foliated, scaly and granular masses; can be cut into thin slices, which are flexible, but not elastic; impressible by the nail; feels greasy; leaves a shining trace on paper; metallic lustre; not altered by heat or acids; gravity 2.

VALUE.—Used for pencils, polishing, glazing, for making steel, crucibles, overcoming friction, etc.

LOCALITIES.—Found in granite, slate and limestone rocks. Sturbridge, North Brookfield, Brimfield, Hinsdale and Worthington, Mass.; Cornwall and Ashford, Conn.; Brandon, Vt.; Woodstock, Me.; Goshen, Hillsboro and Keene, N. H.; Ticonderoga, Fishkill, Roger's Rock, Johnsburg, Fort Ann, Amity, Rossie and Alexandria, N. Y.; Franklin and Lockwood, N. J.; Southampton and Buck's County, Penn.; on the Gunpowder, Md.; Albemarle County, Va.; Wake, N. C.; Tiger River and Spartanburgh, S. C.; Sonora, Cal. (The soft black slate, often mistaken for *Graphite*, leaves a coaly trace on paper not a shining streak.)

35.—GRAY COPPER ORE.

Occurs in crystallized or granular masses; metallic lustre; color between steel-gray and iron-black; brittle; the powder dissolved in nitric acid makes a brownish green solution; melts at a red heat; gravity 5.

VALUE.—An ore of copper, (containing thirty-three per cent.) and silver, of which Nevada specimens have sixteen per cent.

LOCALITIES.—Found with gold, silver and lead. Kellogg Mines, Ark.; Mariposa and Shasta Counties, Cal.; Sheba and De Soto Mines, and near Austin, Nev.; Heintzelman and Santa Rita Mines, Arizona.

36.—Gypsum.

Occurs in plates, fibres coarse and fine, and massive; pearly or glistening; powder white, which if heated and mixed with water, turns hard; does not dissolve in sulphuric acid; may be scratched by the nail; gravity 2.3.

Value.—Used for stucco, manure, glazing, statuary, manufacture of glass, etc. A variety, called *Satin Spar*, worked into necklace beads and other ornaments, is finely fibrous and compact, taking a polish (though easily scratched,) and then resembles pearl or opal.

Localities.—Found with marl or clay, limestone and salt. Camillus, Manlius, Stark and Lockport, N. Y.; on the St. Mary's and Patuxent, Md.; Washington County and Lynchburg, Va.; Charleston, S. C.; Poland, Ottawa and Canfield, O.; Davidson and Summer Counties, Tenn.; Grand Rapids and Sagenaw Bay, Mich.; Des Moines River, Iowa; Walker Lake and Six Mile Cañon, Nev.; Fort Dodge.

37.—Horn Silver.

Occurs in crystals, wax-like masses, or in crusts ; when scratched shows a shining streak ; becomes brown on exposure ; quite soft, easily cut ; a small piece placed on zinc and moistened, swells up, turns black and shows metallic silver on being pressed with a knife ; dissolves in hartshorn ; gravity 5.5.

Value.—An ore of silver, yielding seventy per cent.

Localities.—Found in slate with other silver ores. Lake Superior Mining Region ; Austin and Comstock Lode, Nev. ; Willow Springs and San Francisco districts, Eldorado Cañon, Ariz. ; Poorman Mine, Idaho.

38.—Iron Pyrites.

Occurs in masses and square crystals ; splendent lustre ; color, bronze-yellow ; brittle ; strikes fire with steel ; heated it gives off sulphur fumes ; powder brownish ; gravity 5.

Value.—Affords sulphur, copperas and

alum. When found outside of the coal region, it often contains gold and silver.

LOCALITIES.—Found in all kinds of rocks. Bingham, Corinna, Farmington, Waterville, Brooksville, Peru and Jewett's Island, Me.; Shelburne, Unity and Warren, N. H; Baltimore, Hartford and Shoreham, Vt.; Heath, Hubbardston and Hawley, Mass.; Roxbury, Monroe, Orange, Milford, Middletown, Stafford, Colchester, Ashford, Tolland and Union, Conn.; Rossie, Malone, Phillips, Johnsburgh, Canton, Chester, Warwick and Franklin, Putnam and Orange Counties, N. Y.; Chester, Knauertown, Cornwall and Pottstown, Pa.; Greensboro', N. C.; Mercer County, Ky.; Bainbridge, O.; Galena at Marsden's Diggings, Ill.; on Sugar Creek, Ind.; mines of Colorado and California.

39.—JASPER.

Occurs in masses, either in veins or as rounded stones; dull lustre, yet takes a high polish; breaks with a curved surface;

not attacked by acids; is scratched by *Rock Crystal;* gravity 2.5.

VALUE.—Used for mosaics and other ornaments when compact, fine-grained and bright color.

LOCALITIES.—Found everywhere. Sugar Loaf Mountain and Machiasport, Me.; Saugus, Mass.; Castleton and Colchester, Vt.; Bloomingrove, N. Y.; Murphy's, Col.; Red Bluff, Mont.

40.—KAOLIN.

Occurs in beds; it is a fine, white clay, plastic when wet; when dry is scaly or compact; can be crumbled in the fingers and feels gritty; adheres to the tongue; does not dissolve in acids.

VALUE.—Used for the finest porcelain and for adulterating candy.

LOCALITIES. — Found generally with iron-ore and fire-clay. Common on the eastern slope of the Alleghanies; Branford, Vt.; Beekman, Athol, Johnsburgh and McIntyre, N. Y.; Perth Amboy, N. J.; Reading, Tamaqua and New Garden, Penn.; Mt. Savage, Md.; Richmond, Va.; Newcastle and Wilmington, Del.; Edgefield, S. C.; near Augusta, Ga.; Jacksonville, Ala.

41.—LENTICULAR IRON ORE.

Occurs in beds or masses, consisting of minute flattened grains; little lustre; generally soils the fingers; breathed upon has a clayey odor; color, brownish-red, powder more red; dissolves in strong muriatic acid with some effervescence; brittle; gravity 4.

VALUE.—An ore of iron yielding thirty-three per cent. Generally mixed with other ores at the furnace.

LOCALITIES. — Found in sandstone Wayne, Madison, Oneida and Herkimer Counties, N. Y.; Marietta O.

42.—LIMONITE, OR BROWN HEMATITE.

Occurs in masses, with smooth rounded surfaces and fibrous structure; sometimes as hollow nodules, which are velvety-black inside; its powder when rubbed is yellowish-brown; when strongly heated turns black; scratches glass feebly; brittle; dissolves in hot aqua-regia; gravity 4.

VALUE.—A common ore of pig-iron, containing sixty per cent.; used also for polishing buttons, etc.

LOCALITIES. — Found in heavy beds with mica-slate, quartz, limestone, etc. Salisbury and Kent, Conn.; Amenia, Fishkill, Dover and Beekman, N. Y.; Richmond and Lenox, Mass.; Pittsfield, Putney, Bennington and Ripton, Vt.; Hamburgh, N. J.; Pikeland and White Marsh, Penn.; Marquette, Mich.; Makoquata River, Iowa; Iron Mountains, Stow and Green Counties, Mo.; Centerville, Ala.; near Raleigh and Smithfield, N. C.; on Coal Creek, Col.; and in coal areas generally.

43.—MAGNETIC IRON ORE.

Occurs in granular masses, coarse or fine; attracted by the magnet, or affecting the compass-needle; powder black; brittle; dissolves in muriatic acid; gravity 5.

VALUE.—An important ore, yielding sixty-five per cent.

LOCALITIES.—Found in granite, slate and limestone rocks. Warren, Essex, Clinton, Saratoga, Herkimer, Orange and Putnam Counties, N. Y.; Raymond and Marshall's Island, Me.; Franconia, Jackson, Winchester, Lisbon, Swanzey and Unity, N. H.; Bridgewater, Chittenden, Marlboro, Rochester, Troy and Bethel, Vt.; Cambealon, R. I.; Hawley and Bernardston, Mass.; Haddam, Conn.; Goshen, Webb's Mine, Cornwall and White Marsh, Penn.; Hamburg, N. J.; Scott's Mills and Deer Creek, Md.; Mitchell and Madison Counties, N. C.; Spartanburg, S. C.; Laclede and Crawford Counties, Mo.; Sierra County, (Gold Valley,) Plumas, Tulare, Mariposa, Placer and El Dorado Counties, Cal.

44.—MAGNETIC PYRITES.

Occurs massive; brittle; deep orange-yellow; powder grayish-black; metallic lustre; tarnishes easily; slightly attracts the compass-needle ; melts at a high heat, giving off sulphur-fumes ; gravity 4.5.

VALUE.—Affords sulphur, copperas and nickel.

LOCALITIES.—Found in granite regions, often with copper and iron ores. Stafford, Corinth and Shrewsbury, Vt. Trumbull and Monroe, Conn. ; Port Henry, Diana and Orange County, N. Y ; Hurdstown, N. J. ; Gap Mine, Lancaster County, Pa. ; Ducktown Mines, Tenn.

45.—MALACHITE.

Occurs in incrustations with smooth surface and fibrous ; powder paler green than the mineral ; brittle ; by heat crackles and turns black ; effervesces in acids ; takes a fine polish, showing bands or rings ; gravity 4.

VALUE.—Used for jewelry and inlaid work.

LOCALITIES.—Found in copper and lead mines. Cheshire, Conn. ; Brunswick and Schuyler's Mines, N. J. ; Morgantown, Cornwall, near Nicholson's Gap, Perkiomen and Phœnixville Lead Mines, Pa.; Petapsco Mines, Md.; Davidson County N. C.; Polk County, Tenn.; Left Hand River and Mineral Point, Wis.; Falls of St. Croix, Minn.; Jefferson County and Mine la Motte, Mo.; Calaveras County, Cal.; Big Williams' Fork, Ariz.; Wild Cat Cañon and near Virginia City, Mont.

46.—MANGANESE SPAR.

Occurs in masses; glassy lustre; color flesh or rose-red; becomes black on exposure; tough; melted with borax gives a violet-blue color; gravity 3.5.

VALUE.—Used in glazing stone-ware.

LOCALITIES.—Found in granite regions, often with iron-ore. Blue Hill Bay, Me.; Cummington, Warwick and Plainfield, Mass.; Irasburg and Coventry, Vt.; Winchester, and Hinsdale, N. H.; Cumberland, R. I.; Franklin and Hamburg, N. J.

47.—MARBLE.

Occurs coarse and fine granular; frequently veined or mottled; brittle; can be cut with a knife; takes a polish; effervesces with acids; reduced to quicklime by heat; a gray variety contains stems and joints of worm-like fossils; gravity 2.5.

LOCALITIES.—Brandon, Rutland, Dorset, Shoreham, Pittsford, Middlebury, Fairhaven, Cavendish, Lowell, Troy and Sudbury, Vt.; West Stockbridge, Egremont, Great Barrington, Lanesboro, New Ashford, Sheffield, New Marlboro, Adams, Cheshire and Stoneham, Mass.; Clinton, Essex, Dutchess, Onondaga, Putnam, St. Lawrence, Warren and Westchester, Counties, N. Y.; Smithfield, R. I.; New Haven, Milford, Conn.; near Philadelphia, N. J.; Texas and Hagerstown, Md.; Lancaster County, Pa.; Jefferson and Genevieve Counties, Mo; Knox and Sevier Counties, Tenn.; Joliet, Ill.; Cherokee and Macon Counties, N. C.; Marquette, Mich.; near Deep River and on the Michigamig and Menominee Rivers, Wis.

48 —MICA.

Occurs in masses, which can be split into very thin, elastic leaves; pearly lustre; at a high heat becomes opaque; gravity 3.

VALUE.—Used for doors of stoves, etc.

LOCALITIES.—Found in granite regions. Buckfield, Freeport and Oxford, Me.; Acworth, Grafton and Alstead, N. H.; Chesterfield, Barre, Mendon, South Royalston, Brimfield, Goshen and Russell, Mass.; Monroe, Haddam and Middletown, Conn.; Warwick, Edenville, Edwards, Monroe and Greenfield, N. Y.; Pennsbury, Thornbury, Unionville, Middletown and Chestnut Hill, Pa.; Jones' Falls, Md.

49.—MICACEOUS IRON ORE.

Resembles *Specular Iron Ore*, but consists of thin shining scales or leaves; powder dark red; a thin flake is translucent, showing red light; feels somewhat slippery.

VALUE.—Used as an ore of iron and for polishing.

LOCALITIES.—Hawley, Mass.; Piermont, N. H.; Ticonderoga, N Y.; Warwick, Penn.; Loudon County, Va.

50.—NITRE.

Occurs in thin crusts, delicate needles, or disseminated through the loose earth in caves; glossy lustre; brittle; cool, saline taste; crackles and burns brightly on live coals; a little harder than *Gypsum.*

VALUE.—Used in the manufacture of gunpowder, fulminating powders, nitric acid, etc.

LOCALITIES.—Marion County, Ky.; White County, Tenn.; near Rosiclare, Ill.; Silver Peak, Nev.

51.—OXYD OF MANGANESE.

Occurs in masses and little columns, often with small rounded surfaces; one ore is soft enough to be impressed by the nail, and soils; the other will scratch glass faintly; heated with borax, makes a violet glass; dissolves in hot muriatic acid, giving forth a yellowish-green gas; gravity 4 to 5.

VALUE.—Used for bleaching and for obtaining oxygen.

LOCALITIES.—Found in granite regions,

often with iron-ore. Brandon, Bennington, Monkton, Irasburg and Chittenden, Vt.; Hillsdale, Westmoreland and Westchester, N. H.; Plainfield, West Stockbridge and Conway, Mass.; Salisbury and Kent, Conn.; Montgomery County, Md.; Lake Superior Mining Region; Dubuque, Iowa; Deep Diggings, Mo.; Red Island, Cal.; Martinsburg, N. Y.

52.—PLATINUM.

Occurs in grains or lumps; metallic, silvery lustre; can be hammered out; heavier and harder than silver; not dissolved in nitric acid; gravity 17.

VALUE.—Nearly equal to *Gold*. Used for making chemical and philosophical apparatus, for coating copper, brass, etc.

LOCALITIES.—Found in river-gravel with *Gold*. Rutherford County, N. C.; Klamath region, Cape Blanco, on Salmon River, South Fork of Trinity, Butte, Honcut, Cañon and Wood's Creeks, and on Middle Fork of American River, Cal.; at Gold Flat, Nev.

53.—RED COPPER ORE.

Occurs in crystals and masses; cochineal-red; powder brownish-red; nearly opaque; brittle; dissolves in nitric acid; heated on charcoal yields a globule of copper; gravity 6.

VALUE.—Affords copper, (sixty per cent.,) and blue vitriol.

LOCALITIES.—Found in trap regions with other copper ores. Schuyler's, Somerville, New Brunswick and Flemington Mines, N. J.; Cornwall, Pa.; Ladenton, N. Y.; Lake Superior Region. Not abundant.

54.—RED HEMATITE.

Occurs in compact masses, with rounded surfaces or kidney-shaped; fibrous structure; color brownish-red to iron-black; but powder invariably red; when black, the lustre is somewhat metallic, otherwise dull; brittle; scratches glass with difficulty; dissolves slowly in strong muriatic acid; gravity 4.5 to 5.

VALUE.—An ore of iron, yielding from

thirty-six to fifty per cent. In powder, used as pigment and for polishing metals.

LOCALITIES.—Found usually in beds with granite or limestone. Aroostook County and Hodgdon, Me.; Antwerp, Ticonderoga, Crown Point and Gouverneur, N. Y.; Vernon, N. J.; West Whiteland, Pa; Chatham and Orange Counties, N. C.; Marquette, Mich; Shasta County, Cal. This mineral graduates into a soft, earthy variety, called *red ochre*, and into a compact, slaty variety, called *red chalk*, which has a clayey odor when breathed on.

55.—RED SILVER ORE.

Occurs in crystals and masses; metallic lustre; brittle; powder cochineal-red; easily cut; at a high heat yields a silver globule; the powder heated with potash turns black; gravity 6.

