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NEVADA'S COMMON MINERALS

(Including a Preliminary List of Minerals Found in the State)

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PREFACE

The important position of the United States among the nations of the world is largely due to its natural resources, among which minerals occupy an important place. Today, as never before, the production of minerals is of prime importance to the welfare of the Nation. Minerals are of even greater relative importance in the history and development of Nevada. The discovery of placer gold in Nevada, early in 1849, eventually led to the exploration, settlement, and the development of the resources of the State. Its large precious-metal output was largely responsible for its acquiring statehood during a most critical period in the history of the Nation. Mineral production has always ranked high among the industries of the State and at the present time, as in the past, an unusually large part of the population is dependent for its livelihood upon the mineral industry.

A large, and rapidly increasing, number of persons in the State are interested in minerals. This bulletin is offered primarily as an aid to the prospector and the layman who feel the need of an elementary treatment of mineralogy, and it is planned to be particularly adapted to the minerals of this region. This publication is the outgrowth of a revision of Grawe's work[1] which was popularly received and of such demand that the bulletin is now exhausted. This work has been expanded, by including additional material and the broadening of its scope, so as better to meet the needs of the group for which it is written. A scheme for the identification of minerals is included, together with descriptions of about one hundred and twenty-five minerals commonly found in the State. There is also included a list of all mineral species which are at present known by the writer to occur in the State. This list, though admittedly incomplete, should be of considerable value to those interested in the mineralogy of Nevada.

This bulletin is primarily intended to aid those who have had but little or no previous training in the subject of mineralogy but are interested in the common minerals. It is not intended to take the place of the standard works on the subject; some of which are listed in the bibliography. No claim to originality can be made for a work of this kind, and any merit it may have is in

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[1] Grawe, Oliver R., A table for the determination of Nevada's common minerals; with notes on their occurrence and use. University of Nevada Bull. Vol. 22, No. 1, 1928.

the selection and arrangement of the material, and particularly in its application to those minerals of common occurrence in Nevada.

The writer wishes to acknowledge his indebtedness to Director Jay A. Carpenter of the State Bureau of Mines for suggesting this work and making its publication possible. Mr. Dudley L. Davis and Mr. Robert L. Smith assisted materially in the compilation, and arrangement, of the mineral descriptions. Professor Walter S. Palmer, Director of the State Analytical Laboratory, has aided with his extensive knowledge of Nevada minerals, and Mr. C. D. Woodhouse supplied information on several mineral occurrences. The illustrations were drawn by Mr. Theodore Rischard. Miss Mary Anxo did careful stenographic work on the manuscript and Miss Faith Gianella assisted with the proofreading. The writer greatly appreciates the many others who have aided in various ways with suggestions and information. To mention everyone who has been helpful would make a list that would be entirely too long.

V. P. G.

NEVADA'S COMMON MINERALS

PART I

INTRODUCTION

The mining of minerals in Nevada had its beginning long before the advent of Europeans as evidenced by the ancient abandoned turqouis mines at Sugar Loaf Peak, in Lincoln County, and those near Crescent, in Clark County. Old salt mines on the Virgin River, south of St. Thomas, were worked by the aborigines and it is probable that other minerals, including cinnabar and hematite, were sought for by the Indians. Salt constituted one of the principal mineral products trafficked in by the Indians and many indications of the early working of the Virgin River salt deposits are to be found in the old mines. These are among the earliest Nevada mineral deposits to be mentioned in the literature as they were referred to by John C. Fremont in 1845.

The discovery of placer gold on May 15, 1849, in the gravels of Gold Canyon near Dayton, first called attention to the mineral possibilities of Nevada. Within a short time, many miners were washing gold in Gold Canyon. This activity ultimately resulted in the discovery of the rich decomposed vein material at Gold Hill, near the head of Gold Canyon, early in 1859. In June of that year placer miners found rich silver ore in the outcrop of the Comstock Lode in Ophir Ravine. This was the first discovery of a silver mine in the United States and also, strangely enough, its most famous silver-mining district. The unusual richness of the Comstock ores and the large size of the veins, caused great excitement and precipitated the first of the mining "rushes" for which Nevada has ever since been noted. Prospectors soon were active throughout the Great Basin and this activity led to the discovery of numerous mineral deposits within the region lying between the Wasatch Mountains and the Sierra Nevada. Ninety years later placer miners are again washing gold from Gold Canyon; and the Comstock, which has produced over $400,000,000 in gold and silver, still has many active mines.

The rapid production of wealth from these mines immediately attracted many people to the region and soon established mining as the principal industry. Lumbering, farming, stockraising, and other industrial activities followed the exploitation of the mineral resources.

Mining continues to be the principal industry of the State and promises to retain its importance for a long time to come. Because mining is so closely woven into the everyday life of a large part of our population it naturally follows that many are interested in mineralogy. Many persons are turning to mineralogy as an outdoor hobby which affords an incentive to visit the mountainous areas and the wide open spaces.

The long continued search for minerals in the State is reflected in many of our place names such as Alkali Flat, Alum Gulch, Alunite, Borax, Copper Canyon, Cuprite, Galena, Garnet, Gold Acres, Goldfield, Hornsilver, Iron Point, Mineral County, Niter Buttes, Ruby Range, Salt Wells, Silver Peak, and Tungsten. Many others might be cited.

Conditions favoring the deposition of minerals occurred during several geologic periods, and at numerous localities throughout the State. The mountainous character of much of the region, together with the arid climate, aids in the finding of mineral deposits. The rugged topography allows for rapid erosion and a soil cover is frequently lacking which, together with the scant vegetation, renders easy the discovery of outcrops. A combination of these factors makes Nevada a particularly favorable area in which to collect minerals and study their mode of occurrence and conditions of formation. Few areas, of like size, contain a greater variety of mineral species.

The concentration of minerals in sufficient quality and purity to constitute deposits of commercial value is relatively rare, but this State has been particularly favored in having many such occurrences. There are also a multitude of places, lacking valuable deposits, where minerals of much interest to the student may be collected.

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von Bernewitz: *Handbook for Prospectors.* McGraw-Hill, New York, 1935.

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[2] May be obtained through the Nevada State Bureau of Mines.

[3] See list at the end of this bulletin.

Many interesting and instructive articles may be found in the following periodicals:

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The American Mineralogist. Menasha, Wisconsin.
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ORIGIN, OCCURRENCE, AND ASSOCIATION OF MINERALS

PRINCIPAL MODES OF ORIGIN

A mineral might well be defined "as any naturally occurring chemical element or compound formed as a product of inorganic processes."[4] The solid material underlying the earth's surface is commonly termed the *earth's crust* and it is composed of mineral aggregates which comprise the rocks.

Practically all of the known elements are to be found in the minerals which go to make up the crust of the earth. The decomposition and disintegration products of rock decay are also largely composed of minerals. About 1,500 distinct mineral species are known and a score or more of newly-discovered minerals is added annually. Most of these species are comparatively rare and relatively few of them are important; either as constituents of the rocks or as a source of valuable commercial products. The common rock-forming minerals consist of a quite limited number of silicates which, together with quartz, account for over ninety-eight percent of the materials composing the earth's crust.

CRYSTALLIZATION OF MINERALS

Most mineral species tend to assume distinct forms, bounded by plane surfaces, called crystals. Many crystals are of great beauty and many attractive ones are to be found in the better mineral collections. Crystals greatly aid in the identification of minerals and therefore the study of crystallography becomes of interest and value. There are three principal conditions under which crystals are formed:

FROM FUSION

Through the solidification of fused rock materials, known as magmas, the igneous rocks are formed. Upon cooling, minerals separate from the magna in the form of crystals and the intrusive rocks frequently consist entirely of minerals. The molten rock which flows out upon the surface of the earth cools more rapidly and therefore the formation of crystals may be incomplete. Some of these lavas are made up entirely of glass; most of them contain occasional crystals called phenocrysts; many have a considerable portion consisting of crystals.

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[4] Dana's Manual of Mineralogy, p. VII, Wiley, 1941.

FROM SOLUTION

Many minerals owe their origin to precipitation from solutions. This is evident in the minerals which are found in saline deposits, such as halite (common salt), ulexite, and gypsum. Vein minerals, those lining geodes and vugs, as well as the minerals lining fissures in rocks, or those deposited by springs, originate in this manner. Quartz crystal is a familiar example.

FROM VAPOR

A few minerals are formed through direct deposition from gas or vapor. These are commonly found around volcanic vents, or fumaroles, and at some hot springs. Sulphur forms in such a manner at Steamboat Springs and in other hot spring areas.

MINERALS OF METAMORPHIC ROCKS

Rocks which have been changed greatly in either their physical or chemical makeup are known as metamorphic rocks. Such changes are brought about by the application of high pressure or high temperature, or both of these factors acting together. The change is aided by the action of water or other chemical agent. Most metamorphism involves some solution which serves as a means of transferring material from one place to another. The formation of new minerals commonly results. These minerals may be formed from the original rock material, through its rearrangement and recombination into new compounds with, or without, the introduction of material from an outside source. The new minerals will frequently align themselves in a certain direction due to the pressure existing at the time the metamorphism occurred. The new minerals are stable under those conditions of temperature and pressure existing at the time of formation. Old minerals which are stable under such conditions do not undergo any change. A certain amount of time is necessary for the transformation to minerals which are stable under the new conditions. If the temperature and pressure were not sustained for a sufficiently long period, there will be some materials which would fail to react, and hence remain unchanged.

Certain minerals are stable under high pressures and temperatures and many of these are characteristic of the metamorphic rocks. Among such minerals are garnet, zoisite, tremolite, and kyanite. Most metamorphic rocks have a crystalline structure and the minerals are usually arranged in bands, or laminations, such as may be seen in gneisses and schists. Metamorphic rocks are found in many places in Nevada and are particularly abundant in southern Nevada along the Colorado River and in the Funeral Range.

CONTACT METAMORPHIC MINERALS

A type of metamorphism quite prevalent throughout the State is that associated with the intrusions of granitoid rocks. Because the more intense change occurs along the contact between the intrusive and the intruded rocks, this kind of metamorphism is called contact metamorphism, or pyrometamorphism. Due to the high temperature, and frequently the introduction of materials from the intrusive, the surrounding rocks are altered to a greater or lesser extent. The intensity of metamorphism is dependent upon many factors, one of which is the nature of the intruded rock. Impure limestones, containing considerable alumina and silica, are the most easily affected. The zone of alteration may be narrow or very wide, sometimes extending a half mile or more from the contact. Pure limestones and quartzites are often but little changed. New minerals are formed from materials originally in the intruded rock together with substances brought in by solutions coming from the intrusive rock. Characteristic contact metamorphic minerals are garnet, epidote, tremolite, wollastonite, amphiboles, pyroxenes, spinel, and idocrase. Contact metamorphism is widespread and contact metamorphic minerals are found in every county of the State. These deposits may contain minerals of economic importance, as copper at Yerington, Contact, Spruce Mountain, and elsewhere. Most of the tungsten produced in Nevada comes from scheelite found in contact-metamorphosed limestones. Mineralizing vapors, consisting largely of water, may contain boron, chlorine, and flourine which combine with silicates of calcium, iron, and aluminum to form idocrase, scapolite, and tourmaline, which are common in these deposits.

PEGMATITES

As the deep-seated granitic magmas consolidate into rock masses through the crystallization of minerals, there may be considerable silica, potash, alumina, and other materials which remain fluid and, if the mass is subjected to deformation, this still fluid material is forced into fractures, in both the intrusive and surrounding rocks, in the form of dykes composed largely of orthoclase. Such dikes are coarsely crystalline and are known as pegmatite. Through the influence of hot solutions from the cooling rock mass these dikes frequently undergo alteration together with the introduction of other minerals such as, albite, muscovite, tourmaline, sphene, garnet, and epidote, and they may also contain scheelite, molybdenite, and beryl. Pegmatites are quite common in Nevada but the dikes are usually rather small. In the Humboldt Range scheelite, associated with beryl, has been mined from pegmatite. In the Ruby Range muscovite and beryl are found in pegmatites; and muscovite, in large sheets, has been mined from pegmatites in the Virgin Mountains of southeastern Nevada. Many of the rarer minerals, as well as many beautiful specimens, are found in pegmatites.

VEINS

When minerals are deposited along fissures in the rock, the deposits are known as veins. In some cases the minerals replace the wall rock, along a line of fracture, and is then known as a replacement vein. Veins are frequently straight and well defined but they may be quite irregular. They commonly consist of quartz, calcite, barite, etc., together with galena, chalcopyrite, gold, or other valuable mineral. The valueless material is referred to as gangue, and the valuable constituents as ore, or ore minerals. At times the veins may consist of sufficiently pure barite, or clear calcite, or fluorite, as to be valuable for these products such as the fluorite veins at Broken Hills in Mineral County, or the barite veins in other parts of the State. Typical quartz veins carrying valuable ores, occur at Austin, Tonopah, Virginia City, Tuscarora, and Searchlight. Many others occur in the State. Veins containing metallic minerals are usually associated with an intrusion of igneous rock.