VALUE.—An ore of silver yielding sixty per cent.

LOCALITIES.—Found at gold and silver mines. Washoe and Austin, Nev.; Poorman Lode, Idaho.

56.—RENSSELAERITE.

Occurs in masses; wax-like; a trifle harder than marble; when fresh can be scratched by the nail; soapy feel; takes a polish; cleavable; gravity 2.8.

VALUE.—Used as a marble and worked into inkstands, etc.

LOCALITIES.—Found with *steatite*, *serpentine*, limestone, etc. Antwerp, Canton, Fowler, De Kalb, Edwards, Russell and Gouverneur, N. Y.

57.—ROCK CRYSTAL.

Occurs in crystals and masses; transparent; glassy lustre; colorless; tough; brittle; not acted upon by acids or heat; electric by friction; gravity 2.5.

VALUE.—Cut for ornaments, lenses, etc.

LOCALITIES.—Common in sandstone, limestone and iron ore. Paris, Me.; Benton and Bartlett, N. H.; Sharon and Woodstock, Vt.; Pelham and Chesterfield, Mass.; Ellenville, Little Falls, Watervliet, Fairfield, Middleville, Fowler, Antwerp, Rossie, Lake George and Palatine, N. Y.; Minnesota Mine, Lake Superior; Ouachita Spring, Ark.

58.—ROCK SALT.

Occurs in irregular beds or masses; brittle; saline taste; crackles in the fire.

LOCALITIES.—Found with *gypsum*, clay and sandstone. Washington County, Va.; Petit Anse, La.; Silver Peak, Nev.; Sal mon River Mountains, Oregon.

59.—RUTILE.

Occurs in crystals generally; metallic lustre; powder pale brown; brittle; unchanged by heat or acids; if powdered and fused with potash, then dissolved in muriatic acid, the solution boiled with tinfoil assumes a beautiful violet color; gravity 4.

VALUE:—Used for coloring porcelain and artificial teeth.

LOCALITIES.—Found in granite and limestone rocks. Warren, Me.; Merrimack, and Warren, N. H.; Bristol, Putney and Waterbury, Vt.; Windsor, Shelburne, Barre, Conway and Leyden, Mass.;

Monroe, Conn.; Warwick, Edenville, Amity and Kingsbridge, N. Y.; Sudsbury, West Bradford, Parksburg, Concord and Newlin, Pa.; Newton, N. J.; Crowder's and Clubb Mountains, N. C.; Habersham and Lincoln Counties, Ga.; Magnet Cave, Ark.

60.—SERPENTINE.

Occurs in masses; feeble, resinous lustre; color oily green; powder whitish; often yellowish gray on the outside; can be cut easily; takes a fine polish; becomes reddish by heat; gravity 2.5—same as *Marble.*

VALUE.—Worked into mantels, jambs, table-tops, and many other ornaments

LOCALITIES.—Found as a rock in large masses. Deer Isle, Me.; Baltimore, Cavendish, Jay and Troy, Vt.; Newbury, Blanford, Middlefield and Westfield, Mass.; Newport, R. I.; near New Haven and Milford, Conn.; Port Henry, Antwerp, Syracuse, Warwick, Phillipstown, Canton, Gouverneur, Johnsburg, Davenport's Neck, New Rochelle and Rye, N. Y.;

Frankford, Hoboken and Montville, N. J.; Texas, Pa.; Cooptown, Md.; Patterson, N. C.; Calaveras County, Cal.; Alder Gulch, Mont. Marble veined with serpentine is called *verd-antique*.

61.—Silicate of Copper.

Occurs in incrustations and masses; color bluish-green; not fibrous; surface smooth; easily cut; does not effervesce in acid; blackens by heat; gravity 2.

Value.—An ore of copper, yielding thirty per cent.

Localities.—Found with other copper ores. Somerville and Schuyler's, N. J.; Morgantown and Cornwall, Pa.; Wolcottville, Conn.; Big Williams' Fork, Ariz.

62.—Silver.

Occurs in masses, or strings and threads penetrating rocks and native copper and galena; metallic lustre; tarnishes grayish black; can be cut in slices and hammered out; dissolved in muriatic acid, it turns black on exposure; gravity 10

Localities.—Chiefly found with copper near trap-rocks, and in fine grained *galena* and dark brown *blende*. *Gold* contains from one to fifteen per cent. Bridgewater, N. J.; Davidson and Stanley Counties, N. C.; Lake Superior Region; Poorman's Lode, Idaho; Comstock Lode and Montezuma Ledge, Nev.; Alpine County and Maris Vein, Cal.; Clear Creek County, Col.

63.—SILVER GLANCE.

Occurs in small lumps, plates and threads; color dark gray; cuts like lead; melts in a candle giving off sulphur fumes; gravity 7.

VALUE.—The most important ore of silver, containing eighty-seven per cent.

LOCALITIES.—May be found almost everywhere, except in the coal regions; associated with other ores, quartz, limestone, baryta, etc. Most abundant where mineral veins cross one another. Comstock Lode, Gold Hill, Reese River, Cortez District and Silver-Sprout Vein, Nev.; Clear Creek County, Nev.

64.—SMALTINE.

Occurs in crystals and masses; metallic lustre; color tin-white to steel-gray; powder dark gray; brittle; gives off garlic odor in a candle; melted with borax makes a deep blue glass; gravity 6.5 to 7.

VALUE.—An ore of cobalt and arsenic, containing eighteen to seventy per cent.

LOCALITIES.—Found in veins in granite regions with other ores, Mine la Motte, Mo.; Chatham, Conn.

65.—SMITHSONITE.

Occurs in masses, often rounded, covered with minute crystals, or honeycombed; color white, dirty yellow or stone color; glassy lustre; brittle; effervesces in nitric acid; barely scratches glass; barely translucent; gravity 4.4.

VALUE.—Yields fifty per cent. of zinc.

LOCALITIES.—Found generally in limestone with *galena* and *blende*. Friedenville, Lancaster and Perkiomen, Pa.; Linden and Mineral Points, Wis.; Lawrence, County, Ark.; Ewing's Diggings, Minn.

66.—Spathic Iron.

Occurs in crystals or plates somewhat curving; also (in coal regions) in nodules with concentric layers like an onion; brittle; color varies from white to yellowish-brown or dark-brown; strongly heated it blackens and will then attract the compass needle; the powder effervesces in nitric acid; melted with borax makes a green or yellow glass; gravity 3.8.

Value.—Yields thirty per cent. of iron, well adapted for steel.

Localities.—Found in granite and coal-formations, often with other ores. Plymouth, Vt.; Sterling, Mass.; Roxbury, Conn.; Antwerp, Herman and Rossie, N. Y.; Fentress and Harlem Mines, N. C.; Coal Regions of Western Pa, Virginia, Eastern Ohio, etc.

67.—Specular Iron Ore.

Occurs crystallized and in large masses, high metallic lustre; color steel-gray or iron-black; brittle; opaque except when very thin; the powder when very fine and rubbed on white paper shows red; the powder dissolves slowly in muriatic acid; by a strong heat yields a black mass which attracts the needle; gravity 5.

VALUE.—Yields from fifty to seventy per cent. of iron.

LOCALITIES.—Found in granite regions. Marquette, Mich.; Pilot Knob and Iron Mountains, Mo.; St. Lawrence County, N. Y.; Bartlett, Lisbon and Franconia, N. H.; Chittenden and Weathersfield, Vt.; Sauk County, Wis.

68.—SPINEL RUBY.

Occurs in pyramidal crystals; glassy lustre; powder white; scratches *rock-crystal;* by heat becomes black; gravity 3.5.

VALUE.—A gem; clear specimens weighing over four carats, are valued at half the price of the *diamond.*

LOCALITIES.—Found in granular limestone and clay. Amity and Gouverneur, N. Y.; Franklin and Byram, N. J.; Bolton and Boxborough, Mass.

69.—STEATITE.

Occurs in masses, consisting of minute pearly scales or grains ; can be marked by the nail ; hardens by heat ; soapy feel ; gravity 2.5.

VALUE.—Used for fire-stones, tubes, in manufacture of porcelain, etc.

LOCALITIES.—Found in beds with limestone, serpentine and slate. Orr's Island, Me. ; Francestown, Keene, Orford and Pelham, N. H. ; Athens, Cavendish, Marlboro, Moreton, New Fane, Bradboro, Troy, Waterville, Westfield, Weathersfield and Windham, Vt. ; Middlefield, Lenox and Westfield, Mass. ; Manayunk and Chestnut Hill, Pa. ; Albemarle and Loudon Counties, Va. ; Staten Island and St. Lawrence County, N. Y. ; Bare Hills, Md.

70.- STRONTIANITE

Occurs in crystals and in fibrous or granular masses ; glassy lustre ; brittle ; thin pieces melt before a blow-pipe tinging the flame red ; effervesces with acids ; gravity 3.6

VALUE.—A source of nitrate of strontia used in fire-works.

LOCALITIES. — Found in limestone. Schoharie, Muscalonge Lake, Chaumont Bay and Theresa, N. Y.

71.—SULPHUR.

Occurs in crystals, masses and crusts; brittle; can be easily cut; burns with a blue flame and sulphur odor; gravity 2

LOCALITIES.—Found in limestone and gypsum, and around geysers and sulphur springs. Springport, N. Y.; on the Potomac, twenty-five miles above Washington; Put-in-Bay Island, Lake Erie; Clear Lake, Cal.; Santa Barbara County, Col.; Humboldt County, Nev.

72.—TIN ORE.

Occurs in crystals, grains and masses; high lustre; powder gray or brownish; brittle; will strike fire with steel; unaltered by heat or acids; gravity 7,—being nearly as heavy as lead-ore

VALUE.—The only ore of tin, containing seventy-nine per cent. No gold-mine ever paid such profits as the tin mines of Cornwall.

Localities.—Jackson, N. H.; Temescal, Cal.; Boonville, Idaho; near Fredericktown, Mo.

73.—Topaz.

Occurs in crystals; glassy lustre; brittle; scratches *rock-crystal;* not acted upon by ordinary heat or acids; gravity 3.5.

Value.—A gem; the most esteemed are the rose-red and white.

Localities.—Found in granite. Trumbull, Willimantic and Middletown, Conn.; Crowder's Mountain, N. C.; Thomas's Mountains, Utah.

74.—Tourmaline.

Occurs in crystals, usually in long, slender three-sided prisms which break easily, glassy lustre; brittle; becomes milk-white by heat; scratches *rock-crystal* and *garnet;* gravity 3.

Value.—Used for jewelry.

Localities.—Found in granite rocks. Paris, Albany and Hebron, Me.; Chesterfield and Goshen, Mass.; Newlin and Marple, Pa.

75.—VARIEGATED COPPER ORE.

Occurs in crystals and masses; metallic lustre; quickly tarnishes; color between copper-red and light-brown; powder pale grayish-black; dissolves in nitric acid; at a high heat melts to a copper globule; heated on charcoal gives off fumes of sulphur; gravity 5.

VALUE.—An important ore of copper yielding sixty per cent.

LOCALITIES.—Found in granite, freestone, etc., with other ores. Bristol and Cheshire, Conn; Mahoopeny, Pa.; Copper Mines of N. J.

76.—WAD

Occurs in masses; earthy and loose; can be broken by the fingers, and soils; no lustre; melted with borax makes a violet glass; feels very light.

VALUE.—Used in bleaching and for making smalt.

LOCALITIES.—Found in low places, generally in the vicinity of slate or iron ore beds. Warren, Vt.; Blue Hill, Hodgdon and Thomaston, Me.; Columbia and Duchess Counties, Austerlitz, Canaan Centre and Martinsburg, N. Y.; East Bradford and White Marsh, Pa.; Mine la Motte, Mo.

77.—WILLEMITE.

Occurs in crystals and masses; feeble lustre; brittle; can hardly be cut with a knife; sometimes scratches glass; makes a jelly in muriatic acid; gravity 4.

VALUE.—Contains seventy per cent. of zinc.

LOCALITIES.—Found in limestone with *zincite.* Franklin and Sterling, N. J.

78.—ZINCITE.

Occurs in foliated masses or grains, powder orange-yellow; brittle; dissolves in acids without effervescence; gravity 5.5.

VALUE.—Yields seventy-five per cent. of zinc.

LOCALITIES.—Found in limestone with *Franklinite*, *Garnet*, etc. Sterling Hill and Mine Hill, N. J.

CHAPTER IV.

PROSPECTING FOR DIAMONDS, GOLD, SILVER, COPPER, LEAD AND IRON.

MINERAL RICHES, HOW DISCOVERED—INDICATIONS—SEARCHING FOR DIAMONDS, AND HOW TO DISTINGUISH THEM—PAYING LOCALITIES OF GOLD—"FOOL'S GOLD"—PROSPECTING FOR SILVER AND COPPER—WHERE TO LOOK FOR LEAD AND IRON.

THE mineral riches of a country are frequently discovered by attentively observing the fragments brought down by the action of water from the hills into the valleys ; and on tracing these to their several sources, the veins from which they were originally detached, are in many instances found. Water also acts in another way a very important part in the discovery of mineral veins, as by closely examining the faces of the different gullies and ravines, which intersect a country, a ready means is afforded of ascertaining whether its strata are traversed by metalliferous deposits; and, therefore, in exploring with a view to its mineral productions, no opportunity should be lost of observing the various sections thus naturally laid bare.

When fragments of an ore are found on a hill-side, it is very evident that the vein must lie higher up. If the vein is horizontal and the fragments are found on the top of the hill, there is no probability of finding much if any of the vein, for generally it has been washed away. Ore-veins, however, are almost always nearly vertical; so that boring is of little use, as it might pass by the richest vein, or, striking it lengthwise, give a too favorable result.

As heavy minerals do not drift far, metals are always found near their source.

Horizontal beds can be worked at the least cost.

Pockets and nodules, or any detached masses of minerals, are soon exhausted. Veins, lodes and beds are most valuable.

Boring a three-inch hole, which costs about $1 a foot, is a good method of testing a mineral vein or bed which lies more or less horizontally. A shaft may be sunk in sandstone for from $6 to $3 per cubic yard; in slate and gravel, at from $2 to $1.

The existence of mineral springs, and the rapid melting of the snow in any locality, are no indications of ores.

SEARCHING FOR DIAMONDS. — Few things are so unpromising and unattractive as gems in their native state. Hence their slow discovery. There is little doubt that diamonds exist in many places as yet unknown, or where their presence is unsuspected. It is very difficult for the unpracticed eye to distinguish them from crystals of quartz or topaz. The color constitutes the main difficulty in detecting their presence. They are of various shades of yellowish brown, green, blue and rose-red, and thus closely resemble the common gravel by which they are surrounded.

Often they are not unlike a lump of gum arabic, neither brilliant nor transparent. The finest, however, are colorless, and appear like rock-crystals.

In Brazil, where great numbers of diamonds, chiefly of small size, have been discovered, the method of searching for them is to wash the sand of certain rivers in a manner precisely similar to that employed in the gold fields, namely, by prospecting pans. A shovelful of earth is thrown into the pan, which is then immersed in water, and gently moved about. As the washing goes on, the pebbles, dirt and sand are removed, and the pan then contains about a pint of thin mud. Great caution is now observed, and ultimately there remains only a small quantity of sand. The diamonds and particles of gold, if present, sink to the bottom, being heavier, and are selected and removed by the practiced fingers of the operator. But how shall the gems be detected by one who has had no experience, and who in a jeweler's shop could not separate them from quartz or French paste? The difficulty can only be overcome by testing such stones as may be suspected to be precious. Let these be tried by the very sure operation of attempting to cut with their sharp corners glass, crystal or quartz. When too minute to be held between the finger and thumb, the specimens may be pressed into the end of a stick of hard wood and run along the surface of window glass. A diamond will make its mark, and cause, too, a ready fracture in the line over which it has traveled. It will also easily scratch rock-crystal, as no other crystal will.

But a more certain and peculiar characteristic of the diamond lies in the form of its crystals. The ruby and topaz will scratch quartz, but no mineral which will scratch quartz has the *curved edges* of the diamond. In small crystals this peculiarity can be seen only by means of a magnifying glass; but it is invariably present.

Interrupted, convex or rounded angles, are sure indications of genuineness. Quartz crystal is surrounded by six faces; the diamond by four. The diamond breaks with difficulty; and hence a test sometimes used is to place the specimen between two hard bodies, as a couple of coins, and force them together with the hands. Such a pressure will crush a particle of quartz, but the diamond will only indent the metal.

The value of the diamond is estimated by the carat, which is equal to about four grains, and the value increases rapidly with its weight. If a small, rough diamond weigh four grains, its value is about $10; if eight grains, $40; if sixteen grains, $640. A cut diamond of one carat is worth from $50 to $100.

The imperfections of the diamond, and, in fact, of all cut gems, are made visible by putting them into oil of cassia, when the slightest flaw will be seen.

A diamond weighing ten carats is "princely;" but not one in ten thousand weighs so much.

If a rough diamond resemble a drop of clear spring water, in the middle of which you perceive a strong light; or if it has a rough coat, so that you can hardly see through it, but white, and as if made rough by art, yet clear of flaws or veins; or, if the coat be smooth and bright, with a tincture of green in it,—it is a good stone. If it has a milky cast, or a yellowish-green coat, beware of it. Rough diamonds with a greenish crust are the most limpid when cut.

Diamonds are found in loose pebbly earth, along with gold, a little way below the surface, towards the lower outlet of broad valleys, rather than upon the ridges of the adjoining hills.

SEARCHING FOR GOLD.—The paying localities of gold deposits are the slopes of the Rocky and Alleghany Mountains. Gold need not be looked for in the anthracite and bituminous coal-fields nor in limestone rock. It is seldom found in the beds of rivers. The thing itself is the surest indication of its existence. If soil or sand is "washed" as described in Chapter V., and the particles of gold are not heavy enough to remain at the bottom but float away, the bed will not pay.

Along streams rather high up among the mountains, and in the gravelly drift covering the slopes of the valley below, are the best prospects. Where the stream meets an obstacle in its path or makes a bend or has deep holes, there we may look for "pockets" of gold. Black or red sands are usually richest. Gold-bearing rock is a slate or granite abounding in rusty looking quartz veins, the latter containing iron pyrites or cavities. Almost all iron pyrites and silver ores, may be worked for gold. When the quartz veins are thin and numerous rather than massive, and lie near the surface, they are considered most profitable. Few veins can be worked with profit very far down. As traces of gold may be found almost everywhere, no one should indulge in speculation before calculating the percentage and the cost of extraction. Gold-hunting, after all, is a lottery with more blanks than prizes.

The substances most frequently mistaken for gold are *iron pyrites, copper pyrites* and *mica.* The precious metal is easily distinguished from these by its malleability (flattening under the hammer) and its great weight, sinking rapidly in water.

SEARCHING FOR SILVER.—This metal is usually found with lead ore and native copper. Slates and sandstones intersected by igneous rocks as trap and porphyry, are good localities. Pure silver is often found in or near iron ores and the dark brown zinc blende. The Colorado silver lodes are porous at the surface and colored more or less red or green. Any rock suspected of containing silver should be powdered and dissolved in nitric acid.

Pour off the liquid and add to it a solution of salt. If a white powder falls to the bottom which upon exposure turns black, there is silver in it. Silver mines increase in value as in depth, whereas gold diminishes as we descend.

SEARCHING FOR COPPER.—The copper ores, after exposure, or after being dipped in vinegar, are almost invariably green on the surface. They are most abundant near trap dykes. The pyrites is generally found in lead mines, and in granite and clay-slate. Copper very rarely occurs in the new formations, as along the Atlantic and Gulf borders, and in the Mississippi Valley south of Cairo.

SEARCHING FOR LEAD.—Lead is seldom discovered in the surface soil. It is also in vain to look for it in the coal region and along the coast. It must be sought in steep hills, in limestone and slate rocks. A surface cut by frequent ravines or covered by vegetation in lines, indicates mineral crevices. The galena from the slate is said to contain more silver than that from the limestone. The purest specimens of galena are poorest in silver; the small veins are richest in the more precious metal. A lead vein is thickest in limestone, thinner in sandstone and thinnest in slate.

SEARCHING FOR IRON.—Any heavy mineral of a black, brown, red or yellow color may be suspected to be iron. To prove it, dissolve some in oil of vitriol and pour in an infusion of nut-gall or oak-bark; if it turns black, iron is present. If a ton of rich magnetic ore costs more than $4 at the furnace, good hematite more than $3, and poor ores more than $1.50 or $2, they are too expensive to pay, unless iron is unusually high. Deep mining for iron is not profitable. Generally speaking, a bed of good iron ore, a foot thick, will repay the cost of stripping it of soil, etc., twelve feet thick. Red and yellow earths, called ochres, contain iron. Magnetic ore is easily found by a compass

CHAPTER V.

ASSAY OF ORES.

WHEN AN ORE WILL PAY—WASHING FOR GOLD AND PLATINUM—HOW TO ASSAY GOLD IN THE SIMPLEST WAY—TO TEST ANY ROCK FOR GOLD AND SILVER—TO FIND THE PURITY OF GOLD—TO DETECT AND ASSAY SILVER ORES—ASSAY OF COPPER, IRON, ZINC, TIN AND LEAD ORES—READY METHOD OF TESTING GRAPHITE.

ONE of the first questions asked after the discovery of a metallic ore, is—"will it pay?" We propose to state in plain words a method of determining the character and value of the principal ores, so that any intelligent man, however unscientific, may answer his own question. The chemical analysis or exact assaying of ores is too complicated, and must be left to professional assayers.

"Will it pay?" is an important query; for many ores of even precious metals, are not "paying." Whether an ore is profitable depends not so much upon the relative value of the metal as upon the ease of separating it from the rock or "gangue" as it is called. Thus the minimum percentage of metal, below which the working of the ore ceases to be profitable is—

Of Iron,	25	per cent.
Zinc,	20	"
Lead,	20	"
Antimony,	20	"
Copper,	02	"
Tin,	01$\frac{1}{2}$	"
Quicksilver,	01	"
Silver,	$\frac{1}{2000}$	"
Platinum,	$\frac{1}{10000}$	"
Gold,	$\frac{1}{100000}$	"

That is, an ore of iron which contains less than 25 per cent. of metal will not pay for working; for the reduction of iron in comparison with copper ore is very difficult. Gold is very easily extracted, and hence some quartz rocks which do not apparently contain a particle of gold, pay well, a bushel of rock often yielding half an ounce.

Iron occurs in large masses or beds; but the other metals are scattered in fragments through sand or soil, or exist in veins running through rocks.

WASHING FOR GOLD AND PLATINUM.—This operation, called "panning," is the oldest and simplest method of extracting the precious metals. At the present time, it furnishes to Russia nearly all the gold produced in that empire. It is based on the principle that substances of different weights may be separated by means of water,—the heaviest going to the bottom first. To examine the bank or bed of a river, suspected to contain gold, fill a milk-pan with the sands and carry it to a tub or pool of quiet water. Dip it under, stirring the mass with one hand or a stick. Then pour off the muddy water, fill with fresh water stirring again, and again pour off the light sand, clay, etc. Scales of gold will sink fast; mica flakes will take their time.

Repeat this process till all the fine particles are washed off; then allow just enough water to enter the pan as will cover the sand. By shaking the pan and gradually lowering the side by which it is held, the light sand will flow off, leaving in the corner a heap of coarse sand. Put in a small quantity of water and turn the pan around so as to create a gentle current, when the precious metal, if there be any, can be easily detected, — the gold by its bright lustre, the platinum by its lead color, and both by their malleability. Particles of gold are of uniform color and are either flat or rounded; while other yellow grains are angular. Holding the pan in the sunshine, secure any glittering glassy crystals, and test them for diamonds or rock-crystals. A magnet will remove any particles of magnetic iron-ore.

ASSAY OF GOLD ORE —Gold may be found in quartz rock, in iron and copper pyrites, and in silver ores.

To ascertain if any gold is present in

quartz, reduce the rock to powder and sift it. A certain quantity, say half a peck, is then washed as above described, till a manageable quantity of sand is left. If there is any show of gold, dry the mass and put it in a bowl or glass dish, and add an ounce of quicksilver, stirring the mixture well with a wooden rod. The quicksilver, which will unite with every particle of gold which may be there, is then poured off into a soft leather (chamois) bag. This is squeezed to remove superfluous quicksilver, and a pasty amalgam is left, which is put into an iron vessel and heated red hot. The yellow powder remaining is mixed with saltpetre and melted, when a button of pure gold will be found in the crucible. Quartz ores should yield $6 to the ton in order to pay.

To test pyrites for gold, reduce a given quantity to powder and wash as before; then roast the residue at a red heat. Upon cooling, add quicksilver and treat as just described. Pyrites should yield $1 of gold to the bushel of ore to be profitable.

Native silver often contains gold. To separate them, carefully flatten the alloy with a smooth hammer on an anvil, and then boil it in strong nitric acid in a glass flask for about ten minutes. Carefully pour off the acid into a vial, and wash the powder in the flask (which is fine gold) with water and dry. To the liquid in the vial add a solution of common salt. The white powder which falls should be removed, washed with water, and fused with powdered chalk or iron filings ; a button of pure silver is the result.

Any substance supposed to be or to contain gold may be tested by dissolving it powdered in aqua regia and then pouring in a solution of copperas ; if there is gold, the reddish-brown precipitate, by rubbing, assumes a bright metallic lustre.

To tell whether a globule of silver has any gold in it, put it on a white porcelain dish and moisten it with a drop of nitric acid: if it is pure silver, it will dissolve and retain its white color; if mixed with gold, it will soon turn gray or black.

To test the purity of gold, rub some of it off on a hard black flint slate, and apply to the mark a drop of aqua fortis. If the gold is pure, the yellow streak remains unchanged, but if alloyed it partly disappears; if it is only an imitation of gold, it vanishes altogether.

A ready method of finding the amount of gold in a quartz rock with considerable accuracy, is by taking the specific gravity of the rock (well cleaned) as given on page 13. If the gravity is not over 2.7, it contains little or no gold. If it is 3, it very likely is gold-bearing, although pyrites may be present. But if it is over 5, it is undoubtedly auriferous, and if 12, it is very rich in gold.

It is generally considered that the sand of any river is worth working for the gold it contains, provided it will yield twenty-four grains to the hundred weight.

ASSAY OF SILVER ORE.—Pure silver is easily recognized. But lead and copper ores often contain a large percentage of the precious metal.

To detect silver in lead ore, dissolve the powdered ore in strong nitric acid ; pour off the liquid and insert a piece of pure copper. If silver is present, it will go to the bottom. Or, add to the liquid a solution of common salt, and it will instantly become cloudy or white. If lead ore yields three ounces of silver to a ton, it may be worked for the silver as well as the lead. In Colorado, the average value of silver-bearing galena is $100 per ton.

To test the copper ores for silver, dissolve them in nitric acid ; then add a few drops of muriatic acid, and if silver is present, a white curdy precipitate will fall to the bottom. Native copper, when polished, often shows white spots of silver.

To estimate the proportion of silver in lead ore, reduce a known quantity of the clear ore to powder, mix with a little dry soda and a few nails, and heat in a round-bottomed iron pot or crucible. The lead which is obtained should then be put in a cup having ashes at the bottom, and strongly heated in an open furnace. A globule of silver will be left, if any is present, and being weighed, the percentage can be found.

Rich silver ores may be reduced by mixing them with ten parts of common salt, and exposing the mass for hours in an open furnace, stirring it frequently. When cold reduce to powder and mix with an equal quantity of quicksilver and enough water to make a paste, and agitate the mixture for two days, when the amalgam will fall to the bottom. The amalgam is then squeezed in a leather bag and washed.

Silver glance will yield its metal by heating it before a blow-pipe.

ASSAY OF COPPER ORE.—When the ore is native copper and rock, as at Lake Superior, it should be pounded and the earthy matter washed away. Then mix with a little potash or soda and bring to a high heat in a crucible.

Other copper ores may be tested by dissolving them powdered in dilute aqua regia. The presence of silver will be shown by a white powder on the bottom. Then add considerable ammonia. If there is any copper a blue liquor will be producéd. Strain this through tissue paper, and evaporate to dryness. Dissolve the residue in muriatic acid, and by putting in a piece of iron or zinc, the copper will fall down. Or, add to this solution pure potash ; dry and weigh the powder thrown down ; every 5 parts of it contains 4 parts of copper.

Gray copper and red copper ores may be assayed by heating with charcoal, (both powdered,) in a furnace. Malachite and azurite should be smelted with borax; Copper pyrites and silicate of copper with soda or powdered marble.

A ton of copper ore which contains ten per cent. of metal, pays $25 at the furnace. The ore of copper when roasted, turns black; and when thrown into nitric acid makes a sky-blue solution. A clean knife-blade put into this solution will be coated with copper.

ASSAY OF IRON ORE.—Take a known quantity of the ore in fine powder and mix thoroughly with dry borax (or with one part of fluor spar, one of charcoal and four of salt,) and expose it for an hour in a covered crucible lined with charcoal to a white heat in a wind-furnace for an hour. A button of iron will be found at the bottom, which determines the percentage.

ASSAY OF ZINC ORE.—If the weighed ore is roasted with powdered charcoal, white flowers of zinc will be formed on a piece of cold iron held over it. After thorough roasting, the residue should be weighed; the loss is the oxide of zinc, and every 100 parts of this contain 81 of metal.

All the ores of zinc will dissolve in either nitric or hot sulphuric acid.

ASSAY OF TIN ORE.—Tin-stone will

yield up its metal if mixed with charcoal, borax and soda, and heated on the hearth of a furnace or before a blow-pipe.

The presence of tin may be tested by dissolving the metal thus roasted out, in aqua regia and adding a decoction of Brazil-wood: if the metal was tin, the liquid will be colored a beautiful crimson.

ASSAY OF LEAD ORE. — Both galena and cerussite are rich ores, and when abundant pay well. They are easily reduced by heat, the former being usually mixed with charcoal and iron filings. If a western backwoodsman wants shot or bullets, he kindles a fire in a hollow tree or an old stump, puts some galena on the charred wood, and melts it down. After cooling, he finds the metal at the bottom. The smelting of a ton of lead costs about $6. The average price per ton of galena is $30. When galena is dissolved in warm nitric acid, a clean plate of zinc placed in it will be coated with brilliant blades of lead; if the galena contains silver, a plate of copper will be served in the same way. A solution of chromate of potash poured into a solution of lead ore in nitric acid will throw down a yellow powder.

TO TEST THE PURITY OF GRAPHITE.—Its value depends upon the amount of its carbon. Pulverize and then dry at a heat of about 350 degrees, twenty grains of it; then place it in a tube of hard glass four or five inches long, half an inch wide and closed at one end. Add twenty times as much well dried oxide of lead and well mix. Weigh the tube and contents, and afterwards heat before a blow-pipe till the contents are completely fused and no longer evolve gases. Ten minutes will suffice for this. Allow the tube to cool and weigh it. The loss in weight is carbonic acid. For every twenty-eight parts of loss there must have been twelve of carbon.

CHAPTER VI.

MINERAL SPRINGS.

WHAT ARE MINERAL SPRINGS—GENERAL LOCATION—GAS SPRINGS—IRON SPRINGS—SULPHUR SPRINGS—ALUM SPRINGS—EPSOM SPRINGS—SALT SPRINGS—WARM SPRINGS—ARTESIAN WELLS AND OIL WELLS, AND WHERE TO BORE FOR THEM.

ANY spring which contains a large amount of foreign matter, as gas, salts and earthy ingredients, is called *mineral water*. The special prominence of any ingredient gives it its particular name. Many iron springs contain salt, salt springs contain iron, and both may contain gas; the name is derived from the most prominent ingredient.