The composition and the texture of veins indicates that their origin is due to the deposition of minerals from solutions which arose from deep-seated sources. The association of ore-bearing veins with intrusions is the rule rather than the exception. Such relationships are noted in many mining regions as the monzonite with the ores in the Robinson district, near Ely; the Davidson diorite, and related dikes, at Virginia City; and the intrusive rhyolite at Tonopah. As the solutions rise toward the surface, to regions of lower temperature and decreased pressure, various minerals separate from it and deposit upon the walls of the fissure which is usually completely filled with vein material. The wallrock may undergo replacement with the resulting substitution of vein minerals for the minerals composing the rock.

REPLACEMENT DEPOSITS

Under certain conditions the ore-bearing solutions may dissolve and carry away rock material and at the same time leave new minerals. This type of deposition is known as replacement, and such mineral bodies are known as replacement deposits. Both veins and replacement deposits may be formed in the same district; in fact they are not uncommonly present in the same mine. Replacement deposits are found at Pioche, Goodsprings, Eureka, Mountain City, Mill City, and in many other districts. Veins are also found in these areas. At Eureka, large ore bodies containing lead, silver, and gold, occur as replacement deposits in limestone or dolomite. At Cortez, silver ores have replaced limestone.

HYDROTHERMAL ALTERATION

Heated waters which deposit ores leave evidence of their passage by the changes they have produced in the rocks enclosing veins and other ore bodies. The changes brought about by these heated solutions are known as hydrothermal alteration or hydrothermal metamorphism; terms which suggest the action of hot water. This type of alteration is usually local in distribution, being largely confined to the vicinity of veins and other mineralized areas. During the alteration, new minerals are formed and the rock may undergo replacement with the introduction of new minerals. At Tonopah, the Comstock, and in many other districts, the Tertiary lava rocks have been altered for considerable distances from the veins. Chlorite, sericite (fine muscovite), silica, albite, and pyrite, has been introduced into the surrounding rocks. Andesites take on a greenish hue but their texture is usually preserved. Granites are commonly altered with the formation of fine mica.

When subjected to weathering the altered lavas are commonly bleached to light colors, while some areas are deeply stained with oxides of iron. Such weathered rocks are typical of areas where lava rocks have been mineralized. Bleached areas are common throughout the State and these altered rocks frequently support a characteristic type of vegetation. In western Nevada the yellow pine (*Pinus ponderosa*) prefers these altered areas.

PRIMARY AND SECONDARY MINERALS

In rocks and mineral deposits we commonly find two distinct groups of minerals: (1) Primary minerals originally formed in the rock or deposit; (2) secondary minerals which are the result of the alteration of the original minerals. Secondary minerals may result through weathering processes and they are commonly found in the outcrops, or upper portions, of ore deposits. In ore deposits they are derived from the primary ore minerals, which are usually sulphides, such as chalcopyrite, pyrite, galena, sphalerite, etc. Upon oxidation the sulphides are changed to various sulphates, oxides, hydroxides, and similar combinations. Carbonates are also to be found in many deposits. Galena commonly alters to anglesite (lead sulphate) which, in the presence of the carbon dioxide of the air, or dissolved in water circulating in the deposit, may change to cerussite (lead carbonate). Sphalerite may form the zinc sulphate (goslarite). Chalcopyrite gives rise to chalcanthite (copper sulphate) which is found in old workings of copper mines. Chalcanthite may also be found at shallow depth in many copper prospects. In a limestone region the secondary copper minerals consist largely of the carbonates, malachite and azurite. Chrysocolla (copper silicate) and cuprite (copper oxide) are abundant in some ores. Iron sulphides may give rise to limonite (hydrated iron oxide), melanterite (an iron sulphate), and a variety of other compounds such as those occurring at Steamboat Springs. When there is a complex mineralogy in the primary deposit containing many different metals, together with sulphur, arsenic, antimony, phosphorus, etc., a series of more complex secondary minerals is to be expected. Under such conditions some of the rare arsenates or phosphates of lead, copper, and zinc may be present. Many interesting arsenate minerals are present in the copper and tin deposits at the Majuba Hill mine in the Trinity Range. Some of these more complex minerals occur in beautiful specimens which promise rich rewards to the collector and student. Some of these minerals, which are usually considered as rare, are not uncommon in the oxidized ores of Nevada.

ENRICHMENT OF ORES

Near the surface, ore minerals become oxidized and the soluble products are dissolved in water and carried downward through the deposit. Other minerals, being insoluble, remain in or near the outcrop. During this process the outcrop is constantly being worn away by erosion and oxidation gradually penetrates deeper and deeper. If much pyrite is present, the waters will carry considerable quantities of sulphuric acid which aids in the transportation, in solution, of the products of weathering and also attacks the surrounding rocks. Some material is carried away in solution and scattered throughout the rock mass or may find its way to the surface through springs and seeps. Much of it may, however, be precipitated in the vein or replace the primary ores. The primary minerals go into solution, either partly or completely, while material in solution is being precipitated in their place. Solution and deposition proceed together. That is to say, as rapidly as a small volume of the primary mineral goes into solution an equal volume of material is precipitated from solution. On the other hand, the material in solution may be precipitated in the vein, or on the walls, without replacing a primary mineral. In either case enrichment occurs and the new minerals, precipitated from the solution, are secondary minerals. This process, due to the downward flow of surface waters, is commonly referred to as secondary enrichment. Another term is *supergene* enrichment. Enrichment of primary minerals may also be caused by rising heated solutions, in which case the process is known as *hypogene* enrichment. Hypogene enrichment is usually inconspicuous and may readily pass unnoticed. By enrichment the metal content is increased. In this manner many ore bodies are so enriched as to become of economic importance, whereas, the original deposit may have been too low grade to be of value.

Gold ores may be enriched through the solution of gold and its redeposition in the vein. Through oxidation the pyrite produces sulphuric acid which, in the presence of manganese oxide and a chloride, causes the liberation of chlorine which is an active solvent for gold. If silver is also present it is converted to cerargyrite (hornsilver). The gold chloride is carried down into the vein and is readily precipitated at shallow depths. It is quite probable that this process is responsible for the formation of coarse gold in the outcrops of veins. As chlorides, especially common salt, are widespread in arid regions this process is quite common in the Great Basin.

More complicated processes, other than those referred to above are involved. Surface waters, together with weathering, are responsible for the formation of many secondary products of great mineralogical interest. They also cause the enrichment of silver and copper ores. In such cases the ores are much richer near the surface than they are at greater depths. Common secondary silver minerals are the sulphide, argentite, and the chloride, cerargyrite (hornsilver). The most common secondary copper sulphide is chalcocite, while covellite is found in some ores, and bornite in others. It must be remembered, however, that some mineral species may be either primary or secondary in their mode of occurrence.

PLACER DEPOSITS

Insoluble minerals which remain in the outcrop during weathering, gradually work down the slope and eventually find their way into the water courses. Those minerals which are heavy, and which also resist being broken down into fine material, gradually work to the bottom of the gravels or detritus, and are therefore concentrated along the bedrock. Here gold, copper, tin oxide, tungsten compounds, cinnabar, and other heavy minerals are gradually concentrated while the lighter, or finer, materials are moved more rapidly down the stream. In this manner placer deposits are formed.

Most rocks, and some ore deposits, contain magnetite which, because of its high specific gravity, becomes a common product of placer deposits. Other heavy minerals such as garnet, epidote, diamonds, ilmenite, zircon, and hematite are concentrated in this manner. The heavy minerals are discovered in gravels by the process known as panning. The gravel is placed in a miner's pan and carefully washed under water until the lighter material is carried away. Examination of the concentrate will reveal whether the gravels carry any gold, tin ore, or other heavy valuable material. Once a valuable mineral is discovered, it may be traced to its source by further use of the pan. This method has been successfully used in discovering many deposits of gold and silver, tungsten, mercury, and other valuable minerals. A more intensive application of this effective, though ancient, method of prospecting will no doubt lead to further discoveries of mineral deposits.

WHERE TO LOOK FOR MINERALS

It might be well to first call attention to the regions which offer little promise of minerals. Areas that are deeply covered with detritus derived through weathering processes offer little encouragement except through occasional pieces of float. Float refers to fragments which have become detached from the parent mass and have been moved some distance from their source. Occasionally good material will be found as float and such fragments frequently indicate what to expect in the deposit from which they were derived. The alluvium-covered valley floors offer little encouragement except for some of the more soluble minerals which may form through the evaporation of water. Where rocks are not altered through the action of hot waters or by igneous intrusions, they are usually not mineralized. Unaltered sediments and the younger lavas fall into this group. In some of the younger lavas, however, zeolites and opal may be present. These observations are particularly true of the great lava flows in the northwestern part of the State.

Rocks which have been altered through the action of mineral solutions (see Hydrothermal Alteration) are very readily affected by air and water in the process known as weathering. The mineralized lavas, when attacked by the atmosphere, become bleached to white, cream, red, and buff colors. Some areas have a brilliant red and yellow coloration due to the presence of hydrated iron oxides. The sulphuric acid, derived from pyrite which is usually present in mineralized areas, greatly intensifies weathering processes and is largely responsible for the spectacularly-colored rocks of the desert region. Vivid alteration colors are of frequent occurrence in the vicinity of mines in lava rocks. Such altered regions are worthy of search for valuable minerals although many such altered areas have been found to be of no economic importance; such as the conspicuous bleached lava rocks along the Geiger Grade, between Truckee Meadows and Virginia City.

Rocks metamorphosed by igneous intrusions, as described under contact metamorphism, contain garnet, pyroxene, amphibole, and epidote. The contact metamorphosed rocks may also contain copper or scheelite. Some copper, and much of the tungsten, produced in Nevada has come from such deposits. Granitic rocks are commonly cut by pegmatite dikes which are frequently the source of good mineral specimens and occasionally contain economic deposits. Pegmatites near Oreana, in Pershing County, are the source of much scheelite and also contain numerous beryl crystals. Quartz veins may contain gold and silver as well as other minerals. The heavy minerals which have resisted weathering, may be found by panning the surface materials in the vicinity of mineral deposits. Scheelite, barite, cuprite, cinnabar, cassiterite, and many other valuable minerals may be discovered in this manner. Many of the minerals which are unattractive and inconspicuous, or which occur in very small quantities, may be detected by panning and a careful search of outcrops may result in the discovery of worthwhile minerals. While it is true that

valuable deposits are found by those wholly unfamiliar with minerals, success is more likely to favor those who are able to recognize worthwhile material when found.

A fruitful source of specimens is the dumps of abandoned as well as active mines. Many valuable specimens, considered as having no commercial value, are annually thrown onto the dump. Old mining camps will usually repay a careful search and serve to familiarize one with a variety of mineral occurrences. Old mine workings are often encrusted with secondary minerals and may supply specimens and other material worthy of further study. Good specimens of secondary minerals are to be found in the outcrops, or the upper parts, of ore deposits. They are also found in weathered rocks and as surface deposits in playas (alkali flats).

Almost every town in Nevada is but a short distance from places where worthwhile minerals may be found. After some experience one will be able to discover new mineral localities. It is by no means necessary to confine one's efforts to mines and prospect pits for there are many places, without any mines, in which interesting minerals are to be found. Some mining districts will be found which offer little in the way of mineral specimens while a road cut, an inconspicuous prospect, or even a previously uninvestigated outcrop, may be the source of good specimens. Inquiry made to persons of your locality, who are interested in minerals or mineral products, will frequently result in information concerning nearby places of mineralogical interest.

Much interesting and useful information on the minerals of the State may be obtained from the publications of the United States Geological Survey[5] and those of the Nevada State Bureau of Mines.[6] Publications which will be useful in finding the location of the many mining districts of the State, and which also contain much of interest in regard to Nevada mineral deposits, are:

The Mining Districts of the Western United States: J. M. Hill, U. S. Geol. Survey, Bull. 507, 1912; *Mining Districts and Mineral Resources of Nevada*: F. C. Lincoln;[7] *Metal and Nonmetal Occurrences in Nevada*: Carl Stoddard, Univ. Nevada Bull. Vol. 26, No. 6, 1932; *Mineral Resources of the Region Around Boulder*

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[5] The publications of the United States Geological Survey may be consulted in the larger libraries. A list may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C.

[6] Bulletins of the Nevada State Bureau of Mines are listed at the end of this bulletin.

[7] This publication may be obtained through the Nevada State Bureau of Mines, Reno, Nevada.