Our country is rich in mineral springs; there is not a State without one. But in general they are most numerous in hilly or mountainous regions, especially where the rocks are much deranged in position, or "faulted," as the miners say. As for example, in Eastern New York and in the valley between the Blue Ridge and the Alleghany from Harper's Ferry to the Natural Bridge. The Pacific States, also, are as remarkable for the number and variety of their mineral springs as for their metallic ores.

CARBONATED OR GAS SPRINGS — Springs of this class have a peculiar sparkling character and are continually sending up bubbles of gas. When the quantity of gas is small, it may be detected by adding a little lime water which will give it a milky appearance and deposit a white sediment ; or, dip in a piece of blue litmus paper (which can be had of most druggists), and if there is any carbonic acid gas in the water, it will be reddened ; or, pour in a little vinegar, stir well, and then add a little finely powdered sugar, when the gas, if it is there, will rise in small bubbles.

The most celebrated carbonated springs are the following: Saratoga and Ballston, N. Y.; Clarendon, Vt.; Sweet Springs in Shover's Valley, Pa.; Bladon and Bailey Springs, Ala; "Boiling Springs" near Pike's Peak, Col.; Beer Springs near Bear River, Or. These springs contain salt, soda, magnesia, lime and iron, and are sometimes classed as *saline*, *soda* or *chalybeate* springs.

CHALYBEATE OR IRON SPRINGS.—The presence of iron in a spring may be ascertained by pouring into it an infusion of nut-galls, of logwood or of tan-bark, which will change it immediately to a black or dark color. If the water contains much iron, it may be recognized by its inky taste and by a yellowish powder on the border of the spring or at the bottom of a tumbler when allowed to stand awhile.

If waters have a cool but earthy taste, they contain lime; if bitter, they have magnesia. The "soda springs," so called, are often only saline, carbonated or magnesia waters.

The most famous iron springs are at Saratoga, Sandlake and Catskill, N. Y.; West Bethel, Fryeburg, Eberne and Bethel, Me.; Schooley's Mountain in Washington, N. J.; Bedford, Pittsburg, Frankfort and York, Pa.; Brandywine Springs, Del.; Red Sweet Springs in Monroe County, Rawley's Spring in Rockingham County, and Huguenot Springs in Powhattan County, Va.; in Bath County, Ky.; Yellow Springs, O.; twenty miles east of Knoxville, Tenn.; Madison County, Geo.; Raymond and Lynchburg, Miss.; near Ogden City, Utah; near Mt. Shasta, Col.

SULPHUR SPRINGS.—These are easily recognized by their unpleasant odor, resembling that of rotten eggs. The water blackens silver and a solution of sugar of lead.

Sulphur springs are very numerous. The best known are at Saratoga, Sharon, Clifton, Avon, Manlius, Chittenango, Dry-den and Richfield, N. Y.; Highgate and Newburg, Vt.; Togus, Bethel and West Newfield, Me.; Shover's Valley, Carlisle and Doubling Gap, Pa.; Winchester and Warrenton, Va.; Greenbrier and Monroe Counties, W. Va.; Bath County, Ky.; White's Creek near Nashville and in Granger County, Tenn.; Spartanburg, S. C.; Butts County, Geo.; Tallahatta, Ala.; Tampa, Fla.; near Bitter Creek and Great Salt Lake, Utah; along the Yellowstone River, Mont.; Jackson, Cal.

ACID OR ALUM SPRINGS.—These waters have a more or less sour taste and redden blue litmus-paper.

They are found at Byron and Oak Orchard, N. Y.; Blossburg, Pa.; Bath, Richmond and Rockbridge, Va.

MAGNESIAN OR EPSOM SPRINGS.—These have a bitter taste. To test any water for magnesia, add to a glass of it a solution of phosphate of soda and some hartshorn; if magnesia is present, the liquid first becomes turbid, and finally minute crystals fall to the bottom.

There are Epsom springs at Harrodsburg and Perryville, Ky.; Westport, O.; Raymond, Miss.; Orange County, Ind.; Scott County, W. Va.

SALINE OR SALT SPRINGS.—These contain a large percentage of common salt, and are recognized by their taste. They generally contain many ingredients, (generally seven or eight,) but the salt predominates. A well should contain at least ten per cent. of salt to pay for working. The Syracuse spring yields a bushel of salt to every thirty-three gallons; while the Great Salt Lake contains 22 per cent. Among the most important salt wells are those at Syracuse, Salina and Liverpool, N. Y.; Lubec, Me.; Shannondale, Va.; Bath County, Ky.; Athens County, O.; Hartford, Ind.; Saginaw, Mich.; Oneida, Idaho.

THERMAL OR WARM SPRINGS.—Any spring is so called, the temperature of which throughout the year is above that of the soil around it. They generally occur near the line of junction between the granite or igneous rocks and the stratified rock (slate or limestone) resting upon its flanks. The temperature of such waters in the United States ranges from 73 to 200 degrees, the latter being reached by the Geysers of Montana. Many iron and sulphur springs are also thermal.

The most noted warm springs are at Lebanon, N. Y.; in Bath, Berkley, Monroe and Scott Counties, Va.; Buncombe Counties, N. C.; French Brood River, Tenn.; Meriwether County, Geo.; Washitaw, Ark.; Salt Lake Valley, Utah; near Pyramid Lake, Nev.; along the Malheur and Fall Rivers, Or.; Lincoln Valley, Idaho; on Gardiner's River, in Madison County, and especially in the Yellowstone Basin, Mont.

ARTESIAN WELLS.—To sink a flowing well with any reasonable prospect of success, it is essential that the spot selected should be lower than land in the vicinity, although those higher elevations may be several miles away. The layers of the rocks, also, should dip *towards* the spot rather than away from it. The best indication, but not a certain one, is a *great* basin-shaped valley, to the centre of which the rocks dip on one or more sides. Sandy, lime and slate rocks are more propitious than granite.

OIL WELLS.—Where there are marks of disturbance and misplacement of the rocks, there the experienced sink wells. Rugged hills and sharply-defined valleys are, generally, signs of such dislocation. The line or " break " from which the rocks dip like the roof of a house is considered most favorable. There is no such thing as an " oil rock," for the oil is found at different depths, and the fissure containing it is more or less vertical. In Pennsylvania, the greatest flowing wells have been found in the third sand rock. No limestone has afforded any large supply of oil. Coal in no large quantities is ever found upon or in the immediate vicinity of the oil territory. The "show of oil" increases in value as a sign, with the depth at which it is found. Especially is the finding of a large amount of imprisoned gas, though no oil may be present, regarded as a good indication that oil is near. In the bituminous coal region, a gas spring indicates the probable existence of oil in the rocks below. But generally, "surface shows" are seductive. The great oil belt runs south-westerly from Oil Creek, Pa., to Burning Springs, West Va. But Ohio, Kentucky, Tennessee, Georgia, Alabama, Missouri, Texas, Illinois, Indiana, Michigan and Southern California are also rich in petroleum.

CHAPTER VII.

ARTIFICIAL JEWELRY—HOW MADE AND HOW DETECTED.

MOCK DIAMONDS—"PARIS BRILLIANTS"—THE MANUFACTURE OF PASTES—FALSE RUBY, TOPAZ, SAPPHIRE, EMERALD AND CARNELIAN—HOW TO DISTINGUISH TRUE AND FALSE GEMS—IMITATION PEARL AND CORAL—ARTIFICIAL GOLD—LIST OF PRECIOUS STONES.

"BRISTOL Stones," "Irish Diamonds," "Cape May Diamonds," and "California Diamonds," are skillfully-cut quartz crystals. They are easily detected by the file and by their lightness.

"Paris Brilliants" are more dangerous counterfeits, and are very often sold for genuine. The great establishment of Boarguiguon, in Paris, is the most famous manufactory of artificial gems in the world, employing about one hundred hands. The gems are such perfect imitations that they can be distinguished from real stones only by the closest scrutiny of those experienced in such matters. They fail chiefly in hardness; in brilliancy and gravity they nearly or quite equal the genuine.

Nature has made the most precious stones with the most common materials. The diamond is purified charcoal; while the matter of clay and white pebbles is the base of all other gems.

The chemist has imitated nature in the production of colored gems. The base of these imitations, called "pastes," is "*strass*"—a white glass compound of 300 parts of pure sand, 96 of potash, 27 of borax, 514 of white lead, and one of arsenic. The mixture is put into a crucible and kept at a high heat for 24 hours. This is the philosopher's stone which competes with Golconda. The uncolored glass is used in making mock diamonds and white topaz. Another paste which has very great brilliancy, and, unfortunately, the same gravity as the diamond, is made by melting 100 parts of pure sand, 150 of red lead, 30 of calcined potash, 10 of calcined borax and one of arsenic, keeping the mixture melted for two or three days and then cooling very slowly. Each ingredient is separately reduced to a fine powder.

FALSE RUBY is made by fusing together of strass one ounce and six drams, glass of antimony 37 grains, and purple of cassius one grain; then add eight parts more of strass and fuse for thirty hours; cool and remelt pieces in a blow-pipe. Or, melt five ounces of strass and one dram of manganese.

FALSE TOPAZ can be made from 1008 grains of strass, 43 grains of glass of antimony and one grain of purple of cassius.

FALSE SAPPHIRE.—Add to eight ounces of strass 52 grains of pure oxide of cobalt.

FALSE EMERALD.—To one pound of strass add one dram of verdigris and fifteen grains of crocus martis. Or, take 2304 grains of strass, 21 grains of green oxide of copper, and one grain of oxide of chrome. Or, take an ounce and a half of rock-crystal, six drams of dry soda, two drams of dry borax, two drams of red lead, one dram of nitre, twenty grains of red oxide of iron, and ten grains of green carbonate of copper.

FALSE CARNELIAN.—Strass two pounds, glass of antimony one pound, rouge two ounces, manganese one dram.

FALSE AMETHYSTS AND OPALS are manufactured ; but the fine opal defies imitation, and the amethyst is too common in nature to allow much margin for the "pastes."

In distinguishing true and false gems, no one character should be depended upon. All genuine stones will bear rough handling ; if the merchant says "hands off," refuse to purchase. Any gem worth buying is worth testing.

First : try the *hardness*. The file will make no impression on the diamond and ruby, and will with difficulty scratch the other gems ; while the "pastes" are easily marred. All the precious stones scratch window glass, although opal will not attack common bottle glass. All imitations easily yield to sand. The sapphire is the hardest of colored gems, and opal is the softest The emerald will hardly scratch rock-crystal; its counterfeit not at all. Topaz will scratch ordinary ruby, but will not touch sapphire.

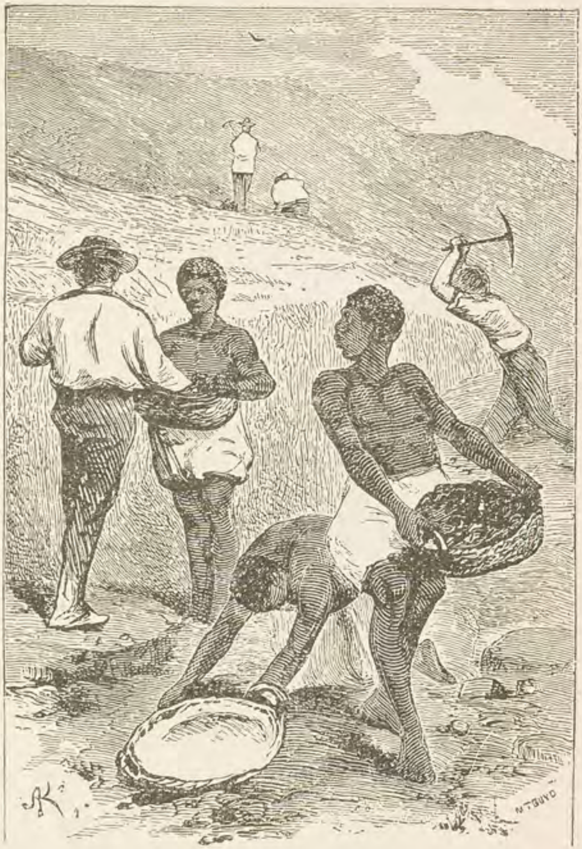
Secondly: as to *weight*. This is the most accurate method, but the stone must be taken from its setting. The mode of taking the gravity has already been given (page 13), and the amount of each is stated in Chapter II. Garnet is the heaviest of gems; weighed in water it loses only one-fourth of its weight; *i. e.*, if a red garnet be suspended by a fine thread from a delicate balance and immersed in a glass of water under it, one-quarter of its ordinary weight in air must be added to the pan from which it is suspended to restore the equilibrium. In like manner, ruby and sapphire lose a little more. The diamond and white topaz lose two-sevenths of their weight. Rock-crystal, amethyst, carnelian and agate lose five-thirteenths; and opal about one-half, being the lightest of gems. The emerald loses more than one-third.

As "paste" *can* be made so as to have the same specific gravity as the genuine article, this test alone can not be relied upon; but very few of the imitations are so carefully made. The test is very convenient in distinguishing gems of like color from each other, as oriental ruby, spinel ruby and red tourmaline, and green tourmaline and emerald.

Thirdly: characteristics depending on *light* and *electricity*. It is not easy to look through a diamond of the first water, while imitations readily permit objects to be seen through them. A very delicate and perfect test of a diamond, distinguishing it from all colorless gems, as white topaz, white sapphire and white zircon, but not from "pastes," is to look through it at a pin-hole in a card. This requires some dexterity, and the gem should be fixed to a steady object by a bit of wax at a proper distance. A true diamond will show but one hole, all the others will show two. As white topaz, when large, is a magnificent stone, it is often palmed off for a diamond of great value; but this test is invariably certain.

A true diamond retains its brilliancy under water.

When a colored stone is placed in the path of the solar spectrum (the row of seven colors into which sunlight is separated by a prism), its color will vary with the portion of the spectrum which falls upon it; and two stones of the same color, but of a different nature, will exhibit different effects. Thus, a paste placed beside a fine colored gem, betrays its worthlessness. A simpler method of testing stones is to look at them through a bit of glass, colored red, yellow, blue or green. Every stone will exhibit, under this test, properties peculiar to itself, and by which its na-



SEARCHING FOR DIAMONDS.

ture may be recognized. This is also a severe test for the purity of tint; for if pure and unmixed, the stone will appear completely black in every other light but its own color. Milky and turbid stones can not bear this test.

A first-class ruby has the color of the blood as it spirts from an artery. The deeper the hue of the emerald the more it is valued; it loses none of its brilliancy by artificial light. The pale rose topaz, the kind most esteemed, is artificially colored by heating it.

If topaz or tourmaline be gently heated, it becomes electric and will attract a thread or suspended pith-ball. No imitation will do this. All real gems when rubbed will attract the pith-ball, and retain the power a long time; the pastes also become electric, but soon lose their attraction. Rub a glass tube with a piece of flannel and bring it near a suspended pith-ball; the latter will be strongly attracted and then repelled. Immediately rub a genuine diamond and bring it near the ball, and it will be attracted. A paste diamond thus rubbed would repel it.

Finally: the breath remains much longer on the pastes than on real gems. The former also betray under a magnifying glass small air bubbles. Diamonds and other first-class stones are always cold to the touch.

False Pearls.—These are glass beads coated with a mixture of three ounces of scales of the blay or bleak fish, half an ounce of fine glue, one ounce of white wax and one ounce of pulverized alabaster. Powdered opal is sometimes used; also the powdered pearl of the oyster and other shells soaked in vinegar, and made up with gum tragacanth. Artificial pearls are usually brittle, and do not weigh more than two-thirds as much as the genuine.

False Corals.—These are made of resin and vermilion; or of marble powder made into a paste with varnish or soluble glass and a little isinglass, colored by Chinese vermilion, and then moulded. They are used for setting in cheap jewelry. The knife shows it to be too soft to be genuine.

ARTIFICIAL GOLD. — The following oroid or imitation gold is sometimes sold for the genuine article which it closely resembles. Pure copper, 100 parts by weight, is melted in a crucible, and then 6 parts of magnesia, 3.6 of sal-ammoniac, 1.8 of quicklime and 9. of tartar are added separately and gradually in the form of powder. The whole is then stirred for about half an hour, and 17 parts of zinc or tin in small grains are thrown in and thoroughly mixed. The crucible is now covered and the mixture kept melted for half an hour longer, when it is skimmed and poured out.

Any imitation of gold may be detected by its weight, which is not one-half of what it should be, and by its dissolving in nitric acid while pure gold is untouched.

PRECIOUS STONES.

ARRANGED ACCORDING TO COLOR AND IN ORDER OF HARDNESS.

Limpid.

- Diamond,
- Sapphire,
- Topaz,
- Rock Crystal.

Blue.

- Sapphire,
- Topaz,
- Spinel,
- Aquamarine,
- Indicolite,
- Turquoise,
- Kyanite.

Green.

- Oriental Emerald,
- Chrysoberyl,
- Emerald,
- Chrysoprase,
- Chrysolite,
- Amazon Stone,
- Malachite.

Yellow.

- Diamond,
- Topaz,
- Fire-Opal.

Red.

- Sapphire-Ruby,
- Spinel-Ruby,
- Brazilian-Topaz,
- Hyacinth,
- Carnelian,
- Rubellite,
- Garnet.

Violet.

- Oriental Amethyst,
- Amethyst.

Black and Brown.

- Diamond,
- Tourmaline,
- Hyacinth,
- Garnet.

CHAPTER VIII.

DISCOVERY OF GOLD IN CALIFORNIA.*

IT was on the 19th day of January, 1848, that James W. Marshall, while engaged in digging a race for a saw-mill at Coloma, about thirty-five miles eastward from Sutter's Fort, found some pieces of yellow metal, which he and the half-dozen men working with him at the mill supposed to be gold. He felt confident that he had made a discovery of great importance, but he knew nothing of either chemistry or gold-mining, so he could not prove the nature of the metal nor tell how to obtain it in paying quantities. Every morning

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*From Simonin's "*Underground Life*," page .346

he went down to the race to look for the bits of the metal; but the other men at the mill thought Marshall was very wild in his ideas, and they continued their labors in building the mill, and in sowing wheat and planting vegetables. The swift current of the mill-race washed away a considerable body of earthy matter, leaving the coarse particles of gold behind; so Marshall's collection of specimens continued to accumulate, and his associates began to think there might be something in his gold mines after all. About the middle of February, a Mr. Bennet, one of the party employed at the mill, went to San Francisco for the purpose of learning whether this metal was precious, and there he was introduced to Isaac Humphrey, who had washed for gold in Georgia. The experienced miner saw at a glance that he had the true stuff before him, and, after a few inquiries, he was satisfied that the diggings must be rich. He made immediate preparation to go to the mill, and tried

THE SAW-MILL OF COLOMA.

THE PLACE WHERE GOLD WAS FIRST DISCOVERED IN CALIFORNIA.

to persuade some of his friends to go with him; but they thought it would be only a waste of time and money, so he went with Bennet for his sole companion.

He arrived at Coloma on the 7th of March, and found the work at the mill going on as if no gold existed in the neighborhood. The next day he took a pan and spade, and washed some of the dirt in the bottom of the mill-race in places where Marshall had found his specimens, and, in a few hours, Humphrey declared that these mines were far richer than any in Georgia. He now made a rocker and went to work washing gold industriously, and every day yielded to him an ounce or two of metal. The men at the mill made rockers for themselves, and all were soon busy in search of the yellow metal. Everything else was abandoned; the rumor of the discovery spread slowly. In the middle of March Pearson B. Reading, the owner of a large ranch at the head of the Sacramento valley, happened to visit Sutter's Fort, and hearing of the mining at Coloma, he went thither to see it. He said that if similarity of formation could be taken as a proof, there must be gold-mines near his ranch; so, after observing the method of washing, he posted off, and in a few weeks he was at work on the bars of Clear Creek, nearly two hundred miles north-westward from Coloma. A few days after Reading had left, John Bidwell, now representative of the northern district of the State in the lower House of Congress, came to Coloma, and the result of his visit was that, in less than a month, he had a party of Indians from his ranch washing gold on the bars of Feather River, twenty-five miles north-westward from Coloma. Thus the mines were opened at far distant points.

The first printed notice of the discovery of gold, was given in the California newspaper published in San Francisco on the 15th of March. On the 29th of May the same paper, announcing that its publication would be suspended, says: — "The whole country, from San Francisco to Los Angelos, and from the sea-shore to the base of the Sierra Nevada, resound with the sordid cry of *gold! gold! gold!* while the field is left half planted, the house half built, and everything neglected but the manufacture of picks and shovels, and the means of transportation to the spot where one man obtained one hundred and twenty-eight dollars' worth of the real stuff in one day's washing; and the average for all concerned, is twenty dollars per diem."

The first to commence quartz mining in California were Capt. Wm. Jackson and Mr. Eliason, both Virginians, and the first machine used was a Chilian mill.

The Reid Mine, in North Carolina, was the first gold mine discovered and worked in the United States, and the only one in North America from which, up to 1825, gold was sent to the Mint.

CHAPTER IX.

DISCOVERY OF SILVER IN NEVADA, AND UNITED STATES GOLD AND SILVER STATISTICS.

SEPARATED from California by the snowy chain of the Sierra, the State of Nevada has been celebrated, since 1860, for its silver mining. In November, 1859, the news of the discovery of silver mines near Lake Washoe was confirmed at San Francisco; and in June, 1860, the mines of Washoe, the central western portion of the State, had already sent such rich results to Europe, that the French Ministers of Finance and Commerce despatched a mining engineer to Nevada to make a close inspection of these wonderful mines. It seemed as if the world were about to be inundated with silver. as it had been by gold ten years previously; and what would those economists now say, who had only recently counselled that the value of gold coin should be lowered or that gold should be demonetized on account of the disturbed relation of these precious metals—the bases of the standard of payment throughout the world generally. Whilst the French engineer visited Nevada and prepared his report, the miners of Washoe continued working their veins of metal. At the present time, 1881, the mines on the eastern slope of the Sierra Nevada annually produce about $12,500,000 of silver, chiefly from the Comstock lode; the total yield of gold from the quartz mines of California is about $17,000,000 per annum. The Comstock lode, in the State of Nevada, may be ranked among the most productive metalliferous deposits ever encountered in the history of mining enterprise; its productive capacity, as now being developed, surpassing, if the mass of its ores do not in richness equal, those of the most famous mines of Mexico and Peru.

The known limits of this lode cover a space of 22,546 feet in a nearly due north and south direction (magnetic). The variation of the needle in that locality is 16½ degrees east. Upon this extensive seat of metalliferous deposits, the mines are divided into three groups: the Virginia Group, seventeen mines, with claims of 13,549⅓ feet; Gold Hill Group, nine mines, of 6,397¼ feet; American Flat Group, three mines, of 2,600 feet. The three groups of twenty-nine mines thus occupy a total length on the lode of 22,546 feet. The Comstock lode was discovered in 1859, by a pit sunk for a water hole on the ground of the Ophir mine; milling the ore began in October of the same year, but the amount of bullion taken out in 1860 is estimated at but $100,000. Since then the Comstock has become the greatest gold and silver mine in the world. To the end of 1878 the yield was estimated at $291,162,205, as follows: From 1860 to 1870 inclusive, of gold and silver together, unclassified, $102,466,240; 1871 to 1878 inclusive, gold, $88,691,498, silver, $91,278,623; 1877 and 1878, gold and silver, unclassified, $1,725,844. Making allowance for the loss by slimes and tailings, the gross contents of the lode, as worked up to 1878 are estimated at $363,961,205. About 6,500,000 tons of ore have been extracted in this time, which a good authority estimates of an average value to the company of $45 per ton of 2,000 pounds.*

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* Church. The Comstock Lode, its Formation and History, N. Y., 1879, pp. 1–5.

APPENDIX.

ORE DEPOSITS.

THE primary source from which metalliferous veins have been derived, and the causes which determined the peculiar metal or metals in each case, are matters about which we know nothing. But the manner in which these deposits have been formed comes within the bounds of reasonable conjecture and has an important bearing upon the commercial value of the deposit, especially as regards its bulk and permanence.

There is abundant evidence in favor of the opinion that all the principal accumulations of useful ores are due to the precipitation of material collected by water in its passage through rocks at various depths, the mineral being very sparsely and widely distributed, dissolved by the water under the influence of considerable heat, and subsequently concentrated and precipitated in favorable situations. These latter were less likely to have been large cavities than narrow spaces, though occasionally there may have been wide areas awaiting the influx of vein matter. But it seems quite as likely that where large veins occur, these are in great measure composed of altered country rock, and owe only a small portion of their contents to extraneous sources. Assuming this origin of metallic veins to be correct, then a knowledge of the geological structure of the district, as bearing upon the formation of the water passages which introduced the metalliferous solutions, is of great significance to the prospector.

This subject has been very thoroughly dealt with by S. F. Emmons, of the United States Geological Survey, and the following remarks are condensed from his published papers. The three principal structural conditions which would produce natural water passages in the rocks forming the earth's crust are:

a. Sedimentation or bedding.

b. Intrusion of eruptive masses.

c. Dynamic movements producing fractures across rock masses of different origin or composition,

a. By the first of above causes, by the deposition of alternating strata of varying degrees of permeability, or by successive flows of igneous rocks, natural channels will be afforded parallel to the stratification or bedding planes, and more or less coincident with them, according to the nature of the material of which the boundary beds are formed.

These primary water channels may be interrupted by either of the two causes, *b, c.*

b. Eruptive dikes or cross-cutting intrusive bodies of any form may interpose relatively impermeable masses across their course, or intrusive bodies running parallel with the bedding may render the plane of contact a more ready water passage than it otherwise would have been.

c. The interruption of these primary

water channels resulting from the varied forms of rock-fracture caused by dynamic movements are manifold and numerous.

The greatest number of underground water channels, though perhaps not those carrying the largest volumes of water, will be afforded by the multitudinous fractures in the crystalline or eruptive rocks, and in the older and more metamorphosed sedimentary strata.

Another possible class of division-planes in rocks are contraction-planes or joints, notably the more prismatic of more recent eruptives. Contraction-planes must be confined to one rock-mass or bed, and cannot cross several of them, as do most mineral-bearing fissures. Also, as contraction-planes alone, there would have been no movement or pressure along them. Hence planes where evidences of movement or pressure are found cannot result from contraction alone.

Ore deposits along bedding planes. Most ore deposits are found in mountainous regions where eruptive and dynamic action have been energetic, consequently, deposits resulting from the flow of water along bedding-planes alone, unconnected with the other classes of water channels, form but a small proportion of the whole. Moreover, deposition will take place more readily from a comparatively sluggish, than from a rapid flow; hence conditions that tend to retard the flow, or cause a partial stagnation at a given point, will favor precipitation at that point. Such would be the actual contact of an impervious stratum, *e. g.*, a body of clayey material—with a readily pervious one like a loose sandstone. Again, in plicated strata, points where by sharp folding the beds are closely compressed together—as on the side of the fold—are often found to carry large bodies of ore. The chemical composition of the beds is also a most important factor. In some regions where thin beds of limestone are scattered through considerable thicknesses of sandstone and shales, the ore is almost exclusively confined to the more attackable limestone.

Deposits along contact-planes. Mineral-bearing solutions gathering in, or flowing along, the planes of contact of eruptive bodies with rocks through which they have been forced would have a tendency to deposit their contents along such planes, whatever the direction of their flow. If they were ascending currents, it may be conceived that they were coming from a hotter region, or from the vicinity of a larger and not so thoroughly cooled mass of igneous rock, where their solvent power was greater, to a cooler region in which this solvent power would be relatively less. If lateral or descending flows, gathering from the mass of one of the walls of the fissure, precipitation might be induced from the solutions thus brought in by a retardation or temporary stagnation of the flow, by dilution through mixing with other waters already circulating in the fissure, or by some chemical interchange resulting from contact with the other wall, if a rock of different chemical composition from that through which the solutions had been passing.

Contact-planes as defined above will more frequently be found to coincide or connect with planes of rock-fracture, since one can hardly conceive of sheets of eruptive rocks being forced through existing rock-masses in the form in which we now find them, unless they had followed some already determined line of fracture, or at least of readiness to be forced open, and it is well known that eruptions of lava at the present day are generally preceded by earthquake shocks, which probably involve a very considerable shattering and fissuring of the earth's crust in the vicinity of the eruption.

Ore deposits along contact-planes are very common. Of deposits along the contacts of dikes or cross-cutting bodies of eruptive rock, hence generally occupying a more nearly vertical position, abundant examples are found, most of which are commonly classed by the miner as fissure-veins, because of the prevailing prejudice in favor of the supposed greater value of that type of deposit. It may be that the whole mass of a narrow dike is impregnated with mineral, and thus constitutes the ore-body; but in the structural sense, it is none the less a contact-deposit, since the deposit has been made by water acting from the contact-planes outward.

Deposits along planes of rock-fracture or fissures produced by dynamic movements. The most prominent and readily remarked of these rock-fractures are the great faults which have played so important a part in determining the orographic relief of our globe. The greatest of these faults often extend for miles in length, and the displacement of the opposed rock-masses on either side of the fault may amount to several thousand feet. Minor faults, or displacements, which are found in infinite variety, especially in regions of great dynamic disturbance, may not produce any readily apparent effect upon the surface-features, and yet may be recognizable as determining the flow of springs, or be detected by the underground workings of mines. They have been most thoroughly studied in the workings of coal mines, where the importance of careful underground mapping is most generally appreciated, since the determination of the direction and amount of throw of such faults has an actual money value. In all these rock-fractures the evidence of a movement of displacement, as disclosed by the discrepancy or want of correspondence in the adjoining walls, is usually very prominent. There are other and much more numerous rock-fractures, in which there is either no movement of displacement, or it is so slight as to be with difficulty detected. Among them certain classes are characterized by their frequency and their general parallelism in two or more co-ordinated directions, and at angles often approaching a right angle with each other.

Causes of fracture.—It is hardly necessary to state that the force which produces the folding, faultings and rock-fractures, in short the mountain-building force, must be considered as a result of the secular construction of the earth's crust, the forces exerted resulting from the attempt of an already consolidated crust to fit itself more closely to a shrinking nucleus. Their effect is felt probably only upon a comparatively thin outer portion of the earth's crust; at any rate it is a very thin portion of this crust which comes under our observation. This crust may be conceived, therefore, as having been since its first formation in a condition of tension, a gradually increasing force, which from time to time found its relief in earth-movements producing corrugations on its surface, and hence relative elevations along certain orographic lines, which for some reason or other were lines of least resistance or of weakness. Such lines, once determined, have been the scene of most marked expression of these constantly recurring movements of relief from tension. Closely connected with such movements have been the eruptions of igneous material, forced up from below, either from a region of permanent fusion of the earth's crust, as was formerly and most generally maintained, or, according to later views, from local reservoirs, brought into a fused condition as a more or less direct result of these movements, by the disturbance of the equilibrium between the various forces involved in the general condition of tension. Whatever their source, the eruptions of igneous rocks have unquestionably had a very close connection with orographic disturbances, and further have indirectly played an important part in the formation of most ore-deposits.

Observation teaches us that these successive periods of dynamic disturbance, or of mountain-building, must have been followed by periods of relative quiescence, during which the regions elevated into land-masses, were worn down by atmospheric abrasion, and their comminuted debris carried into the adjoining oceans to form a new series of sedimentary beds. Each successive series of dynamic movements would involve not only this newer series, but also the older and already plicated and fractured series of rocks; and thus the structural conditions are found to be more complicated and more difficult to decipher, the older the rocks in which we have occasion to study them.

Common characteristics of compression-fractures.—There are three phases of structural evidence of rock-fractures and displacement resulting from compression, one or more of which characterize the various types of fissures carrying ore-deposits. These are:

a. Striations and "slickenside" surfaces.

b. Breccia or fragmentary material in the fissure itself, or zones of crushed or broken rock-material included between intersecting systems of fissures.

c. A sheeting of the country rock parallel with the main fracture: in other words, the occurrence of a system of minor fractures which divide the country-rock up into a system of approximately parallel plates or sheets. The distance between these parallel fractures, or the thickness of the sheets, may be reckoned by inches, by feet, or by hundreds of feet, according to the varying texture of the rock-masses involved, or the different dynamic conditions which have produced the fracture.