Dam: Hewett, Callaghan, Moore, Rubey, and Schaller, U. S. Geol. Survey Bull. 871, 1936.[8]

It is possible to list here only a relatively small number of the numerous mineral localities of the State that would prove interesting to the mineralogist. However, for the benefit of those unfamiliar with the minerals of the State, who would like to have information as to some of the places where collecting may be done, there is listed below some localities from each Nevada county. No attempt has been made to list the more important, or the more accessible areas but rather to give several in each county which should be worth visiting. Many of these localities are noted for the variety and beauty of their minerals, others will be found interesting because of unusual mineral occurrences, while some of them are of general interest only. Information pertaining to many of these regions will be found in the publications referred to above, while others have received but brief, or probably no, mention in the literature. In most Nevada towns there will be found persons who are interested in mineral collecting, and in some of the larger towns there are mineralogical societies whose members are thoroughly acquainted with mineral localities in their part of the State. It might be well to call attention to the fact that the more isolated areas are to be reached only over desert roads which may be impassible during certain seasons. Some of these areas are quite far from habitations and it would be unwise, and perhaps hazardous, for those unfamiliar with the desert country to venture into such places without suitable equipment, or without the services of a guide who is familiar with the country. A thorough inquiry should be made as to the roads and other conditions pertaining to such areas.

A short list of Nevada mineral localities, by counties, follows:

CHURCHILL COUNTY—Bernice, Coppereid, Chalk Mountain, and Wonder.

CLARK COUNTY—Boulder City, Crescent, Copper Chief district, Goodsprings, Las Vegas, and Searchlight.

DOUGLAS COUNTY—Many mines and prospects in the Pinenut Mountains.

ELKO COUNTY—Contact, Mountain City, Railroad district, prospects in the Ruby Range, Sprucemont, Tacoma, and Tuscarora.

ESMERALDA COUNTY—Coaldale, Columbus, Goldfield, Gold Point, and Montezuma.

EUREKA COUNTY—Eureka and vicinity, and also Mineral Hill.

HUMBOLDT COUNTY—Getchell Mine, National, Red Butte, Sulphur, and Virgin Valley.

LANDER COUNTY—Austin, Copper Basin, Copper Canyon, and Cortez.

LINCOLN COUNTY—Bristol Silver, Comet, Pioche, and Tempiute.

LYON COUNTY—Churchill Buttes, Silver City, Wabuska, and Yerington.

MINERAL COUNTY—Aurora, Candelaria, Copper Mountain, Pilot Mountains east of Luning and Mina, Rhodes Marsh, and Thorne.

NYE COUNTY—Beatty and vicinity, Belmont, Bullfrog, Ellsworth, Manhattan, Oak Springs, and Tonopah.

ORMSBY COUNTY—Many prospects in the Pinenut Mountains, and in the Sierra Nevada west of Carson City.

PERSHING COUNTY—Numerous mines in the Humboldt Range, Lincoln Hill near Rochester, Majuba Hill, Nightingale, Oreana, Seven Troughs, and various mines in the Trinity Range.

STOREY COUNTY—Castle Peak, Gold Hill, and Virginia City.

WASHOE COUNTY—Antelope Range, Buffalo Salt Marsh, Galena district, Leadville, Peavine Mountain, and Steamboat Springs.

WHITE PINE COUNTY—Bald Mountain, Hunter, Kimberly, Ruth, and Tungstonia.

Other mineral occurrences are given in the descriptions of the various minerals in Part III.

COLLECTION AND CARE OF MINERAL SPECIMENS

When valuable mineral specimens are found they should be collected with care as much excellent material is ruined by rough treatment or careless handling. Considerable care and skill is required to detach delicate specimens; even rather rugged material may be spoiled. After collecting, the specimens should be protected by carefully wrapping each separately. First cover the specimen with soft paper, then wrap it in heavier paper and place it in a suitable container so that it will withstand transportation. Good specimens may be utterly ruined if not protected. Some of the secondary minerals, which form in damp places, will deteriorate if exposed to dry air and some minerals are unstable in a moist atmosphere. These should be sealed in glass containers. Every specimen worthy of collecting should be

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[8] Some of these publications are to be found in your local library. Others would probably be ordered if a sufficient demand for them existed.

accompanied by a note giving the name of the mineral, if known, the locality where found, the date, and the name of the collector. Further description, or notes of interest relating to the specimen, should be enclosed with it or entered in a notebook. Before a specimen is placed in your mineral cabinet, a label should be filled out giving a serial number and the essential information listed above. A corresponding number should be placed upon the specimen. Much of the value of a specimen is lost unless it is carefully labeled and its locality given.

Should you find minerals which you cannot identify, some of the material should be submitted to someone who is competent to determine its nature. Much valuable material, otherwise overlooked, may be brought to light in this manner.

DISPOSITION OF SPECIMENS

A good mineral collection is well worth acquiring and much pleasure may be derived from it. Many people of the State have collections and several of these are really excellent.

Good specimens may be sold to collectors, mineral dealers, and to some of the larger museums. Especially attractive specimens, well crystallized material, and particularly crystals of the rarer minerals, will find a ready market.[9] Some specimens bring good prices. If you do not desire to sell specimens you will find that they will be appreciated by other collectors, or by the curators of museums where they will be preserved for the benefit of the general public. Many of our public schools maintain mineral collections for the instruction of the students. This work should be encouraged and extended. The Mackay School of Mines, University of Nevada, has an excellent collection which is tastefully arranged and well lighted. Here are to be seen many of the minerals for which our State is noted as well as many from other States and foreign countries. It is open to the public every day except Saturday afternoons, Sundays, and holidays. The museum attracts many visitors. This collection is constantly being added to; largely through gifts sent in by persons who find new localities or from good specimens found in the development in the older districts.

An organization should be formed of those in a given locality who are interested in the study of minerals. Exchange of specimens, field trips, and discussions lead to the mutual benefit of its members. Many of the larger towns already have active mineral societies.

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[9] Names of mineral dealers will be found in some of the periodicals listed on page 10.

PART II

GENERAL CHARACTERISTICS OF MINERALS

INTRODUCTION

The visible materials of the earth are seen to be complex aggregates of material and apparently varying greatly in composition, from place to place. This complexity is more apparent than real, however, for chemical research has revealed that all of these materials composing the earth, including rocks, soils, water, air, etc., are made up of about ninety-two elementary building materials. These are the *elements* which go to make up all chemical compounds. For brevity in description, and as a convenient means of expression, each element is designated by a *symbol.*

Chemical analyses of all of the various kinds of inorganic materials further indicate the relative simplicity of the earth's composition. Of the ninety, or more, elements, only twelve make up over ninety-nine percent of the earth's materials. F. W. Clarke,[10] who has made an exhaustive study of the subject, gives the following average percentages of the elements making up the known terrestrial material:

Element	Symbol	Percent	Element	Symbol	Percent
Oxygen	O	49.20	Potassium	K	2.40
Silicon	Si	25.67	Magnesium	Mg	1.93
Aluminum	Al	7.50	Hydrogen	H	0.87
Iron	Fe	4.71	Titanium	Ti	0.58
Calcium	Ca	3.39	Chlorine	Cl	0.19
Sodium	Na	2.63	Phosphorus	P	0.11

Total for the twelve most common elements 99.18
All other elements .... .82

Total 100.00

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[10] The data of geochemistry: U. S. Geol. Survey Bull., 770, p. 36, 1924.

Among those other elements which make up but 0.82 percent, the following are to be found as constituents of the common minerals of the State:

Element	Symbol	Element	Symbol
Antimony	Sb	Mercury	Hg
Arsenic	As	Molybdenum	Mo
Barium	Ba	Nitrogen	N
Beryllium	Be	Silver	Ag
Bismuth	Bi	Strontium	Sr
Boron	B	Sulphur	S
Copper	Cu	Tellurium	Te
Carbon	C	Titanium	Ti
Fluorine	F	Tungsten	W
Gold	Au	Vanadium	V
Lead	Pb	Zinc	Zn
Manganese	Mn	Zirconium	Zr

Surprisingly enough, most of the elements which are important in the materials used in everyday life are comparatively rare. Usually they are present in unrecognizably small quantities in rocks, and it is only under unusual, and especially favorable, circumstances that these elements have been concentrated in commercial quantities. Nevada has been greatly favored as a region in which so many of these different substances have been deposited in workable deposits.

Out of these relatively few substances, thousands of combinations have been made by nature. In each *compound* certain elements are combined in definite proportions, by weight, which the chemist indicates by a *formula.* Thus common salt (halite) is found to contain one unit of sodium and one of chlorine. The combination of these two elements is represented by the formula $NaCl$. However, sodium has a relative weight of 23.00 while that of chlorine is 35.46, so that the percentage, by weight, for sodium is 39.4, and for chlorine it is 60.6. All minerals are chemical compounds which have formed through natural processes. Each of the simpler minerals will, when pure, contain a definite percent of each of its component elements. A few minerals consist of but a single element and hence the element is said to exist free (uncombined) in nature and are then referred to as *free* or *native.* Native gold, silver, copper, mercury, and sulphur, are examples. Many minerals, however, are quite complex through having many elements in their makeup. Some minerals can be profitably mined when the percentage of gangue, or waste material, is large, while

other minerals are of little value if even relatively small amounts of impurities are present. In general, nonmetallic deposits must contain a high percentage of the valuable constituent and have less impurities than do metallic deposits. Rock which averages less than 0.0002 percent gold has been profitably worked, when present in sufficient quantity, while a small amount of quartz may render dumortierite useless as a mineral for the manufacture of high-grade porcelain.

CLASSIFICATION OF MINERALS

Minerals may be classified in a variety of ways. The basis of classification may be use, occurrence, or some particular property. However, minerals are chemical compounds and since their uses, occurrences, and properties are ultimately dependent upon their constituents, the scientific basis of classification is one dependent upon chemical composition. On such a basis minerals may be arranged into many groups, such as:

1. Elements (uncombined; free)—Sulphur (S), gold (Au), silver (Ag), etc.
2. Oxides (compounds of oxygen with other elements)—Quartz (SiO_2), hematite (Fe_2O_3), cuprite (Cu_2O), corundum (Al_2O_3).
3. Sulphides (compounds of sulphur with other elements)—Pyrite (FeS_2), galena (PbS), chalcopyrite ($CuFeS_2$), molybdenite (MoS_2).
4. Chlorides (compounds of chlorine with other elements)—Halite ($NaCl$), cerargyrite ($AgCl$).
5. Fluorides (compounds of fluorine with other elements)—Fluorite (CaF_2).
6. Silicates (compounds of silicon and oxygen with other elements)—Kyanite (Al_2SiO_5), orthoclase ($KAlSi_3O_8$), zircon ($ZrSiO_4$).
7. Carbonates (compounds of carbon and oxygen with other elements)—Calcite ($CaCO_3$), smithsonite ($ZnCO_3$), cerussite ($PbCO_3$).
8. Sulphates (compounds of sulphur and oxygen with other elements)—Anhydrite ($CaSO_4$), thenardite ($NaSO_4$), anglesite ($PbSO_4$).
9. Nitrates (compounds of nitrogen and oxygen with other elements)—Soda niter ($NaNO_3$), niter (KNO_3).
10. Borates (compounds of boron and oxygen with other elements)— Borax ($Na_2B_4O_7.10H_2O$), ulexite ($NaCaB_5O_9.8H_2O$).

11. Tungstates (compounds of tungsten and oxygen with other elements)— Scheelite ($CaWO_4$), wolframite [$(Fe,Mn)WO_4$], huebnerite ($MnWO_4$).
12. Molybdates (compounds of molybdenum and oxygen with other elements)—Wulfenite ($PbMoO_4$).
13. Phosphates (compounds of phosphorus and oxygen with other elements)— Apatite [$3Ca_3(PO_4)_2.Ca(F,Cl)_2$], vivianite [$Fe_3(PO_4)_2.8H_2O$].

Because of more complex compounds a complete classification is more extensive than is indicated above. More extended classifications will be found in the standard works on mineralogy such as those listed on pages 8 and 9.

PHYSICAL PROPERTIES OF MINERALS

Since minerals are chemical compounds they have definite physical and chemical properties. The chemical properties of minerals may be determined by their behavior toward other chemical substances called *reagents.* A study of the chemical, and many of the physical properties, requires special equipment and training. A detailed treatment of many of the properties of minerals is beyond the scope of this bulletin.[11]

CRYSTALS

When a mineral is forming, its atoms tend to assume a regular arrangement and then the mineral is said to be *crystalline*; if the arrangement is irregular the material is *amorphous.* Most minerals tend to crystallize. If the mineral grows, unhindered by its surroundings, a definite shape is generally assumed and a *crystal* results. The crystals are bounded by plane surfaces known as *crystal faces.* The various shapes that are taken by crystals are known as *crystal forms;* such as a cube, pyramid, prism, etc. Two or more forms of the same system may occur together on a crystal; or the crystal may consist of but a single form.

Some of the commoner shapes, or crystal forms, are:

Cube. Six faces at right angles with one another. Shown in figure 1a and 1c.

Dodecahedron. A twelve-sided figure bounded by diamond-shaped faces (illustrated in figure 1d), or faces with five edges as in the case of the *pyritohedron,* common to pyrite.

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[11] Books dealing with the various properties of minerals and their determination will be found listed on pages 8 and 9.

Octahedron. An eight-sided figure with equal triangular faces. Figure 1b and 1c.

Pinacoid. This form consists of but two parallel similar faces and hence it always occurs together with other forms. Figures 2b, 3a, 3b, 3d, 4b, 5a, 5b, 5c, etc.