It will at once suggest itself that these are all phenomena characteristic of faults. But they are also found, at times, where there may be no recognizable evidence of actual displacement of the rock-masses on either side of the fissure or fracture. On the other hand, it will be equally evident that fissures characterized by these phenomena can hardly be the result of contraction, or shrinkage-cracks.

Striations are not confined to well-defined fissures, but are found on smaller planes within rock-masses; but in any case they seem to necessarily give evidence of movement under pressure, be the amount of that movement never so small.

Fragments of country-rock are often rounded. These have less probably fallen into the fissures from the walls, and become rounded by attrition either against the walls or against each other, than been produced by the rubbing or dragging of one wall against the other. The greater or lesser size of the fragments would, in a measure, prove a greater or less distance between the walls, but it seems that under the enormous pressure that must have accompanied these rock-fractures, the spaces between the walls must have been more or less completely filled with attrition-material, only part of which would be actual rock fragments, and the rest finely comminuted material which, under the dissolving agency of percolating waters, would finally result in more or less impure clays. The rounding of the fragments, on the other hand, is readily accounted for as the action of these same percolating waters, it being a well-recognized fact that the decomposing action of moisture in any form acts more rapidly on the corners or angles of a rock-mass than on its flat surfaces, and the sharper the corner the more rapidly is it eaten away.

Crushed zones are merely larger phases of the same actions as produce the breccia material, and are subject to the same general laws, only differing in their greater dimensions and the more irregular shape of the enclosing walls.

The sheeting of the country-rock in faulted or fractured regions where ore deposits abound is a phenomenon to which too little attention has been paid. Its importance as a feature of fissure-veins is, however, great, both from a geological and practical point of view. That it has hitherto escaped due recognition is probably due to the prevalence of the old idea that vein-deposits are necessarily the filling of open fissures, and to the failure to appreciate to how great an extent they are actually the replacement of rock-material rendered more readily accessible and attackable by the dynamic movements which produced the fissure.

From individual fissure-faults there is a gradual transition into co-ordinated fractures, as a rule, greater in number in a given area, but of less individual extent, which form a sort of fractured zone with two or more prominent directions of fracture, apparently of nearly contemporaneous formation. These Emmons calls *compression joints*, because they always show one or more of the evidences of compression, viz., striation, brecciation or crushed material, and sheeting of the country rock. Such complicated systems of fracture would appear to involve the action of more than one system of dynamic movement; that is. a force of compression acting at the same time in different directions, and hence combining with the direct plicational strain more or less strain of torsion.

In the larger joints or fractures observed in mining districts the effects of direct compression have been more marked, and the effects of the torsional strain are probably more seen in the minor fractures, or stringers and leaders, as the miners call them. In the map of a mining district characterized by a multitude of small veins, it will be found that the more detailed the map, and the more thoroughly the veins have been explored and represented thereon, the more regularity and uniformity in their directions are shown. It must be borne in mind, however, that such a map never represents the totality of the fissures in the district, but only such parts of them as have been found sufficiently rich to exploit for ore.

It is an evident fact that by a succession of dynamic movements, especially when accompanied by torsional strains, an almost infinite variety of fissures and passages for mineral-bearing waters may be produced, and that it would therefore not be possible beforehand to describe all the various structural conditions under which ore-deposits may occur. But certain conditions suggest themselves as a result of the structural method of considering them that would seem to have a general application.

Structural generalizations. — Extent of fissures. Since the dynamic movements are confined to the crust of the earth, it is evident that the fissures produced by them cannot literally have an indefinite extent in depth, though in certain cases it is very possible that the extent may be practically indefinite, as it may go beyond the limits at which mining is practicable. It is fair to assume that those fissures which have the greatest horizontal extent will have the greatest extent in depth; in other words that their vertical and horizontal dimensions bear some sort of proportion to each other. If, therefore, as some have maintained, the vein-filling has in all cases been brought from some source at great depths in the earth, the greatest fault-fissures would be expected to be the greatest and most frequent ore-producers, since they would reach nearer to this unknown source.

But rather the reverse is the case, which, as far as it goes, furnishes an argument in favor of the view that the vein-material has been derived from the surrounding though not of necessity absolutely contiguous rocks. On the great fold-faults are found no considerable deposits of ore, and it is comparatively rare that continuous deposits are found along a single well-defined fault-fissure. The majority of deposits seem to occur where there are a series of fissures, more or less regularly co-ordinated, in which several of the series are prominently accentuated. In such systems there seems to be a tendency for the rich ore-bodies or bonanzas to extend in a direction which lies at an angle with that of the main fissure, or to continue for a certain distance along one fissure and then to pass into another fissure, set off at a little distance from the first. It would seem probable that there must be some structural reason for the concentration of the ore in this way. The practical lesson to be learned is that the prospector should not confine his explorations to the single fissure in which the ore occurs, but when he runs out of bonanza in that, he should seek a continuance of it in some adjoining fissure or plane, in a direction to be determined by the study of the system of the fracturing of the region and of the general direction of the bonanzas.

Vein-walls. The second generalization is in regard to the *walls*, which have generally been considered an important and almost indispensable characteristic of a true fissure-vein. The typical wall which the miner considers an evidence of a strong and well-defined fissure-vein is a comparatively smooth, generally striated rock-plane, and frequently coated with a clay-selvage—a band of decomposed argillaceous material which itself generally shows evidence of pressure and movement. From the above structural point of view of the origin of vein-fissures, it is evident that the character of the wall and selvage is dependent on the composition of the rock and the amount of displacement and pressure. The grinding of one face of rock against another will undoubtedly tend to plane both off and to produce a certain amount of fine attrition-material; but this attrition-material will not necessarily be reduced to clay unless it has further been subjected to the decomposing action of water, which has carried off certain portions and left an argillaceous residue. The extreme instance of such decomposition is found in the muddy accumulations at the bottom of caves in limestone, which are simply the less soluble residues, mostly silica and alumina, resulting from the dissolution of large quantities of more or less impure limestone.

These walls and selvages are a frequent accompaniment, but by no means an essential characteristic, of an ore-bearing fissure. It is quite conceivable that one or both may be wanting; and such occurrences are not uncommon in nature. Take, for instance, the veins of Butte, Montana. There are a series of co-ordinated fractures or compression-fissures in a remarkably homogeneous mass of granite. Apparently there has been little or no displacement of the walls of these fissures relatively to each other; hence, but little attrition-material has been produced; and for this reason—and probably, also, on account of the character of the rock and because it was not much decomposed along the fissure-planes before the advent of the ore-bearing solutions—no clay-selvages have been formed, and the ore-bearing solutions have eaten into the wall-rock to varying distances, replacing it more or less completely by vein-material, and leaving no definite boundaries or walls to the deposits. There is no reason, however, for considering them any the less true fissure-veins or less valuable ore deposits on this account.

On the other hand, under certain conditions, instead of an absence of well-defined walls there may be so many as to mislead the miner who depends too implicitly upon them as a boundary of his ore-body. In the Gunnison region, for instance, where, owing to the plasticity of the country-rock, it has been divided along the main fracture-planes into a series of very thin parallel sheets, the space between these sheets has frequently been filled by quartz, which thus forms a thin sheet often so completely reproducing the form of the fissure as to present a cast of the striation-surface. Such a sheet of quartz, when the adjoining bands of country-rock have been replaced by vein-material, forms a hard, well-defined wall to the ore-body, which delights the eye of the honest miner and enhances in his mind the value of his property.

Ore may be found as well on one side as on the other of such a wall, and not unfrequently is apparently confined to one side for a considerable extent along the length of the vein, and then is found almost as exclusively on the other side. In one prominent instance a new body of rich ore was struck by cross-cutting into the foot-wall country. The moral is that judicious cross-cutting forms a very important part of vein mining, but should be conducted with due regard to the fracture-system of the adjoining country, and to the evidence to be obtained as to the course followed by the ore-bearing currents, or it may involve an unnecessary amount of dead work.

Banded structure. In most of the deposits of the Gunnison region, there is a noteworthy appearance of banded structure parallel with the walls of the fissure. The evidence of faulting and of the thin sheeting of the country-rock is there so clear that the explanation at once presents itself that this appearance arises from the fact that the deposits are partly a filling-in of interstitial spaces, and partly a replacement of thin sheets of country-rock, the differing composition of the bands resulting rather from the necessary variation in the process of deposition than from essential differences in the ore-bearing solutions. Were one to examine there only a large body of rich ore, and neglect to examine the adjoining poorer deposits, and to study the structural conditions of the region, one might be led to adopt some of the complicated explanations set forth in books on ore-deposits, such as successive reopenings of the vein, to account for the conditions found, instead of the simple one given above.

Crushed zones. Cases occur where the systems of rock-fracture intersect each other, and under suitable conditions considerable portions of the country-rock included between such intersecting fractures may be broken up or crushed to such an extent as to admit a relatively free passage of percolating waters. Where such waters are mineral-bearing, the interstices between the fragments will offer spaces for the precipitation of their contents, or where the rock is readily soluble the fragments themselves may be replaced by vein-material.

Where three or more nearly vertical fracture-planes intersect each other near the same point, the prismatic body of rock included between the intersections may be so crushed and broken as, in a district rich in mineral-bearing solutions, to give rise to what are generally known as chimney deposits. Where the fracture-planes are merely joints along which there has been but little movement, and no clay-selvages have consequently been formed, the ore-solutions will eat out the rock in such a way that the ore-chimney may appear to have a rounded instead of an angular horizontal section, and the fracture-planes themselves may have become, by the decomposition of the adjoining country-rock, so obscured as to be with difficulty traced in the immediate vicinity of the ore-body.

Repeated movements along fissure-planes. It is a well-recognized fact of structural geology that in successive dynamic movements in the same region there will be a tendency for fractures to follow already determined planes of fracture. Furthermore, it appears that the faulting of a rock-mass is not necessarily a geologically instantaneous movement, but that the displacement may continue for some time after the first fracture has been determined, probably dying out very gradually. Some such continued movement seems necessary to give time for the reduction by the action of water of the attrition-material to the clayey condition in which it is often found. We may expect therefore, to find evidence in large fissures of repeated movements.

Cross-fractures and even apparent displacement of one fracture by another, may be produced by one and the same strain. Hence, in studying a system of fissures, one must not too hastily conclude that each direction of fracture means a distinct movement, or even that displacement of one fissure by another necessarily proves that the latter was produced by a distinct and later movement; to be sure of this some of the other evidences of movement must be found.

Some very interesting facts in connection with two adjacent properties in Boulder Co., Colorado, are worthy of notice. The vein

A runs first in porphyry, then in contact between porphyry and granite, and sometimes wholly in granite. The vein-stone is a hard, flinty, white quartz. The gold is free and often very coarse; rarely accompanied by pyrite and chalcopyrite, increasing on entering the granite, when blende and galena also occur, but as tellurium minerals.

The vein B is a bluish quartz, with chalcedony and finely disseminated pyrites. The value is in metallic gold, petzite, and sylvanite. While most of the metallic gold was deposited as native gold, a certain portion has evidently been rendered free by the partial decomposition of the tellurium-minerals. The richest ore usually occurs in two narrow seams or streaks often only one foot, but at times as much as ten feet apart; the intervening space being more or less mineralized rock. The miners working as lessees on this vein consider it richest in the schistose rock, and poorest when it is in the porphyry, on its course through the dyke. Though the openings on the vein, in the dyke, are limited, this opinion appears to be correct.

So distinct are the characteristics of these veins that the crossing of B through A is plainly marked and confirms the opinion that the gold mines of the country belong to at least two distinct periods of vein-formation.

That the ores from B (the tellurium vein) are of a lower grade where the vein passes through the porphyry dyke than elsewhere may be due to the formation of the A vein first. This vein probably drained the dyke of much of its disseminated mineral values. B doubtless received its mineral through the schistose or gneissic rocks, and is consequently richer where enclosed in those rocks than in the dyke.

Prospectors, as a rule, look for richer or larger bodies of ore where veins unite or cross each other. In this property there are two interesting occurrences of this kind. The A veins unite at a point 100 feet below the surface. These are similar veins of the same age. The result is seen in larger and richer ore-bodies mined in the stopes adjacent to the junction of the veins. In the other case the crossing of the B (tellurium) vein through the A vein, which was the passing of a later through earlier veins, produced no local enlargement or enrichment of the ore-bodies. It may be inferred with probability as a general rule, subject of course to local exceptions, that for the production, by the junction of two veins, of ore-bodies larger or richer than are characteristic of either vein separately, the two veins should be of contemporaneous origin.

Perhaps the last proposition may be both confirmed and explained by restricting its application to such cases of enrichment as result from the simple enlargement of the space available for deposition, and the consequent diminution of the speed of percolating currents—both of which conditions are observed to produce similar effects in veins which vary in dip or width but are not intersected by other veins. Practical miners look for the larger ore-bodies in the flat places and the wide places of the vein; and the pinches, though they do now and then compensate by special richness for their contracted size, are usually as "lean" as they are thin.

The theory of the formation of ore-deposits by replacement, as opposed to that by the filling of pre-existing cavities, may be applied to deposits in rocks which are not so readily soluble as limestone, in which cases the percolating solutions would have first attacked the relatively more soluble among their constituents. Very many so-called fissure-veins in crystalline rocks are formed by percolating water circulating along joints, shrinkage cracks, fault-planes, or zones of crushed rock, which have filled the interstitial places and replaced the materials of the adjoining country-rocks to a greater or lesser extent by the materials they held in solution, but are not the filling of any considerable open cavities. The comb-structure of veins, on which the early geologists founded their theory that a vein was necessarily the filling of a pre-existing cavity, is of comparatively rare occurrence.

Cracks or fissures must undoubtedly have existed, which determined the concentration of mineral solution along their course; but whether such cracks were to any great extent fault-planes, whose movement might have left large open spaces between the irregularities of their walls, seems questionable. In Leadville one of the most noticeable facts is that the fault-planes which may be supposed to reach to great depths have been found barren of ore except by secondary infiltration from surface-waters, or as attrition-material from pre-existing deposits, when the fault-line cuts across such deposits.

The idea that a fissure-vein necessarily extends to an indefinite depth is another popular error, and is not founded on good geological reasoning. Whatever the nature of the fissure along which the deposit has taken place, whether fault-plane, joint or shrinkage-crack, there must be some mutual relation between the horizontal and the vertical dimensions. In other words, the study of structural geology shows that the length of such a fissure or crack must bear some proportional relation to its extent in depth, and the probability is that the latter must be less than the former.

The present tendency of the results reached by careful and well-authenticated determinations of the origin and manner of formations of ore-deposits is in favor of a continually-increasing applicability of the following conditions:

That they are deposited from solutions made by percolating waters.

That the deposition takes place very rarely in actually open cavities, but most frequently by metasomatic interchange, or by replacement of the more soluble or more accessible portions of a rock or members of a rock series.

That these solutions do not necessarily come directly upward, but simply follow the easiest channels of approach.

That these materials are not immediately derived from sources at some unknown depth, but from neighboring bodies of rock within limited and conceivable distances.

That where, as is often the case, ore-deposits are associated with, or in the vicinity of, bodies of eruptive rock, especially the older intrusive rocks, there is a reasonable probability that these materials have been derived from these rocks.

If the solutions came from the country-rock, at or above the level of the ore-deposit, it is most likely that the hanging-wall will be more or less obliterated, and the foot-wall relatively distinct. This follows from two considerations: First, because the rock of the hanging-wall is in such case the main source of the water-supply for the fissure, the natural effect of gravity (apart from special water-channels) being to carry the waters of the foot-wall away from the vein, and to some other vein below it; and secondly, because the disintegrated rock of the hanging-wall would naturally deposit debris on the foot-wall, protecting it from disintegration, and thus preserving its definite form. The only "boundary" of such a vein would be a commercial one, viz., the line at which the ore ceased to pay.