Prism. The faces are usually rectangular and the edges are parallel. Prisms are terminated by other forms. Figures 2b, 2d, 3b, 3d, 4b, 5a, 5b, 5c, 5d, etc.

Pyramid. This crystal form consists of triangular faces which meet in a point. Figures 2a, 2c, 2d, 3c, 3d, 4a, 6a, etc.

Rhombohedron. A rhombohedron is a six-sided form in which the faces do not meet at right angles. It has the appearance of a cube that has been deformed along one of its diagonals. Figure 4c.

Tetrahedron. Four equal triangular faces make up the tetrahedron.

Crystal faces are arranged with respect to *crystallographic axes.* It has been determined that there are six arrangements of crystallographic axes giving rise to six crystal *systems* as follows:

Isometric System. The isometric system includes all of those crystals whose faces can be referred to three axes of equal length and at right angles to one another. Crystal forms of the isometric system are shown in Figure 1.

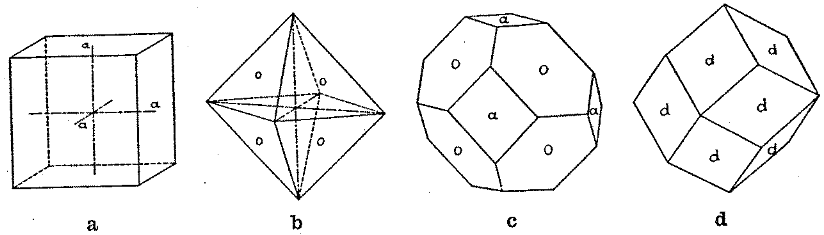

Figure 1. **Isometric crystals. (a) Cube of pyrite. (b) Magnetite octahedron. (c) Pyrite showing the octahedron truncated by a cube. (d) A dodecahedron of garnet.**

Tetragonal System. There are three axes at right angles. Two axes are of equal length; the third axis is longer, or shorter, than the other two. Forms are illustrated in Figure 2.

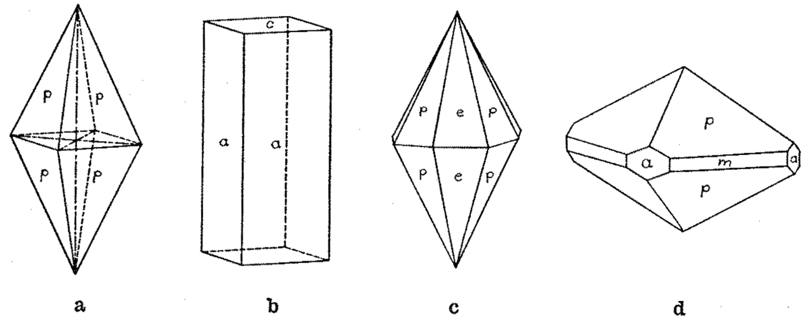

Figure 2. Tetragonal crystals. (a) An anatase pyramid. (b) A prism of the first order "a," and basal pinacoid "c." (c) First and second order prisms. (d) A crystal of idocrase showing the pyramid "p" truncated by a first order prism "m," and a second order prism "a."

Orthorhombic System. There are three axes at right angles but of unequal length. See Figure 3.

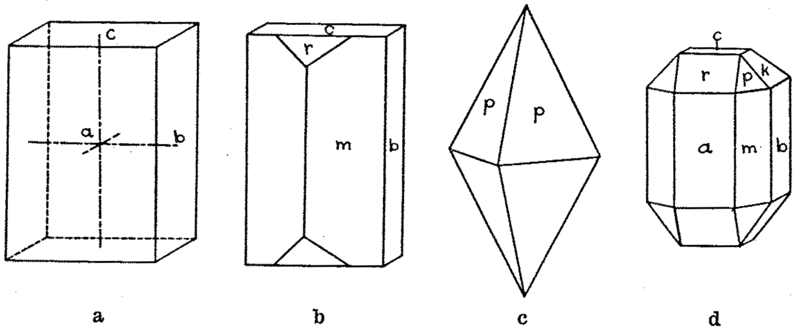

Figure 3. Orthorhombic crystals. (a) The macropinacoid "a," brachypinacoid "b," and the basal pinacoid "c." (b) A crystal of staurolite showing prism "m," brachypinacoid "b," macrodome "r," and basal pinacoid "c." (c) Sulphur crystal with the steep pyramid "p." (d) Olivine crystal illustrating the pyramid "p," prism "m," brachydome "k," macrodome "r," macropinacoid "a," brachypinacoid "b," and the basal pinacoid "c."

Hexagonal System. This system has three axes, which lie in a plane, and are at 60 and 120 degrees from one another. A fourth axis, longer or shorten than the other three, is perpendicular to this plane. Hexagonal forms are shown in Figure 4.

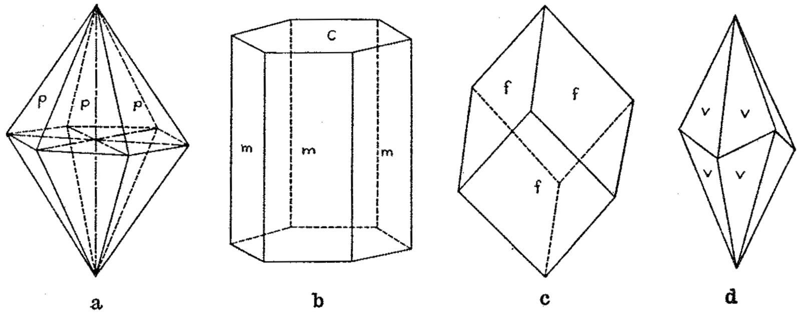

Figure 4. Hexagonal crystals. (a) A dihexagonal pyramid. (b) First order prism "m," and basal pinacoid "c." (c) A steep rhombohedron of calcite. (d) A calcite scalenohedron.

Monoclinic System. In the monoclinic there are three axes of different lengths. Two or these axes lie in a plane and are inclined to each other. The third axis is perpendicular to the plane containing the other two. Figure 5 illustrates monoclinic crystals.

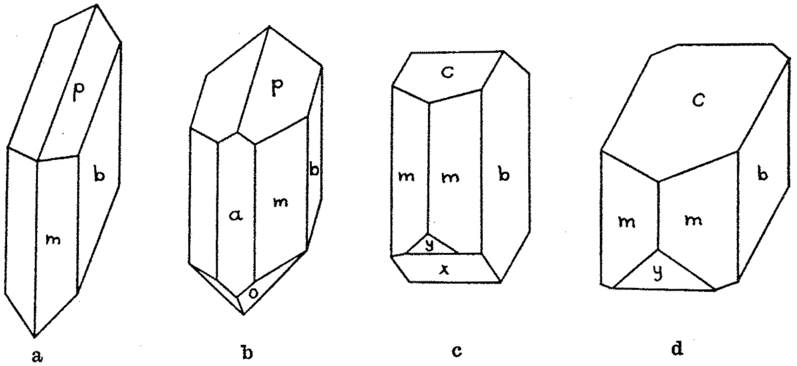

Figure 5. Monoclinic crystals. (a) Gypsum crystal with clinopinacoid "b," clinodome "p," and prism "m." (b) A pyroxene crystal with pyramid "p," orthopinacoid "a," clinopinacoid "b," and prism "m." (c) and (d) Represent orthoclase crystals with prism "m," orthodomes "x" and "y," and basal pinacoid "c."

Triclinic System. The triclinic system has three crystallographic axes of different lengths. All of the axes are inclined to each other. Some of the common forms of the triclinic are shown in Figure 6.

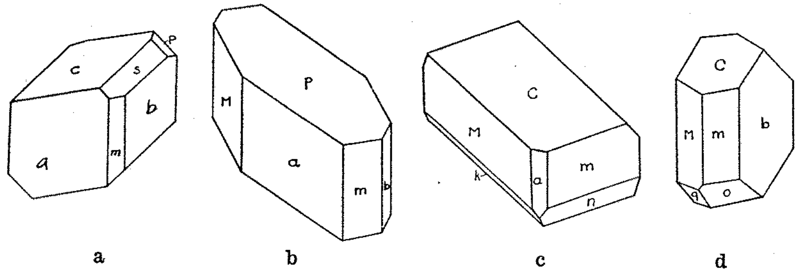

Figure 6. Triclinic crystals showing (a) axinite, (b) chalcanthite, (c) rhodonite, and (d) albite.

OTHER PROPERTIES USED IN THE DESCRIPTION OF MINERALS

The following pages describe the principal physical properties which are most commonly used in describing minerals.

CLEAVAGE AND FRACTURE

Some minerals tend to break along smooth, flat surfaces. This property is called *cleavage.* Cleavage surfaces are parallel to a possible crystal face, and are usually parallel to a face which commonly occurs on the crystals of a given mineral. Cleavage is, therefore, a clue to the crystal form and the crystal system. The cleavage planes glisten in reflected light and, even though the mineral may be an aggregate of small crystals, each cleavage face will reflect light. Cleavage is named after the crystal form to which it is related. For example, a mineral with cubic cleavage, like galena, will break into cubic fragments. Mica, having basal cleavage, can be separated into innumerable sheets parallel to the basal pinacoid. Some minerals, like galena, cleave equally well in three directions; others, for instance hornblende, cleave in two directions at angles 124 and 56 degrees. Calcite has three cleavage directions. Other minerals may have four, as fluorite, or six, in the case of sphalerite.

A broken surface which is not a plane cleavage face is called a fracture. Minerals with poor cleavage, or none at all, yield good fracture surfaces. Fracture always occurs in a direction in which there is no cleavage. The kinds of fracture are:

Even. A fairly smooth, but not plane, surface.

Uneven. Irregular surface without any special character.

Hackly. Many irregular and sharp edges on the broken surface.

Conchoidal. A rounded, or shell-like, surface with curved ridges having a concentric arrangement.

Splintery. A fracture like that of wood which is broken across the grain.

Earthy. Fracture surface like that of clay or chalk.

TENACITY

Tenacity is that property of a mineral which depends upon the cohesion of its particles, or the tendency to hold together. Various terms are used to describe this property.

Brittle. Easily shattered.

Malleable. Can be hammered into thin sheets.

Ductile. Can be drawn into wires.

Friable. Granular minerals which crush readily, or separate easily into its individual particles.

Sectile. Can be cut into thin shavings.

Flexible. Thin sheets of the mineral bend readily without breaking.

Elastic. When thin sheets of the mineral are bent, within the so-called elastic limit, they will when released, return to their original shape.

Tough. Strongly resists being shattered. In opposition to brittle.

COLOR

Some minerals have a definite and characteristic color, others are variable in color, while still others are either colorless or white. Often the true color is modified by the color of impurities, stains, inclusions, or mixtures. Alteration of the surface may notably modify the color or other properties of a mineral.

DIAPHANEITY

This property is dependent upon the characteristics of a mineral which govern the penetration of light. Objects may be distinctly seen through a *transparent* mineral. A *translucent* mineral allows the passage of diffused light but does not allow clear vision through it. An *opaque* mineral will not transmit light even through very thin pieces. Some which appear to be opaque will be found to pass light through thin flakes or splinters.

LUSTER

Luster depends upon the intensity, or relative amount, of light which is reflected from the surface. Common terms used are: *Adamantine,* a brilliant diamond-like luster. *Glassy or vitreous,* the luster of ordinary glass or quartz. *Silky,* like the sheen of silk or satin. Other, self-explanatory, terms are pearly, waxy, dull, submetallic, and metallic. Only those minerals are considered to have a metallic luster which are opaque in thin pieces and which have the sheen of metal.

STREAK

The color of the finely-powdered mineral is called its *streak*. This may be determined by drawing the mineral across the surface of unglazed white porcelain. The unglazed surface of broken china or unglazed white tile will serve for this purpose. Another method is to put some of the finely-powdered mineral on white paper for comparison.

All colorless and white minerals give a white streak. Usually the color of the streak is a tint of the color of the mineral but not infrequently it is decidedly different. In such a case the streak is an important characteristic in determining the mineral. It should be kept in mind that impurities, or alteration, will affect the color of the streak.

HARDNESS

One of the most important physical properties of minerals is their *hardness*. This is a measure to their resistance to being scratched. Certain common minerals are used as a scale of hardness, known as Moh's Scale, to which other minerals may be referred. Numbers are used to designate the relative hardness. A mineral falling in between two numbers in the scale of hardness is given a hardness number halfway between the two numbers as 3.5, 6.5, etc. Talc is taken as the softest mineral, hardness of 1, and diamond, the hardest known substance, is taken as 10. These numbers, however, do not represent the absolute relative hardness as gypsum is not twice as hard as talc, nor is quartz twice as hard as orthoclase. It is thought that diamond is as much harder than corundum as that mineral is harder than talc.