TESTING MINERALS BY THE BLOW-PIPE.

TO ascertain the effect of heat on minerals, a small instrument, called the blow-pipe, is used. In its simplest form it is merely a bent, tapering tube of brass from 7 to 10 inches long, with a minute aperture at its smaller end. It is used to concentrate to a point the flame of a lamp or candle, and this is done by blowing through it while the smaller end is just within the flame. After blowing awhile, the moisture of the breath often condenses in the tube, and to receive this moisture some forms of blow-pipe are provided with an air-chamber.

When the blow-pipe is made of brass it

is usual to have an ivory mouth-piece, as it is more agreeable to the mouth. Silver, however, is the best material, and the point should be of platinum.

Operations with the blow-pipe often require an uninterrupted heat for a considerable length of time, and always longer than a single breath of the operator. It is therefore requisite that breathing and blowing should go on together. This may be difficult at first, but the necessary skill or tact is soon acquired. Let the learner attempt first to breathe through his nostrils with his cheeks inflated and mouth closed. This accomplished, if the blow-pipe is now put to the mouth, he will find no difficulty in continuing his respirations while the muscles of the inflated cheeks are throwing their contained air through the blow-pipe. When the air is nearly exhausted, the mouth may again be filled through the nose without intermitting the process of blowing.

The *blow-pipe flame* consists of two cones —an inner of a blue color, and an outer, yellow. The heat is most intense just beyond the extremity of the blue flame. The inner flame is called the *reduction* flame, and the outer the *oxidation* flame. A mineral reduced to the metallic state by the *inner*, may often be oxidized, or combined with oxygen, in the *outer*, flame, where it is in contact with the atmosphere. For oxidation, the beak of the blow-pipe should have a large aperture, and the wick of the lamp should also be large. The heat may be that of incipient redness.

When it is desired to produce a reducing action, the point of the blow-pipe is just allowed to touch the flame, which should completely envelop the assay, as the substance to be tested is called. To produce an oxidizing action the point of the blow-pipe should be inserted a little into the flame, and the assay should be placed at or a little beyond the point of the flame.

The best flame is that of a lamp with a large wick fed by olive oil. A common candle with a large wick will answer for most of the purposes of the prospector, and is most conveniently carried about. When used the wick should be bent in the direction of the flame.

To support the mineral in the flame, either charcoal or platinum forceps or wire may be used. The charcoal should be well burnt but firm; that from pine wood is best, as it burns with least ashes. The reaction of the carbon of the coal aids in reducing or decomposing many mineral species. The mineral kyanite, and also mica, are sometimes used for a support when more convenient means are not at hand.

To test the presence of water or of a volatile ingredient, the mineral may be supported near one end of a test-tube which may be three or four inches long and the bore a little larger than a quill. The end is then heated with a spirit lamp, or the flame is concentrated on the exterior of the tube beneath the assay, and the volatilized substance usually condensed in the upper part of the tube. By inserting into the upper end of the tube a strip of litmus paper or other test paper, it is ascertained whether the fumes are acid or not, the color of the paper, if so, changing to red.

The specimen subjected to the flame of the blow-pipe should be a very small, thin fragment, especially when the mineral is not very fusible, fusion being often thus obtained, when impossible with a fragment without thin edges. A fragment as large as a pea might afford a score of pieces, large enough for a blow-pipe trial.

Many minerals remain unaltered before the blow-pipe unless some substance be added to aid in the fusion or reduction. These substances are called *fluxes*. Those in common use are borax, carbonate of soda (calcined) and microcosmic salt.* Care

* This salt, a phosphate of soda and ammonia, may be made by dissolving 16 parts of sal ammoniac in a small quantity of boiling water, and afterwards adding 100 parts of crystallized phosphate of soda, boiling gently the whole, and then setting it away to cool. The salt of phosphorus is deposited in small crystals. If the heat is too great during ebullition, decomposition takes place.

should be taken to obtain the fluxes pure, and for this purpose it is well to dissolve and recrystallize the borax. The soda should be tested for sulphuric acid, as any adulteration with this acid will give the glass obtained with silica a brown or reddish color. The fluxes should be powdered and added to the mineral, and the whole assay should not exceed the size of a small pea. One-fourth this size is better than larger. The soda should be added in small successive doses. This flux is often absorbed by the charcoal, but generally reappears when the heat is sufficiently raised.

Besides the fluxes mentioned other tests are sometimes used of which the following are the most important:

Nitrate of cobalt in solution for distinguishing alumina and magnesia The solution should be pure, free from alkali and slightly concentrated. It is advisable to have a bit of platinum wire in the cork stopper, in order to take out a drop upon it when required for use.

Boracic acid and *iron wire*, used in testing for phosphoric acid.

Tin foil, for using with certain peroxides of metals to reduce them to protoxides. The assay previously heated in the reducing flame should be touched with the end of the tin foil, a very minute quantity of a metallic oxide being often thus detected.

Gypsum and fluor, used as tests of one another. When two parts of the former rendered anhydrous by heating, and one of the latter, are mixed and heated, they fuse to a clear glass, which forms a milk-white enamel on cooling. The globule from fluor and heavy spar is transparent when cold; and that with sulphate of strontium is more or less frothy.

e. Saltpetre is employed in discovering manganese, bringing out the characteristic amethystine color when the quantity of this metal is too small to color glass without this reagent. The heated globule is touched with the point of a crystal, just at the moment of suspending the blast. The melted mass swells, foams, and either becomes immediately colored, or upon cooling.

f. Anhydrous bisulphate of potash, used for detecting lithia. It is kept in a coarse powder in a bottle well secured from moisture.

g. Oxalate of nickel, or nitrate of nickel, used to detect potash. The nickel should be quite free from cobalt. It may be tested by treating it with borax, with which it should give a brown, not a blue bead.

The examination of an assay with borax and salt of phosphorus is generally made on platinum wire where the color of the bead is more readily observed. Make a small loop in the end of the platinum wire, heat it to whiteness in the blow-pipe flame and dip it into powdered borax or salt of phosphorus. Heat again in the blow-pipe flame—adding more of the reagent if necessary—until a clear glassy bead is formed. While the bead is hot, touch it to a minute speck of the assay, and heat again in the oxidizing, then in the reducing flame. If no distinct color is produced, add a little more of the assay to the same bead, and heat again, repeating the operation as many times as may be necessary.

The examination with soda is generally performed on charcoal in the reducing flame. When the result looked for is the production of minute globules of metal, care should be taken that they do not escape observation. If necessary a portion of the charcoal around the assay may be cut out, ground up with a little water in a small mortar and the charcoal and soda washed away. Any shining particles of metal may then be readily detected. When two or more metals are present an alloy is usually formed.

Below, some of the reactions with the fluxes or reagents are given:

Silicon, *silicates*. Silicon dissolves with effervescence when fused with soda on charcoal, forming a glass which is transparent when hot. The silicates are decomposed by salt of phosphorus on platinum wire, and the silicon is set free, often remaining as a skeleton of silica in the globule.

Potassium, sodium, lithium. Sodium gives an intensely yellow color to the flame, even when in combination; yet this color may be otherwise produced. Potassium often gives a violet tinge, and lithium a purple-red color to the flame; but the presence of sodium vitiates the test by communicating its own color. A glass of borax containing potassium becomes blue when a little oxalate of nickel is carefully added, while a glass of soda becomes brown; and this holds good for potassium although sodium be present. A lithium salt fused on platinum foil, if sodium be present, produces a yellow stain; but this stain is also produced by other reagents. If a lithium mineral be mixed with one part of fluor finely pulverized, and one and a-half parts of bisulphate of potassium, the flame is red; if no lithium is present, it is faint violet.

Calcium and calcium salts impart a brick-red color to the flame, and the substance glows with the white look of alkali earths.

Magnesium. Magnesium and many magnesian silicates afford a clear rose-red color with cobalt solution after long heating. A fragment after heating should be moistened with the solution and then heated again. The color deepens on cooling. Magnesium is not acted on by soda.

Alumina. If a fragment of alumina, or if an aluminous silicate, after heating to redness, be moistened by cobalt solution and again heated, but not to fusion, it assumes a fine blue color. The harder species should be finely pulverized. The test is sure except when oxides of certain metals are present; and also when saltpetre is present, since it gives a blue color with silicon and zirconium, and in some other cases.

Arsenic and arsenical compounds give off usually arsenical fumes having a garlic odor when heated on charcoal or with soda. With many of the compounds heated in an open tube a white sublimate of arsenious oxide is produced and the characteristic garlic odor given off. Arsenic and some of its compounds when heated in a closed tube give a sublimate which has a metallic lustre. If the mineral contains sulphur as well as arsenic, a red or yellow sublimate of a sulphide of arsenic may be formed. Some compounds of arsenic impart a light blue color to the outer blow-pipe flame.

Sulphur. Sulphides yield fumes of sulphur when heated in charcoal, in a closed tube or in an open tube. A compound of sulphur when heated on charcoal with soda yields a mass which stains a silver coin black or brownish black when moistened and placed upon it.

Tellurium and tellurides give fumes but no odor. Heated on charcoal the oxide covers the charcoal with a brownish yellow coating and the inner flame directed upon this coating is tinged bright green. In an open tube a white or whitish sublimate is produced which before the blow-pipe fuses to clear colorless drops.

Chromium. With borax both in the oxidizing and reducing flame chromium gives a bead which is green when cold; but on platinum wire in the outer flame the color nearly disappears. Chromic iron gives the same color, and it is brightened on the addition of tin-foil.

Antimony. The ores of antimony afford on charcoal dense, white, inodorous fumes which partly escape and partly condense on the coal. The oxides form with soda, on the platinum wire, a clear, colorless bead, which becomes white on cooling; on charcoal they are reduced. In an open tube antimony gives white fumes, which coat the glass and vaporize easily on a new application of the heat, without fusion to globules.

Titanium yields with borax a colorless glass which becomes milk-white on flaming. In the inner flame, the glass with little of the assay is first yellow and afterward amethystine and transparent. With more assay on charcoal in the inner flame, it becomes dark blue or nearly black on cooling; but it is pale blue afterward on flaming. On platinum wire with salt of phosphorus it forms in the outer flame a clear, colorless glass; in the inner flame, a red or violet-blue glass, when cold, especially if tin be added. When iron is present the color after heating in the inner flame is deep red on cooling. Silicious titanic minerals, such as ephene, do not give the reaction with borax, except after long heating in the inner flame with salt of phosphorus, and it is apparent only on cooling.

Tin. Fused with soda on charcoal in the reducing flame, compounds of tin yield a globule of the metal, and at the same time a coating is formed on the coal which is slightly yellow when hot but is white when cold. The reduction of tin is much assisted when a little cyanide of potassium is used with the soda. This coating, moistened with the cobalt solution and heated in the oxidizing flame, assumes a bluish green color.

Lead. Fused with soda in the reducing

flame on charcoal, compounds of lead yield a globule of the metal. When heated on charcoal a coating is produced which is lemon yellow while hot and sulphur yellow when cold. The coating imparts to the reducing flame an azure blue color.

Zinc. Oxide of zinc with borax gives a clear glass, which is milk-white on flaming; or with more assay is enamel-white on cooling. In the inner flame on charcoal, fumes are given off and a white coating surrounds the assay. With soda on charcoal, the ores, even when containing little zinc, afford the peculiar bluish flame of burning zinc, and the oxide is deposited on the coal. With cobalt solution zinc gives a green color, while tin yields a bluish-green color.

Cadmium. Oxide of cadmium, even when in small proportions in other minerals, when heated on charcoal deposits a reddish brown color. The test is more delicate when soda is used.

Copper. Oxide of copper gives a fine

green glass with borax, which becomes cinnabar-red on cooling. The ores are reduced on charcoal with soda and a malleable copper-colored globule is obtained. When the copper is combined with oxides that are reduced together with it, borax and tin should be used. If iron be present, the copper and iron are obtained separately.

Manganese. Oxide of manganese gives with borax in the outer flame an amethystine globule which becomes colorless in the inner flame. With soda on platinum foil, the oxide gives a green color which is bluish on cooling. When other minerals are present, soda should be added, and then the bluish-green color is obtained, even with less than one per cent. of manganese.

Iron. With borax on platinum wire, iron in the outer flame gives a dark red glass which becomes yellowish or colorless on cooling. In the inner flame it affords a bottle-green color, or a bluish-green in a more perfect reduction. With tin the green color is hastened. Minerals containing much iron become magnetic when highly heated in the reducing flame, especially if soda is used.

Cobalt. With borax on platinum wire, minerals containing cobalt give a clear blue bead which does not become opaque on flaming. If arsenic or sulphur is present the assay should first be heated on charcoal until fumes are no longer emitted. If a small quantity of iron be present the bead will be green while hot, but blue when cold.

Nickel. With borax on platinum wire, nickel yields a bead in the oxidizing flame which is violet while hot but reddish brown when cold. In the reducing flame the bead becomes gray and cloudy, and sometimes opaque, from a separation of metallic nickel. With continued blowing the metal collects together, and the bead becomes colorless. The reaction is obscured by the presence of iron, cobalt or copper.

Gold. When gold is in combination with metals which are volatile at a high temperature, such as tellurium, mercury, antimony, it is only necessary to heat the alloy on charcoal with the oxidizing flame, when the gold remains behind in a pure state, and may be recognized by its physical properties. Lead is removed by the process of cupellation, as will be explained under "Silver."

When associated with copper, the presence of which is easily detected by salt of phosphorus on charcoal, the alloy, for instance, gold coin, is dissolved in pure melted lead, and the new compound subjected to the process of cupellation on bone-ash. Copper is by this means entirely removed. To test the remaining globule for silver, it is treated with salt of phosphorus on charcoal in the oxidizing flame; the silver is gradually oxidized and dissolved by the glass, which, when cold, assumes an opal-like appearance. To determine approximately the relative proportions of the two metals, the metallic globule is taken from the cupel, placed in a small porcelain dish containing some nitric acid, and heat applied. If the alloy contains 25 per cent. of gold or less it turns black, the silver is gradually dissolved, and the gold remains behind as a brown or black spongy or pulverulent mass. If the alloy contains more than 25 per cent. of gold, the globule turns also black, but the silver is not dissolved. If both metals are present in about equal proportions, the globule remains unaltered. If the amount of gold is considerable it is indicated by the color of the alloy.

In both of the latter cases it must be fused on charcoal with borax and at least twice its weight of silver, free from gold, and then treated with nitric acid, when the separation will be complete. To form a gold button, it must be well washed with distilled water and fused on coal with borax, and it will then have the pure gold color and bright surface.

When associated with metals which *per se* are infusible before the blow-pipe, such as platinum, iridium, palladium, the metallic globule obtained by cupellation shows much less fusibility than pure gold. The exact nature of the foreign metals cannot be ascertained before the blow-pipe, and the wet method of assaying must be resorted to.

Silver. Many compounds of silver yield a globule of the metal when fused with soda on charcoal in the reducing flame. When treated for a long time with the reducing flame, a slight, dark-red coating is produced.

When in combination with metals which are volatile at a high temperature, such as bismuth, lead, zinc, antimony, the substance is heated alone on charcoal when, after the volatilization of these metals by long blowing, a button of pure silver remains behind, and a reddish coating is deposited on the charcoal. If associated with much lead or bismuth, these metals are best removed by cupellation, a process which is executed as follows:

Break off the bowl of a common clay-pipe and make a suitable upright holder of twisted wire. Fill the pipe three-quarters full of any kind of dry earth or pulverized rock, fill the remainder of the pipe with finely pulverized bone-ash, with which previously may be advantageously mixed a minute quantity of soda, and then dampened to an almost imperceptible degree. The top is made smooth and slightly concave by pressing on it with the head of an ordinary carriage bolt. The cupel is then dried by the blow-pipe with the flame of a candle or spirit lamp. On this little cupel the assay is placed, and heated with the oxidizing flame until the whole of the lead or bismuth is oxidized and absorbed by the cupel. When the assay is once fused the blue point of the flame can be held well away from it, the operation will proceed rapidly, and there will be less loss of silver than if greater heat be used. The silver, or if gold is present, the alloy of silver and gold, remains as a bright metallic button on the cupel.

When combined with metals which are not volatile, but which are more easily oxidized than silver, the presence of this metal may in some cases be detected by simply treating the alloy with borax or salt of phosphorus on charcoal. Copper, nickel, cobalt, etc., are oxidized and their oxides dissolved by the flux, while silver remains behind with a bright metallic surface. But when these metals are present to a considerable extent, another course has to be pursued, a course which may always be taken when a substance is to be assayed for silver, or silver and gold.

The assay-piece is reduced to a fine powder, mixed with vitrified borax and metallic lead (the quantities of which altogether depend upon the nature of the substance, and for which, therefore, no general rule can be given), and the mass placed in a cylindrical hole of the charcoal. A powerful reducing flame is given until the metals have united to a button, and the slag appears free from metallic globules. The flame is now converted into an oxidizing flame and directed principally upon the button. Sulphur, arsenic, antimony, and other very volatile substances are volatilized; iron, tin, cobalt, and a little copper and nickel become oxidized and absorbed by the flux; silver and gold, and the greater part of the copper and nickel, remain with the lead (and bismuth if present). When all volatile substances are driven off, the lead begins to become oxidized and the button assumes a rotary motion. At this period the blast is discontinued, the assay is allowed to cool, and when perfectly cold, the lead button is separated from the glass by some light strokes with the hammer. It is now placed on a cupel of bone-ash and treated with the oxidizing flame until it again assumes a rotary motion. If much copper or nickel is present the globule becomes covered with a thick infusible crust which prevents the oxidation aimed at; in this case another small piece of pure lead has to be added. The blast is kept up until the whole of the lead and other foreign metals, *viz.*, copper and nickel are oxidized. This is indicated by the cessation of the rotary movement, if only little silver is present, or by the appearance of all the tints of the rainbow over the whole surface of the button, if the ore was very rich in silver. After a few moments it takes the look of pure silver. The oxides of lead, copper, etc , are absorbed by the bone-ash, and pure silver, or an alloy of silver with other noble metals remains behind, and the button may be tested for gold, etc., after the method given under "Gold."

Fluorides. When fluorides are heated with salt of phosphorus previously melted in an open glass tube, the glass is corroded and Brazil wood paper, placed within the tube, is turned yellow. The salt of phosphorus used for this purpose should be free from all chlorides. If fluorine is present only in small quantity, the assay may be heated in the same way without the salt of phosphorus.

Phosphates. If a phosphate be fused with boracic acid, and the extremity of a small iron wire be inserted into the melted globule, and the whole be heated in the reduction flame, the globule formed at the extremity of the wire will prove to be more or less brittle when struck with a hammer on an anvil. As the bead cools a flash of light is usually seen. Before this trial it should be ascertained that no sulphuric or arsenic acid is present which may also form a globule with the iron; nor any metallic oxide reducible by the iron.

Boron imparts a bright yellowish green color to the blow-pipe flame. This is heightened by moistening the assay with sulphuric acid before heating. If the result is not satisfactory, mix one part of the powdered mineral with one part fluorite and three of bisulphate of potassium, and fuse on platinum wire. Boron, if present, will impart the green color to the flame at the instant of fusing.

Mercury. Compounds of mercury, when heated in a closed tube with soda, yield a sublimate of metallic mercury, which may be rubbed into globules with a piece of copper wire.

Tungsten. On platinum wire with salt of phosphorus in the oxidizing flame, a yellowish or colorless bead is produced which, treated with the reducing flame, is green while hot but blue when cold. On charcoal with salt of phosphorus in the reducing flame the bead becomes a deep green if treated with tin. The reaction is obscured if iron is present.

In addition to the instruments already described the following are of importance: *A small hammer*, with a slightly rounded face and a transverse sharp edge at the other extremity. *An anvil*, or piece of steel three inches long, one broad, and three-sixteenths thick, to be used for pulverizing minerals, for which purpose the specimen should be first wrapped in a piece of paper. *Platinum foil*, for enveloping minerals that decrepitate. *Fine platinum* wire, bent at one end into a circle one or two lines in diameter; it very conveniently holds the assay in fusion. *Cutting pliers*, for separating small fragments of a mineral for assay.

PRODUCT of GOLD and SILVER in the UNITED STATES from 1792 to 1844, and Annually from 1845 to 1899, inclusive.

[The estimate for 1792–1873 is by R. W. Raymond, Commissioner, and since by Director of the Mint.]

Years.	Gold.	Silver.	Total.
Apr. 2, 1792–July 31, 1834	$14,000,000	Insignificant	$14,000,000
July 31, 1834–Dec. 31, 1844.	7,500,000	$250,000	7,750,000
1845	1,008,000	50,000	1,058,000
1846	1,140,000	50,000	1,190,000
1847	889,000	50,000	939,000
1848	10,000,000	50,000	10,050,000
1849	40,000,000	50,000	40,050,000
1850	50,000,000	50,000	50,050,000
1851	55,000,000	50,000	55,050,000
1852	60,000,000	50,000	60,050,000
1853	65,000,000	50,000	65,050,000
1854	60,000,000	50,000	60,050,000
1855	55,000,000	50,000	55.050,000
1856	55,000,000	50,000	55,050,000
1857	55,000,000	50,000	55,050,000
1858	50,000,000	500,000	50,500,000
1859	50,000,000	100,000	50,100,000
1860	46,000,000	150,000	46,150,000
1861	43,000,000	2,000,000	45,000,000
1862	39,200,000	4,500,000	43,700,000
1863	40,000.000	8,500,000	48,500,000
1864	46,100,000	11,000,000	57,100,000
1865	53,225,000	11,250,000	64,475,000
1866	53,500,000	10,000,000	63,500,000
1867	51,725,000	13,500,000	65,225,000
1868	48,000,000	12,000,000	60,000,000
1869	49,500,000	12,000,000	61,500,000
1870	50,000,600	16,000,000	66,000,000
1871	43.500,000	23,000,000	66,500.000
1872	36,000,000	28,750,000	64,750,000
1873	36,000,000	35.750,000	71,750,000
1874	33.500,000	37,300,000	70,800,000
1875	33.400,000	31,700,000	65,100,000
1876	39.900,000	38,800,000	78,700,000
1877	46,900,000	39,800,000	86,700,000
1878	51,200,000	45,200,000	96,400,000
1879	38,900,000	40,800,000	79,700,000

PRODUCT of GOLD and SILVER in the UNITED STATES.—*Continued.*

Years.	Gold.	Silver.	Total.
1880	$36,000,000	$39,200,000	$75,200,000
1881	34,700,000	43,000,000	77,700,000
1882	32,500,000	46,800,000	79,300,000
1883	30,000,000	46,200,000	76,200,000
1884	30,800,000	48,800,000	79,600,000
1885	31,800,000	51,600,000	83,400,000
1886	35,000,000	51,000,000	86,000,000
1887	33,000,000	53,350,000	86,350,000
1888	33,175,000	59,195,000	92,370,000
1889	32,800,000	64,646,000	97,446,000
1890	32,845,000	70,465,000	103,310,000
1891	33,175,000	75,417,000	108,592,000
1892	33,000,000	82,101,000	115,101,000
1893	35,955,000	77,576,000	113,531,000
1894	39,500,000	64,000,000	103,500,000
1895	46,610,000	72,051,000	118,661,000
1896	53,088,000	76,069,000	129,157,000
1897	57,363,000	69,637,000	127,000,000
1598	64,463,000	70,384,000	134,847,000
1899	71,053,000	70,807,000	141,860,000
Total	2,305,914,000	1,655,798,000	3,961,712,000

The following tables show the amounts and the classification of Gold and Silver used in the Industrial Arts in the United States each year from 1880 to 1899 inclusive:

Gold and Silver Bars Furnished for Use in Manufactures and the Arts, and Classification of the Material Used, by Calendar Years, from 1880 to 1899, inclusive.

GOLD.

Calendar Year.	United States coin.	New material.	Old material.	Foreign bullion and coin.	Total.
1880	$3,300,000	$6,000,000	$395,000	$1,267,600	$10,962,600
1881	2,700,000	7,000,000	522,900	1,547,800	11,770,700
1882	2,500,000	7,000,000	696,500	671,500	10,868,000
1883	4,875,000	7,840,000	1,549,300	194,500	14,458,800
1884	5,000,000	6,000,000	3,114,500	385,500	14,500,000
1885	3,500,000	6,736,927	1,408,902	178,913	11,824,742
1886	3,500,000	7,003,480	1,928,046	638,003	13,069,529
1887	3,500,000	9,090,342	1,835,882	384,122	14,810,346
1888	3,500,000	9,893,057	2,402,976	718,809	16,514,842
1889	3,500,000	9,686,827	3,218,971	291,258	16,697,056
1890	3,500,000	10,717,472	3,076,426	362,062	17,655,960
1891	3,500,000	10,697,679	4,860,712	628,525	19,686,916
1892	3,500,000	10,588,703	4,468,685	771,686	19,329,074
1893	1,500,000	8,354,482	2,777,165	804,254	13,435,901
1894	1,500,000	6,430,073	2,184,946	543,585	10,658,604
1895	1,500,000	8,481,789	2,976,269	471,027	13,429,085
1896	1,500,000	7,209,787	2,369,343	316,804	11,395,934
1897	1,500,000	7,184,822	2,571,428	613,981	11,870,231
1898	1,500,000	9,463,262	2,164,976	437,641	13,565,879
1899	1,500,000	13,267,287	2,734,985	344,906	17,847,178
Total.	$56,875,000	$168,645,989	$47,257,912	$11,572,476	$284,351,377

Gold and Silver Bars Furnished for Use in Manufactures and the Arts, and Classification of the Material Used, by Calendar Years, from 1880 to 1890 inclusive.

Silver (Coining Value).

Calendar Year.	United States coin.	New material.	Old material.	Foreign bullion and coin.	Total.
1880	$600,000	$5,000,000	$145,000	$353,000	$6,098,000
1881	200,000	5,900,000	178,000	371,000	6,649,000
1882	200,000	6,344,300	212,900	440,300	7,197,500
1883	200,000	4,623,700	561,900	755,000	5,540,600
1884	200,000	4,500,000	170,000	650,000	5,520,000
1885	200,000	4,539,875	462,186	62,708	5,264,769
1886	200,000	3,626,195	404,155	825,615	5,055,965
1887	200,000	4,102,734	480,606	654,991	5,438,331
1888	200,000	6,477,857	652,047	771,985	8,101,889
1889	200,000	7,297,933	611,015	657,997	8,766,945
1890	200,000	7,143,635	640,100	1,245,419	9,229,154
1891	200,000	7,289,073	858,126	1,256,101	9,603,300
1892	200,000	7,204,210	647,377	1,249,801	9,301,388
1893	100,000	6,570,737	1,222,836	1,740,704	9,634,277
1894	100,000	8,579,472	1,221,177	982,399	10,883,048
1895	100,000	9,825,387	1,378,136	973,501	12,277,024
1896	100,000	7,965,449	1,076,829	1,061,995	10,204,273
1897	100,000	9,200,497	1,103,460	797,193	11,201,150
1898	100,000	10,176,784	949,312	632,449	11,858,545
1899	100,000	12,845,942	2,047,584	684,137	15,677,663
Total.	$3,700,000	$139,213,780	$15,022,746	$15,566,295	$173,502,821

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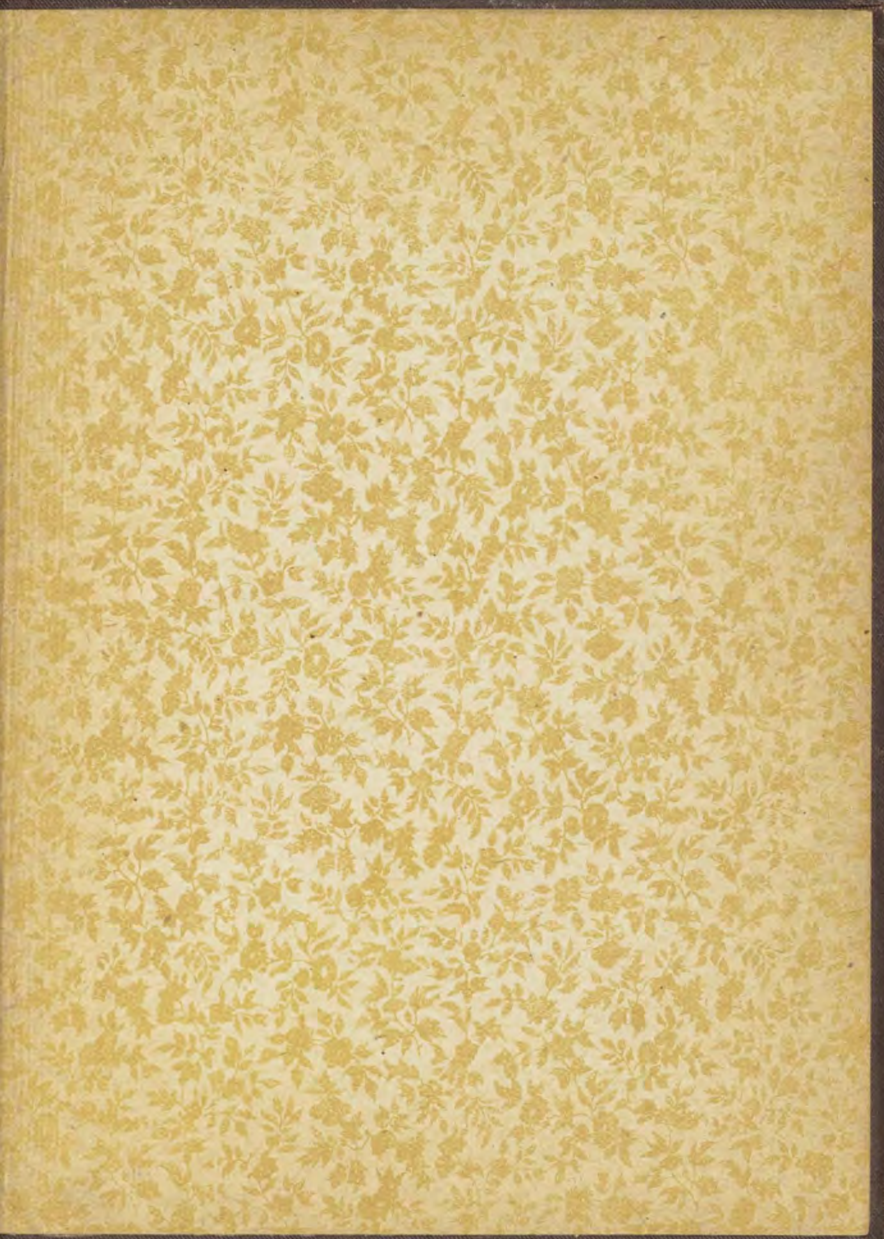

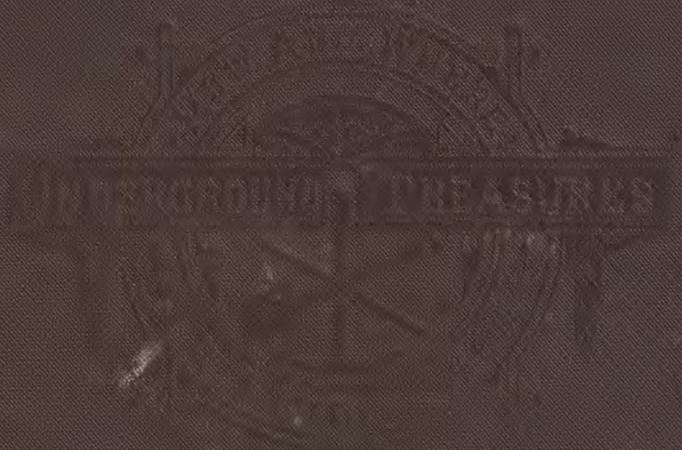
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