MOH'S SCALE OF HARDNESS

Mineral	Hardness
Talc	1
Gypsum	2
Calcite	3
Fluorite	4
Apatite	5
Orthoclase	6
Quartz	7
Topaz	8
Corundum	9
Diamond	10

For practical purposes it is well to know that the fingernail has a hardness of about 2.5, a copper or silver coin, about 3, ordinary glass is about 5.5, and a knife blade is slightly less than 5.5. These substances will be found very useful in the determination of hardness of a great number of minerals.

A mineral of the hardness of 1 can be scratched by all of the above implements. One with a hardness of 4 cannot be scratched by the fingernail, or a copper coin, but a knife will scratch it easily. It must always be remembered that minerals of the same hardness will scratch each other; that is, quartz will scratch quartz, etc. In determining hardness, use a fresh surface and make sure that a scratch really results; not simply a trail of powder. Granular minerals may have their particles forced apart in an attempt to determine hardness, whereas, it is the hardness of the individual grains that is of importance. Hardness, like other properties, may vary with the crystallographic directions. This difference is usually small but is very striking in the case of kyanite, for example, which has a hardness of about 5 parallel to the length, and 7 across the crystal.

SPECIFIC GRAVITY

The *specific gravity* of a mineral is an expression of its weight compared to the weight of an equal volume of water. A cubic inch of mineral of specific gravity of three would weigh three times as much as a cubic inch of water. The average specific gravity of the minerals of common occurrence is probably about 2.7. Those with a specific gravity of 2 are noticeably of light weight, and those with specific gravities of 3.5 or above, are noticeably heavy. In judging the specific gravities of two minerals, one should select pieces of nearly the same size so that the weight of equal volumes is compared. Specific gravity is commonly abbreviated as "G."

STRUCTURE

Various structures are assumed by minerals and these are of considerable significance in recognizing certain species. Familiar terms used to describe these structures are:

Crystalline. A structure due to the orderly arrangement of atoms throughout the mass. Most minerals are crystalline which may be indicated by cleavage.

Crystal. A crystalline substance bounded by plane surfaces. Many crystalline substances do not show well-formed crystals.

Amorphous. Without crystal form or an orderly internal arrangement of its atoms.

Radiating. Crystals arranged about a common center like the spokes of a wheel.

Acicular. Slender, needle-like crystals.

Dendritic. A fern-like, or tree-like branching of a mineral growth upon a surface.

Filiform. In the form of thin wires or threads.

Granular. A crystal aggregate of fine or coarse individuals like marble.

Drusy. An incrustation of small crystals covering a surface. Commonly found in vugs.

Botryoidal. A semiglobular structure resembling a cluster of grapes which are pressed together.

Reniform. Shaped somewhat like a kidney.

Amygdaloidal. Almond-shaped, applied to lavas whose vesicles are filled with mineral matter.

Foliated. In leaves or sheets.

Micaceous. With the appearance of mica or can be cleaved into exceedingly thin sheets.

Lamellar. Consisting of plates of appreciable thickness.

Stalactitic. Suspended, icicle-like aggregates.

Concentric. Composed of layers about a common center; onion-like structure.

Oolitic. A concretionary structure with small rounded particles; grains like small bird shot.

Pisolitic. Rounded concretionary particles about the size of peas.

Nodular. With a surface of rounded lumps or masses.

Tabular. With broad flat surface.

Compact. A uniform aggregate of closely-packed minute particles.

Massive. Compact material without definite crystals.

Disseminated. The mineral occurs, usually in small particles or veinlets, distributed through the rock.

SPECIAL PROPERTIES

Minerals may have characteristics other than those described above. Some of these are porosity, solubility, taste, odor, feel, and magnetism. If a mineral has a definite taste it is water soluble. Odor is best detected if the mineral is first moistened by blowing the breath upon it. Some minerals, like the metals, feel cold, others harsh, greasy, or soapy, when rubbed between the fingers. Magnetism can best be detected on finely-crushed material. If the magnetism is not strong it may be noted by bringing the material near to a suspended magnet. A few minerals, when turned in the light, show a play of colors; this property is known as iridescence. Such phenomena are observed when a thin film of oil covers water. Striations are fine parallel lines on the surface of a mineral.

OTHER AIDS TO IDENTIFICATION

Minerals do not occur haphazardly distributed in rocks but occur where they do because certain components were present, and because of certain forces that have acted during their formation. When their environment changes the minerals also tend to change to meet the new conditions. Therefore, minerals are indicators of the conditions existing at the time of their deposition. Those minerals which are produced by the same kind of processes are usually chemically similar. Therefore *association* becomes a means of indicating what minerals are likely to occur together. For example, galena and sphalerite, or pyrite and chalcopyrite, are often found together because they are all sulphides and are produced under similar conditions. Similarly, in the upper portions of mineral deposits, carbonates such as malachite, azurite, and cerussite, are found with such oxides as limonite, cuprite, and hematite. This association is due to the fact that these minerals are stable under the conditions existing at, or near, the surface. Some of them are combinations with the carbon dioxide from the air while others obtained oxygen from the same source. The sulphides from which they were formed were unstable in these surroundings. As minerals are often accompanied by characteristic alteration products, this feature also aids in their identification. For example, chalcopyrite may become coated with malachite whereas pyrite, which may be mistaken for chalcopyrite, commonly alters to brown limonite. After some experience the worker will note other alteration products which suggest the nature of the original mineral.

PART III

THE DETERMINATION OF NEVADA'S COMMON MINERALS

INTRODUCTION

The physical properties of minerals are of the greatest importance in their determination. With some minerals these properties are so distinctive that the mineral is readily recognized. With many others identification is possible with the aid of a few simple tests, and there is a large number, particularly of the rarer species, which require, in addition to easily determined properties, the aid of chemical, optical, or other tests before their identity can be positively established.

It is well for the beginner constantly to keep in mind that more information than it is possible to give here, is necessary for the certain determination of a great number of minerals. Furthermore, there are many minerals to which even the skilled mineralogist must apply further tests in order to identify them. However, the reader will find in the key and descriptions, at the end of this section, sufficient information to determine with reasonable certainty, a considerable number of the more common minerals. For those who wish to pursue the study of mineralogy further (and many will find it an interesting subject), suitable texts will be found listed in the selected bibliography on pages 8 and 9.

The occurrence, associated minerals, and alteration products will prove valuable aids in suggesting other minerals which may be present. These also reveal much concerning the nature of the processes by which the minerals were formed and also their subsequent history. If the association is not accidental, as is sometimes the case, it may give considerable information as to the temperature and pressure existing at the time of deposition. It follows, therefore, that the one who best understands minerals will be best able to interpret the conditions existing at the time of their formation.

If one is unable to determine a mineral to his own satisfaction a specimen should be referred to more experienced persons for examination. At the Mackay School of Mines, University of Nevada, is located the State Analytical Laboratory which was instituted by an act of the State Legislature in 1895. Tests on mineral specimens, sent in for identification, have been carried on at the school since 1892. During each year the laboratory makes hundreds of free determinations for the citizens of Nevada and this work has been directly responsible for the discovery of many valuable deposits which might otherwise have been overlooked. In addition, this continuous work on the minerals of the State has brought to light numerous occurrences of various minerals that would otherwise have remained unknown.

Most methods for the rapid determination of minerals are dependent upon their physical properties. The various schemes in use differ principally in completeness, in the emphasis laid upon certain characteristics, and in the order in which the various tests are applied. In the plan adopted here, only the properties most readily determined in the field are made use of. These properties are hardness, color, and streak. In many cases specific gravity and cleavage are important features. With some practice it will be found that specific gravity can be estimated with sufficient accuracy to be of considerable use in mineral identification. In the mineral descriptions, which are necessarily brief, only the more essential properties are given, together with the chemical composition and other distinguishing features, and occasional simple tests for the major constituents. Within each group, the minerals are further arranged in the order of decreasing specific gravity. In this bulletin it is intended to describe only the more common, or the more important, minerals occurring within the State. It will be found helpful, and at times necessary, to refer to the standard works on mineralogy for more complete descriptions or for many species not listed here.

KEY TO MINERAL IDENTIFICATION

PAGE

Minerals With a Hardness of 7 or Above (as hard as, or harder than, quartz)—

Minerals Less Than 7 in Hardness (not so hard as quartz)—

II. Colored Minerals Giving Colorless Streaks—

III. Colorless, White, or Gray Minerals Giving Colorless Streaks—

USE OF THE KEY

The purpose of the "key" is to eliminate all but a few minerals having similar properties. This will indicate the group in which the unknown mineral is to be found.

Suppose we have a mineral with a hardness of about 3, dark in color, and giving a lead-gray streak. It has a metallic luster, a good cleavage in one direction, and a bright luster on freshly-exposed surfaces. The color, hardness, and streak indicate that it will be found under I A. Of the minerals in this group both stibnite and jamesonite have these properties. The difference in the cleavage, or a test for lead, will distinguish between them. In many cases the properties of the mineral will not be so distinctive as those indicated above, and may be found to apply to several minerals. It will then be necessary to use additional features, or make further tests, to differentiate between them. A good plan is to familiarize oneself with the key by running down several known minerals.

Minerals which have a variety of colors are listed under their more common colors in the several groups. Those with a hardness near the division between two groups are listed in both groups. An attempt has been made to place the description of each mineral in that division in which it most commonly occurs.

In determining the hardness of an unknown mineral, test it against the materials listed in the scale of hardness. A sharp edge, or point, of the unknown should be rubbed to and fro, using moderate pressure, on a smooth surface. Care must be exercised to determine whether a scratch has really resulted; not simply a train of powder from the mineral being tested.

DESCRIPTION OF MINERALS

MINERALS WITH A HARDNESS OF 7 OR ABOVE (AS HARD AS, OR HARDER THAN, QUARTZ)

I. Minerals With a Distinct Cleavage

CASSITERITE, SnO_2. H. 6–7. G. 6.8–7.1. See page 42.

GARNET, $R''_3R'''_2(SiO_4)_3$. H. 6½–7½. G. 3.5–4.3. See p. 43.

CORUNDUM, Al_3O_3. H. 9. G. 4. Hexagonal.

The crystals are striated, very hard, and show a hexagonal cross-section. Colors are commonly bluish gray, or brownish to white. Common corundum includes all colors except the transparent varieties. The crystals are frequently barrel-shaped. The surface is commonly altered to soft minerals. Other varieties are: (1) Sapphire and ruby; the blue and red gem varieties. Also rarely yellow, green, or purple. (2) *Emery* is a mixture of corundum and magnetite, hematite, and other impurities. Corundum occurs in granular limestones and dolomites, gneiss, syenite, mica slate, and in many other metamorphic rocks. It is usually found associated with magnetite, spinel, chlorite, feldspar, kyanite, and diaspore. Corundum is not acted upon by acids. A fragment heated before the blowpipe, after moistening with cobalt solution, gives a blue color; indicating the presence of aluminum. Common corundum is extensively used as an abrasive while the clear varieties are highly valued as gems. Corundum is found in Nevada near Thorne in the Gillis Range, and at Buckskin at the north end of Smith Valley in Douglas County. It is probably more widespread in the State than is indicated above.

STAUROLITE, $Fe(AlO)_4(AlOH)(SiO_4)_2$. H. 7–7½. G. 3.6–3.75.
Orthorhombic.

Crystals are commonly brown to black prisms. Sometimes twinned and crossed at 90° and 120°. Also as single tabular crystals which may have the appearance of garnet, except for the crystal shape and cleavage. One distinct cleavage. Often contains inclusions of other minerals. Found in gneisses and schists. Occurs with garnet, sillimanite, kyanite, tourmaline, and other metamorphic minerals. Found near Las Vegas and also at Beatty. Probably much more widely distributed. It reacts for tests of aluminum, silica, and iron.

STAUROLITE, $Fe(AlO)_4(AlOH)(SiO_4)_2$. H. 7–7½. G. 3.6–3.75. See page 41.

OLIVINE, $(Mg,Fe)_2SiO_4$. H. 6½–7. G. 3.3–3.4. See p. 66.

DUMORTIERITE, $8Al_2O_3.B_2O_3.6(SiO_2).H_2O$. H. 7. G. 3.3–3.36. Orthorhombic.

Usually occurs fibrous, columnar, or massive. The color is usually violet, blue, or lilac, but may be green, white, or colorless. One imperfect cleavage. Found in pegmatites, schists and other metamorphic rocks. Dumortierite is insoluble in acids, and gives a reaction for boron. Usually recognized by its color and mode of occurrence. When heated to 1500°C it is converted into a white, enamel-like substance, called mullite ($3Al_2O_3.2SiO_2$). It is a relatively rare mineral but is found in the south end of the Granite Range in pegmatite dikes, in schistose volcanics at Oreana, and in schists and veins in the Rochester district, and also at Manhattan. The largest known deposit is that at Oreana where a considerable tonnage is mined for use in the manufacture of spark plugs and other high-grade ceramics.

TOURMALINE (a complex boro-aluminum silicate).[13] H. 7–7½. G. 3–3.2. Hexagonal.

Crystals are of prismatic habit commonly with a triangular cross-section. They are differently terminated on the ends and are often slender and acicular. The prism faces are usually finely striated parallel to the prism edge. Subconchoidal to uneven fracture; difficultly cleavable. The mineral is brittle, and has a striking vitreous luster. It is transparent to opaque. The color is commonly black, sometimes brown, and rarely green, pink, or colorless. Tourmaline is difficultly fusible; some varieties giving a black enamel. Varieties: (1) Common tourmaline is black (schorlite) and widely distributed. (2) Dravite, brown magnesian tourmaline, is found at Lincoln Hill near Rochester, and also in Cottonwood Canyon, near Brucite in the Paradise Range. (3) Rubellite, the lithia-bearing tourmaline, has been reported from the State. Schlorlite (black, iron tourmaline) is common in pegmatites, and some ore veins, of the State.

BERYL, $Be_3Al_2(SiO_3)_6$. H. 7½–8. G. 2.7–2.8. Hexagonal.

Commonly in prisms showing a plane at end one. Various colors such as green, light blue, yellow, and white. Very difficultly fusible and insoluble in acids. Large loose crystals are occasionally found. Imperfect cleavage, conchoidal to uneven fracture. Varieties: (1) *Emerald*, bright emerald-green in color due to a small amount of chromium; of gem quality only when clear and reasonably free from flaws. (2) *Aquamarine*, pale bluish green. (3) Ordinary beryl of various colors. Beryl occurs as a contact mineral in mica schist, clay slate, and in pegmatites. Used as a source of beryllium or as gems. It is found in pegmatites in the Ruby Range, in Elko County, and also near Oreana, in the Humboldt Range. At the latter locality it occasionally grades into emerald of poor quality.

QUARTZ, SiO_2. H. 7. G. 2.65–2.66. Hexagonal rhombohedral.

In glassy clear, milky, smoky, or rose-colored crystals and in shapeless masses. Known as *rock crystal* if clear and colorless; *amethyst*, if violet to purple; *smoky quartz*, if dark to nearly black; *citrine*, or *false topaz*, if yellow to brownish yellow. A reddish variety is known as *rose quartz*. Quartz is insoluble and infusible, has a conchoidal fracture, and vitreous luster. One of the most common minerals and is very abundant and of widespread occurrence. It is used as an abrasive, smelter flux, silica sand, rock crystal for optical instruments and radio transmitters, and for many other purposes. Quartz is present in great abundance in most ore veins.

CHALCEDONY, SiO_2. H. 7. G. 2.6–2.64. (Microcrystalline silica).

May be white, black, and a variety of colors. It is deposited at hot springs, and by surface waters. Occurs in epithermal veins, and is also a common product of weathering. There are numerous varieties which have received many names based on differences in color or structural features. *Jasper*, an impure yellow or red variety containing iron oxides, is quite common and found in numerous localities. *Agate* is chalcedony of various structures and colors. Chalcedony is of widespread occurrence in the State.

MINERALS LESS THAN 7 IN HARDNESS (Not so Hard as Quartz)

I. Colored Minerals Giving Colored Streaks

A. BLACK MINERALS WITH BLACK STREAKS

IRON (*Native Iron*), Fe(Ni). H. 4–5. G. 7.3–7.8. Isometric.

Iron has a steel-gray to black color and a metallic luster. It is white on a fresh fracture but becomes dark, to almost black, on long exposure. The fracture is hackly. Usually massive, and rarely

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[13] The composition of the tourmaline group is rather complex, and variable in different species. In addition to boron, aluminum, and silica; the alkalies, iron, and magnesia may be present.

KYANITE, Al_2SiO_5. H. 5 and 7. G. 3.6 ±. See p. 65.

EPIDOTE, $HCa_2(Al,Fe)_3Si_3O_{13}$. H. 6–7. G. 3.3–3.5. See p. 65.

OLIVINE, $(Mg,Fe)_2SiO_4$. H. 6½–7. G. 3.3–3.4. See p. 66.

DUMORTIERITE, $8Al_2O_3.B_2O_3.6(SiO_2).H_2O$. H. 7. G. 3.3–3.36. See p. 44.

AXINITE, $H(Ca,Mn,Fe)_3Al_2B(SiO_4)_4$. H. 6½–7. G. 3.3. See p. 72.

ANDALUSITE, Al_2SiO_5. H. 7–7½. G. 3.1–3.2. Orthorhombic.

Crystals are usually coarse, nearly square or rhombic cross section, prisms. Also in irregularly-formed masses. The color is pink, pearl-gray, reddish brown, or bluish. Distinct cleavage and uneven fracture. Andalusite is a common constituent of clay slates, argillaceous schists, and similar rocks. The variety *chiastolite* contains carbon symmetrically arranged. It is commonly associated with sillimanite, muscovite, kyanite, dumortierite, and tourmaline. Used in the manufacture of refractory materials such as spark plugs and porcelain. It is infusible and is insoluble in acids. Found, associated with dumortierite, at Oreana, and with corundum in the Gillis Range near Thorne. Widespread in the metamorphic rocks of western Nevada.

BERYL, $Be_3Al_2(SiO_3)_6$. H. 7½–8. G. 2.7–2.8. See p. 44.

II. Minerals With No, or an Indistinct, Cleavage

CASSITERITE, SnO_2 (Sn = 78.6 percent). H. 6–7. G. 6.8–7.1. Tetragonal.

The mineral is usually black or brown; sometimes reddish, yellow, or gray. The luster is adamantine. Imperfect cleavage. The streak is white, grayish, or brownish. Varieties are: *Tinstone* which is crystalline or massive; *stream tin*, from alluvial deposits; *wood tin* is botryoidal with a fibrous interior. Cassiterite is the principal ore of tin. Associated minerals are topaz, fluorite, tourmaline, quartz, arsenopyrite, etc. It is occasionally found in pegmatites. Fragments of cassiterite boiled in dilute hydrochloric acid, with metallic zinc, will be covered with a dull gray coating of metallic tin which brightens upon rubbing. It is insoluble, or but slightly acted upon by acids. Cassiterite is found in rhyolite flows near Tuscarora and also at the Izenhood ranch north of Battle Mountain, and in a rhyolite stock, associated with copper minerals, at Majuba Hill. Wood tin is associated with specular hematite in the rhyolite north of Battle Mountain.

ZIRCON, $ZrSiO_4$. H. 7½. G. 4.7. Tetragonal.

Zircon usually occurs in small, nearly square, brown or gray prisms. It is sometimes reddish or greenish in color. It may also be colorless, especially when in very small crystals in igneous rocks. Adamantine luster. Large, well-formed crystals may be found in pegmatites. It is a minor constituent of igneous rocks, or of the sands derived through the weathering of rocks. Associated with magnetite, apatite, biotite, and sphene. The variety called *hyacinth* is orange colored, and when transparent is used as a gem. Zircon is infusible. In a fine powder it is acted upon by sulphuric acid. Gives test for zirconia. Zircon is a common mineral and is found, in minor amounts, throughout the State.

GARNET, $R''_3R'''_2(SiO_4)_3$.[12] H. 6½–7½. G. 3.5–4.3. Isometric.

Garnet may occur as irregular grains, massive, or in well-formed dodecahedrons or trapezohedrons. The color is red, black, brown, or may be yellow, white, or green. It is quite brittle. The surface is at times coated with softer minerals such as limonite or chlorite. Garnet is found in pegmatites, igneous rocks, and in many sediments that are metamorphosed near igneous intrusives. It is common in gneisses and schists and in stream sands. Garnet is a common and widely distributed mineral in Nevada. Varieties: (1) Grossularite, $3CaO.Al_2O_3.3SiO_2$. G. 3.53. Commonly found in contact-metamorphosed limestones. It is colorless, white, pale green, yellow, brown, or red. (2) Almandite, $3FeO.Al_2O_3.3SiO_2$. G. 4.25. This is precious garnet when transparent and deep red. It may be brownish-red to black and grades to andradite. (3) Andradite (common garnet), $3CaO.Fe_2O_3.3SiO_2$. G. 3.75. The colors are various: brownish shades of green, also red, yellow, and black. (4) Spessartite, $3MnO.Al_2O_3.3SiO_2$. G. 4.18 The color is red with a tinge of violet or brownish red. Gem variety is found in rhyolite near Lane City in White Pine County.

Most garnets are readily fusible but they are insoluble in acid. Very abundant in many places in Nevada. Bright red garnets, among the earliest minerals found in the State, gave the Ruby Range its name. Pale brown to brownish red garnets are found in the Nightingale district. Common garnets are of widespread occurrence.

CORUNDUM, Al_2O_3. H. 9. G. 4. Hexagonal. See p. 41.

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[12] R″ may be calcium, magnesium, ferrous iron and manganese; R‴ may be aluminum, ferric iron, and chromium.

in well-formed crystals. May show perfect cleavage and a lamellar structure. Iron is strongly magnetic and is quite malleable. Meteoric iron is always alloyed with nickel and usually contains some copper and cobalt. Polished meteoritic iron, upon etching, shows characteristic patterns known as Widmanstatten structure. Iron is not a common mineral but is a component of most meteorites. So far but four meteorites have been found in Nevada, but there are probably many others in the State which have so far escaped discovery. Specimens of several meteorites, including Quartz Mountain and Quinn Canyon irons, are on display in the Mackay Museum.

ARGENTITE (*Silver Glance*), Ag_2S ($Ag = 87.1$ percent). H. 2–2½. G. 7.3. Isometric.

The mineral has a metallic luster and the color and streak are blackish lead-gray. It is very sectile. On charcoal it yields sulphur fumes and a globule of metallic silver. It is the most important primary ore of silver. Secondary argentite is sometimes "sooty." Argentite is associated with other silver minerals together with galena, tetrahedrite, chalcopyrite, bornite, pyrite, limonite, calcite, quartz, etc. Argentite is an important silver mineral at Fairview, the Comstock Lode, Gold Circle, Mountain City, Tonopah, Wonder, in the Humboldt Range, and in many other Nevada mining districts.

WOLFRAMITE (also Huebnerite and Ferberite), $(Fe,Mn)WO_4$. H. 5–5½. G. 7.1–7.5. Monoclinic.

The crystals of wolframite are tabular or prismatic, very heavy, and are brown to black in color. The luster is sub-metallic and the streak is dark brown. The perfect cleavage is characteristic. It may also occur bladed, lamellar, or granular. These tungsten minerals are found in quartz veins together with fluorite, scheelite, arsenopyrite, and many other minerals. Wolframite is quite fusible. Hydrochloric acid solutions of the tungsten minerals, when boiled with metallic tin, give a blue solution which eventually becomes brown. Fusion with soda may be necessary before wolframite can be dissolved in acid. Wolframite grades into ferberite, richer in iron, and into huebnerite, which contains more manganese. Ferberite is found at Beatty and also near Panaca. Huebnerite was named, and first described, from specimens from Ellsworth in the Paradise Range, Nye County. Wolframite occurs in the Comet mine, and at Ellsworth, Round Mountain, several localities in the Snake Range, and elsewhere.

GALENA, PbS ($Pb = 86.6$ percent). H. 2½. G. 7.5. Isometric.

Galena is dark lead-gray and gives a dark-gray to black streak. It has a brilliant metallic luster. Crystals are usually cubes or octahedrons. The cleavage is perfect cubic which distinguishes galena from similar-appearing minerals. Some galena is quite rich in silver. Galena is usually present in silver mines. Frequently altered to cerussite and anglesite. Galena ores are found in veins in igneous rocks, in limestone (as fissure veins and as replacement deposits), and less frequently as a contact mineral. Associated minerals include sphalerite, pyrite, chalcopyrite, silver minerals, quartz, calcite, and many others. Galena is the principal source of lead and is sometimes a valuable ore of silver. Found in numerous localities.

STEPHANITE (*Brittle Silver Ore*), Ag_5SbS_4 ($Ag = 68.5$ percent). H. 2–2½. G. 6.2–6.3. Orthorhombic.

The color and streak are iron-gray. The mineral has a metallic luster. Its brittleness aids in its identification. Usually fine-grained, or massive, and frequently disseminated, but rarely in good crystals. Stephanite, a primary mineral, is commonly present in the upper portions of silver veins. It decrepitates on heating. When heated in strongly oxidizing flame it gives a coating of antimony oxide on charcoal and a metallic silver globule. Heated in an open tube it fuses and yields sulphur fumes. Associated with other silver minerals and galena, tetrahedrite, sphalerite, barite, quartz, chalcopyrite, and many other minerals. It is a common mineral in Nevada silver deposits and was an important ore in the mines at Austin, Clifford, Comstock Lode, Lewis, Mineral Hill, Silver Bow, and in other districts.

CHALCOCITE (*Copper Glance*), Cu_2S ($Cu = 79.8$ percent). H. 2½–3. G. 5.5–5.8. Orthorhombic.

Found massive or disseminated in black grains. Metallic luster, but frequently rather dull. The streak is lead-gray to black. The color is lead-gray, usually with a dull black tarnish. It is an important, both primary and secondary, ore of copper; sometimes coated with malachite. It is soluble in nitric acid and gives tests for copper and sulphur. Associated with other copper minerals, principally chalcopyrite, bornite, cuprite, and covellite, as well as with pyrite, galena, hematite, sphalerite, quartz, calcite, and barite. Chalcocite is present in practically all of the copper mines, as well as in many of the silver mines, of the State.

MAGNETITE, Fe_3O_4 (Fe = 72.4 percent). H. 6. G. 4.9–5.2. Isometric.

The color is black, with dull to metallic luster, and the streak is black. It is strongly magnetic and is itself sometimes a magnet (*lodestone*). When crystallized it forms octahedrons. Occurs crystalline, massive, granular, and disseminated. Brittle. Lenticular masses in metamorphic rocks, near contacts, sometimes constitute ore. It is a common minor constituent of many igneous rocks. Magnetite is also abundant in many "black sands." It is a valuable ore of iron. Associated with chlorite, pyrite, chalcopyrite, quartz, feldspars, zircon, pyroxene, etc. Found in many of the contact-metamorphosed limestones of the State; sometimes in considerable quantity.

TETRAHEDRITE (*Gray Copper*), $5Cu_2S.2(Cu,Fe,Zn)S.2Sb_2S_3$ (Cu = 52.1 percent). H. 3–4½. G. 4.6–5.1. Isometric.

Commonly crystallizes in tetrahedrons, also massive, granular, or compact. The color is dark-gray to iron-black and the streak black, inclining to brownish. Brilliant metallic luster. Often contains silver, lead, zinc, or mercury; the antimony may be in part replaced by arsenic. It is a common subordinate mineral in veins with chalcopyrite, sphalerite, galena, argentite, and the ruby silver minerals. In many Nevada mines it was an important silver mineral; the variety freibergite contains from 3 to 30 percent of silver. Tetrahedrite is common in many Nevada mines and is found at Aurora, Birch Creek, Cherry Creek, Copper Canyon, Cortez, Fairview, Lucky Boy mine, and in many mines in the Humboldt Range.

PYROLUSITE, $MnO_2.x(H_2O)$. H. 1–2. G. 4.7–4.8. Amorphous.

Color is black and the mineral gives a black streak. Occurs as soft black needles, radiating fibers, or dull black masses. When in crystals it is probably always pseudomorphous after manganite. It is a common product of the weathering of other manganese minerals. Pyrolusite soils the fingers readily and will mark paper with a dull black streak. Frequently forms beautiful dendritic patterns, resembling ferns. One of the chief sources of manganese. Treated with hydrochloric acid, it evolves chlorine gas. With concentrated hydrochloric acid gives inky-black solution. May give water when heated in a closed tube. It is associated with psilomelane, braunite, manganite, limonite, hematite, and clays. Pyrolusite is of widespread occurrence in Nevada. It is a common mineral in the upper portions of some silver-bearing veins.

BRAUNITE, $3MnMnO_3.MnSiO_3$ (MnO = 90 percent). H. 6–6½. G. 4.8 ±. Tetragonal.

The color and streak are dark brownish-black to steel-gray. Luster submetallic. Brownish black granular masses and occasionally in pyramids closely resembling octahedrons. Occurs in veins, commonly as the alteration product of rhodonite. Associated with other manganese minerals and barite, hematite, limonite, etc. Gives a test for manganese with the borax or soda bead. It is soluble in hydrochloric acid with resulting gelatinous silica upon evaporation. It is a common mineral in the manganese deposits in the eastern part of the State, also south of Golconda. Good crystals are found ten miles southeast of Ely.

PSILOMELANE, MnO_2 (with various impurities). H. 5–6. G. 3.7–4.7. Amorphous.

The color is dark gray to iron-black, streak brownish black. The luster is submetallic to dull. It may be massive, botryoidal, nodular, stalactitic, or as an incrustation. Psilomelane is usually a secondary mineral found only in the zone of weathering. It is also deposited from springs and then may contain tungsten. Some such deposits, like that at Golconda, are valuable ores of tungsten. It is one of the chief ores of manganese. Soluble in hydrochloric acid with the evolution of chlorine. In concentrated hydrochloric acid gives an inky-black solution. Associated with other manganese minerals, limonite, clays, etc. Found at Las Vegas, Golconda, Central Range, in Brunswick Canyon in the Pinenut Range, and elsewhere.

STIBNITE, Sb_2S_3 (Sb = 71.4 percent). H. 2. G. 4.5–4.6. Orthorhombic.

Occurs as crystals, either bladed, acicular, radiating, columnar, or prismatic; also massive. The color and streak are lead-gray to black. Brilliant metallic luster and perfect cleavage. Tarnishes black. Fuses in a match or candle flame. Occurs in veins of quartz either alone or with cinnabar, arsenic minerals, pyrite, and also in gold and silver ores. Commonly alters to yellow, white, and gray antimony oxides. The principal source of antimony. Good crystals come from Manhattan in Nye County, and from near Sodaville in Mineral County. Stibnite is also common in the mines in the Humboldt Range, Battle Mountain, Bernice, Steamboat Springs, and many other places. Delicate hair-like crystals are occasionally found in the sinter, or on the edges of hot pools, at Steamboat Springs.

ENARGITE, Cu_3AsS_4 ($Cu = 48.3$ percent). H. 3. G. 4.4 ±. Orthorhombic.

Enargite is gray-black to iron-black in color and has a black streak. The luster is metallic. It is brittle with one perfect cleavage. A primary mineral associated with other copper minerals also with pyrite, sphalerite, quartz, galena, barite, arsenic minerals, etc. Soluble in aqua regia and reacts for copper, arsenic, and sulphur, when heated before the blowpipe. Enargite is rather widespread in the mines of the State. It is found at the Black Panther mine two miles north of Reno, in the northern part of the Pine Forest Range, in the Glencoe mine in the Kern Mountains, and at many other places.

GRAPHITE, C. H. 1–2. G. 2.2. Hexagonal.

Commonly occurs as shining black flakes or dull masses. The luster is metallic to earthy. Occurs chiefly in metamorphic rocks through the alteration of carbonaceous material but also in veins. Graphite has a greasy feel and will readily mark paper. It is infusible and unattacked by acids. In small flakes it may be confused with molybdenite. It is distinguished by its black streak on glazed paper, while molybdenite has a bluish tinge and its streak on glazed paper is yellowish green. The thin laminae are flexible and opaque. Common in crystalline limestones and sometimes in igneous rocks. Its chief use is in making refractory crucibles, lubricants, paint, pencils, electrodes, etc. For many of these purposes it must be rather pure. Found near Verdi, Luning, Carson City, north of Austin, in the Pioche district, the Gillis Range, Ruby Range, Humboldt Range, and in other localities.

B. MINERALS, NOT BLACK, BUT GIVING BLACK STREAKS

GALENA, PbS. H. 2½. G. 7.5. See p. 47.
ARGENTITE, Ag_2S. H. 2–2½. G. 7.3. See p. 46.

ARSENOPYRITE, FeAsS. H. 5½–6. G. 6–6.2. Orthorhombic.

The color is silver-white to steel-gray with a metallic luster. Crystals are wedge-shaped but the mineral may be massive, granular, nodular, or drusy. Brittle. When struck with steel, arsenopyrite emits a garlic-like odor. Readily decomposed by nitric acid, with the separation of sulphur. Reacts for sulphur and arsenic before the blowpipe and becomes magnetic. Associated with quartz, galena, chalcopyrite, pyrite, and gold and silver ores. Frequently contains gold too fine to be seen in a miner's pan and detected only by fire assay. Commonly alters to greenish scorodite. Of widespread occurrence in Nevada at Austin, Bartlett Creek, Battle Mountain, Birch Creek, Carson City, Eureka, Washoe district, Good Hope, Manhattan, Majuba Hill, National, Tuscarora, and at many other places.

JAMESONITE, $2PbS.Sb_2S_3$ ($Pb = 50.8$, and $Sb = 29.5$ percent). H. 2–3. G. 5.5–6. Monoclinic.

Jamesonite has acicular crystals, but may occur fibrous, columnar, or compact and massive. Color is lead-gray with a grayish black streak. The cleavage, transverse to the length, is distinctive; thereby differing from stibnite. Some varieties contain small amounts of iron; others may have silver, copper, or zinc. Some Nevada jamesonite, like that from the Montezuma and Sheba mines, contains appreciable quantities of silver and might properly be classed as *owyheeite*. Jamesonite may alter to bindheimite. It is soluble in hydrochloric acid with the evolution of hydrogen sulphide; slender needles of lead chloride separate out upon cooling. Decomposed by nitric acid leaving a white residue of basic antimony oxide. Heated on charcoal it gives yellow and white sublimates of lead and antimony. Present in many mines in the Humboldt and Trinity ranges. Also found in the Santa Rosa Range and at Candelaria.

CHALCOCITE, Cu_2S. H. 2½–3. G. 5.5–5.8. See p. 47.

BORNITE (*Peacock Ore*), Cu_5FeS_4 ($Cu = 63.3$ percent). H. 3. G. 5.1. Isometric.

Luster metallic. Usually massive, granular, or compact. Color copper red to bronze on fresh surface, tarnishes purple, blue, or black, often varigated. Very brittle. Gray-black to black streak. Soluble in nitric acid with separation of sulphur. Solution made basic with ammonia gives flocculent ferric hydroxide precipitate and a blue solution (copper test). Commonly associated with copper minerals, also with pyrite, pyrrhotite, and arsenopyrite. A valuable source of copper. Common in quartz veins. Occurs at Contact, Ely, Ferber, Genoa, Mountain City, Peavine, Spruce Mountain, Yerington, and in other mineralized areas.

TETRAHEDRITE, $5Cu_2S.2(Cu,Fe,Zn)S.2Sb_2S_3$. H. 3–4½. G. 4.6–5.1. See p. 48.

PYRITE, FeS_2. H. 6–6½. G. 5. Isometric.

Luster metallic; splendent. Color pale brass yellow, often tarnished on surface. Hard and brittle. Will strike fire when struck with steel, giving an odor of burning sulphur. Greenish black streak. Compact and granular masses, stalactites, nodular concretions or in crystals with cubes, pyritohedrons, and octahedrons. Cubes are commonly striated. Associated with magnetite, hematite, chalcopyrite, bornite, sphalerite, galena, etc. Source of sulphuric acid and often contains gold or silver. The most common sulphide and it is present in practically all mines. Common in many rocks where there are no valuable metals.

Marcasite, FeS_2. H. 6–$6\frac{1}{2}$. G. 4.9. Orthorhombic.

Luster metallic. Coxcomb structure or radiating crystals are common. Color pale yellow to steel-gray. Streak grayish to brownish black. The fresh fracture is usually white. Distinguished from pyrite by its color, structure, and crystal form. Is easily altered to limonite, ferrous sulphate, etc. A common secondary mineral. Found with pyrite, galena, sphalerite, cinnabar, etc. Found as stalactites in a cave near Copper Canyon. Present in the ores of Buckhorn, Jarbidge, Goldfield, Imlay, also at Steamboat Springs, and in many mines of the State.

Braunite, $3MnMnO_3.MnSiO_3$. H. 6–$6\frac{1}{2}$. G. 4.8 ±. See p. 49.

Covellite, CuS ($Cu = 66.4$ percent). H. $1\frac{1}{2}$–2. G. 4.7. Hexagonal.

Covellite occurs disseminated or as incrustations; occasionally as hexagonal crystals. Has a submetallic, faint pearly to resinous, or earthy luster. Indigo blue to very dark blue; sometimes will turn a fine purple color upon moistening with water. Frequently in thin flexible laminae. Transluscent in very thin plates. Streak is lead-gray to black. Readily fusible with evolution of sulphur fumes. Soluble in nitric acid to a green solution which turns deep blue (copper) with excess of ammonia. Its characteristics are quite distinctive. Common as an alteration product in the oxidized zone of copper deposits. Occurs in many of the copper mines of the State. Found in Comstock Lode, Humboldt Range, Red Butte, Steamboat Springs, Yerington, etc.

Molybdenite, MoS_2 ($Mo = 60$ percent). H. 1–$1\frac{1}{2}$. G. 4.6–4.7. Hexagonal.

Luster metallic. Resembles graphite, but bluish in color; streak on glazed paper is greenish while that of graphite is black. Is easily cleavable into flexible nonelastic plates. Sometimes alters to yellow fibrous molybdite or to powellite. Will mark paper, soils the fingers, and feels greasy. Gives sulphur fumes, and a pale yellow sublimate of MoO_3, in an open tube. Infusible. Occurs in pegmatites, granite, schists, and crystalline limestones. Associated with quartz, feldspar, pyrrhotite, cassiterite, wolframite, and scheelite. An important ore of molybdenum. Occurs at Alum Canyon, Belmont, Birch Creek, Cherry Creek, Eureka, Ely district, Oak Springs, Verdi, Silver City, Sweetwater, Winnemucca, etc.

Psilomelane, MnO_2. H. 5–6. G. 3.7–4.7. See p. 49.

Pyrrhotite, Fe_7S_8. H. 4. G. 4.6. Hexagonal.

Luster metallic. Color bronze-yellow to copper-red; usually tarnished. Streak dark grayish black. Magnetic. Decomposed by hydrochloric acid with evolution of hydrogen sulphide. Usually massive. Occurs with basic igneous rocks, sometimes by magnetic differentiation, also in veins with ores. Associates are pyrite, chalcopyrite, pentlandite, magnetite, in veins or in contact metamorphic deposits, and in pegmatites. Often contains a small amount of nickel. Found in many Nevada localities; notably, Aurum, Copper King, Red Canyon, Nightingale, Siegel mine in the Shell Creek Mountains, Smith Valley, and other districts.

Stibnite, Sb_2S_3. H. 2. G. 4.5–4.6. See p. 49.

Chalcopyrite, $CuFeS_2$ ($Cu = 34.5$ percent). H. $3\frac{1}{2}$–4. H. 4.1–4.3. Tetragonal.

Luster metallic. Color brass-yellow, often tarnished, or iridescent. Compact granular masses or wedge-shaped crystals. Easily cut with a knife. Streak greenish black. Associated with other copper sulphides, pyrite, galena, and sphalerite, in quartz veins. Primary copper mineral in quartz veins and replacements deposits, also found in contact-metamorphic areas. Most important ore of copper. May carry gold and silver. Decomposed by nitric acid, giving free sulphur and a green solution; ammonia in excess changes the color to deep blue and precipitates brown ferric hydroxide. Occurs at Gold Butte, Kimberly, Mountain City, Ruth, Wellington, Yerington, and is a common constituent in base- and precious-metal veins throughout the State.

C. MINERALS WITH GREEN TO BLUE STREAKS

Malachite, $CuCO_3.Cu(OH)_2$ ($Cu = 57.5$ percent). H. $3\frac{1}{2}$–4. G. 3.9. Monoclinic.

Occurs as bright green crusts, also stalactitic or botryoidal. Sometimes in small slender crystals. Luster vitreous to adamantine, often dull or earthy. Color bright green to dull green.

Streak paler green than the color of the mineral. Effervesces in nitric, or hydrochloric acid and the solution turns blue when ammonia is added in excess. In a closed tube it blackens and yields water. A secondary mineral which is common in the upper portion of copper deposits and abundant throughout the State as at Contact, Ely district, Ludwig, Oak Springs, Railroad, and Santa Fe districts, Yerington, etc.

AZURITE, $2CuCO_3.Cu(OH)_2$ (Cu = 55.3 percent). H. 3½–4. G. 3.8. Monoclinic.

Luster vitreous; almost adamantine. Color various shades of dark blue. Streak blue. Brittle. One perfect cleavage. Gives the same tests as malachite. The dark blue color and effervescence in acid is distinctive. Occurs crystalline, massive, or dull and earthy. Associated with malachite, chrysocolla, cuprite, and other copper ores. A secondary mineral found in the upper portions of veins. Found in small amounts in many copper and gold-silver mines. Found at Ely, Contact, Lee, Ludwig, Spruce Mountain, Yerington etc.

AURICHALCITE, $2(Zn,Cu)CO_3.3(Zn,Cu)(OH)_2$. H. 2. G. 3.64. Monoclinic.

Plumose, tabular, or laminated crystals and also in drusy masses. Commonly associated with malachite, smithsonite, and other secondary copper and zinc minerals. Color and streak is pale green to sky-blue. Pearly luster. Aurichalcite is a secondary mineral found in the upper portions of copper-zinc deposits. Easily soluble with effervescence in acids. Reacts for copper and zinc. The occurrence, and characteristic properties, aid in its recognition. Usually considered as a rare mineral but it is fairly common in Nevada. Noted at Cortez, Bristol Silver, Goodsprings, and near Muncy Creek in the Shell Creek Range. Excellent specimens come from Muncy Creek and Goodsprings. Has been observed in small amounts in several other localities.

AMPHIBOLE, $RSiO_3$. H. 5–6. G. 3.0–3.6. (See hornblende below, and also actinolite, p. 64.)

HORNBLENDE (Ca, Mg, Fe, Al, silicate). H. 5–6. G. 3–3.5. Monoclinic.

Luster vitreous. Brittle with perfect cleavage. May be fibrous. Color green to black; streak grayish green. Crystals have a six-sided cross-section with angles between adjacent faces near 125°. A rock-forming mineral. Easily fusible but insoluble in acids. Associates: biotite, pyroxenes, chlorite, quartz, feldspar, etc. A very common mineral; one of the amphiboles.

CHLORITE, $H_8Mg_5Al_2Si_3O_{18}$. H. 2–2½. G. 2.6–2.8. Monoclinic.

Luster pearly on cleavage faces. Color grass-green to blackish green. Streak pale green. Mica-like crystals, cleavable into thin, flexible, nonelastic plates. Soapy feel. Sometimes occurs in scaly masses. Associated with garnet, biotite, amphibole, feldspar, serpentine, and pyroxene. Found in crystalline schists, and is a widespread and common secondary mineral in igneous rocks. Commonly forms through the alteration of other minerals such as garnet, hornblende, pyroxenes, biotite, etc. Usual varieties are clinochlore and prochlorite.

TURQUOIS, $CuO.3Al_2O_3.2P_2O_5.9H_2O$. H. 5–6. G. 2.6–2.8. Triclinic.

Luster waxy. Brittle. Color sky-blue, bluish green to greenish gray. Streak greenish to white. Usually massive or amorphous. Occurs in thin seams or as disseminated grains. In closed tube gives water and turns black on heating. Soluble in hydrochloric acid and reacts for copper and phosphorus. Nevada produces the bulk of the turquois mined in the United States. Used as a gem stone and for ornamental stone. Found in many places in Nevada, near Austin, Battle Mountain, Crow Springs, Ely, Columbus, Yerington, and many other places.

CHRYSOCOLLA, $CuSiO_3.2H_2O$. H. 2–4. G. 2–2.4. See p. 68.

CHALCANTHITE, $CuSO_4.5H_2O$. H. 2½. G. 2.1–2.3. See p. 68.

D. MINERALS WITH LIGHT TO DARK-GRAY STREAKS

MERCURY (*Quicksilver*), Hg. H. 0. G. 13.6. Liquid (hexagonal at —40°C).

Luster is metallic and brilliant but tarnishes grayish. Liquid at ordinary temperatures but easily volatile (350°C) with vapor constantly escaping even at room temperature. It can readily be detected through the use of ultra-violet light and a fluorescent screen. Readily coats gold, silver, or copper. Found as globules in many quicksilver mines along with cinnabar, metacinnabar, opal, chalcedony, limonite, etc. Found in Nevada at Castle Peak in Storey County, near the hot springs south of Rowland, in the mercury mines east of Lovelock, and it probably occurs, in small amount, at many other places.

SILVER (*Native Silver*), Ag. H. 2½–3. G. 10.5. Isometric.

Occurs as branching crystals, wire-like filaments, and in flakes or masses. It is quite ductile. Luster is metallic and the streak is silver-white. Silver-white color on freshly-exposed surface but tarnishes dark upon exposure; usually quite dark when found in the oxidized zone. Occurs with cerargyrite, cerussite, and other oxidation products, in veins containing other silver minerals, together with galena, stibnite, tetrahedrite, etc. Small amounts of native silver are found in many mines but it is of rarer occurrence than is native gold. In Nevada native silver is found at Fairview, Gold Circle, in the Mable mine in the Garfield district, Mountain City, Palisade, Tonopah, Virginia City, and in other localities.

IRON, Fe(Ni). H. 4–5. G. 7.3–7.8. See p. 45.

GALENA, PbS. H. 2½. G. 7.5. See p. 47.

ARGENTITE, Ag_2S. H. 2–2½. G. 7.3. See p. 46.

STEPHANITE, Ag_5SbS_4. H. 2–2½. G. 6.2–6.3. See p. 47.

JAMESONITE, $2PbS.Sb_2S_3$. H. 2–3. G. 5.5–6. See p. 51.

CHALCOCITE, Cu_2S. H. 2½–3. G. 5.5–5.8. See p. 47.

CERARGYRITE (*Horn Silver*), AgCl (Ag = 75.3 percent). H. 1–1½. G. 5.55. Isometric.

Cubic crystals are rare. Usually massive as plates or incrustations. Colorless, gray, bluish to violet. Will readily darken on exposure to light and commonly dark colored as found. Transparent to translucent and resembles wax. The luster is resinous to adamantine. The streak is light colored and shining. Cerargyrite is very sectile and easily dented with the fingernail. It is insoluble in nitric acid but is slowly soluble in ammonia. Gives a silver globule when reduced on charcoal. With copper oxide gives azure-blue flame due to the chlorine. From the ammonia solution silver chloride is precipitated upon acidulation. A valuable ore of silver occurring with native silver, cerussite, limonite, calcite, quartz, etc., in the outcrops of ore deposits. It is usually a relatively inconspicuous mineral when present in small grains or thin crusts. Found at Austin, Divide, Eagleville, Eureka, Fairview, Mountain City, Rawhide, Sulphur, Tonopah, Treasure Hill, Wonder, and numerous other localities. Large masses were mined at Divide. Treasure Hill is noted for the huge masses of cerargyrite produced there. One of these weighed over 12,000 pounds (6 tons).

BRAUNITE, $3MnMnO_3.MnSiO_3$. H. 6–6½. G. 4.8 ±. See p. 49.

COVELLITE, Cu_2S. H. 1½–2. G. 4.7. See p. 52.

STIBNITE, Sb_2S_3. H. 2. G. 4.5–4.6. See p. 49.

E. MINERALS WITH RED OR REDDISH BROWN STREAKS

COPPER (*Native Copper*), Cu. H. 2½–3. G. 8.8–8.9. Isometric.

Usually as twisted or wire-like forms, frequently aborescent. Distinct crystals are rare. Metallic luster. Copper-red color which may tarnish to brown or nearly black. Highly ductile and malleable. Shining reddish streak. A minor ore of copper. Soluble in nitric acid giving a greenish solution which turns dark blue on the addition of ammonia. Native copper is usually secondary and due to the alteration of sulphide, or oxidized, copper minerals. Minor amounts at Copper Basin, Ludwig, Kimberly, Mountain City, Ruth, Yerington, and other districts.

CINNABAR, HgS (Hg = 86.2 percent). H. 2½. G. 8.1. Hexagonal.

Soft, heavy, fine-grained crystals of brilliant red to reddish brown color. Streak vermillion red. Luster adamantine to earthy. Sometimes altered to black metacinnabar on the surface, also to metallic mercury. One good cleavage parallel to the length of the crystals. Occurs as crusts, massive, as veinlets, or disseminated grains, and filling cavities in sedimentary or igneous rocks. Also in *opalite* and in sinters deposited by hot springs. Pulverized, and rubbed on copper with hydrochloric acid, it leaves a white coating of metallic mercury. Heated in a closed tube, with an equal volume of soda or lime, globules will form in the cooler part of the tubing. Accompanying minerals are pyrite, marcasite, stibnite, sulphur, opal, and quartz. Cinnabar is the chief source of mercury. It is found in numerous places in the State which is one of the leading producers of mercury. Mined at Bottle Creek, Castle Peak, Humboldt Range, Ione, Ivanhoe, Mina, Santa Rosa Range, Sonoma Range, Steamboat Springs, and in many other localities. Steamboat is famous as a locality where cinnabar is now being deposited from hot springs.

CASSITERITE, SnO_2. H. 6–7. G. 6.8–7.1. See p. 42.

HUEBNERITE, $MnWO_4$. H. 5–5½. G. 7 ±. See p. 46.

CUPRITE (*Ruby Copper*), CuO. (Cu = 88.8 percent). H. 3½–4. G. 6. Isometric.

Forms cubic crystals but usually is dark red masses, also brick-red to earthy. The crystals are deep red to crimson, sometimes hairlike as in *chalcotrichite*. The color is various shades of red to almost black and the streak is shining brownish red. Luster adamantine or submetallic to earthy. Found in the oxidized portions of copper deposits together with limonite, malachite, chrysocolla, native copper, azurite, etc. A secondary mineral and a minor ore of copper. Sometimes associated with the black oxide tenorite (*melaconite*). In the ores at Copper Basin, in the Carson Range near Hunter Lake, at Cuprite, Grand Deposit mine, Kimberly, Red Metals mine on Peavine Mountain, Ruth, Searchlight, and there are numerous other occurrences.

PYRARGYRITE (*Dark Ruby Silver*), Ag_3SbS_3 ($Ag = 59.8$ percent). H. 2½. G. 5.8. Hexagonal.

Crystals are prismatic and hemimorphic. Sometimes with rhombohedral and scalenohedral terminations. Color dark red to gray and black. In thin fragments the color is deep ruby-red. Streak is Indian-red. Translucent. Luster is adamantine to submetallic. Fuses easily, giving an antimony sublimate on charcoal; with prolonged heating the coating may be tinged red, near the assay, due to volatilization of silver. With fluxes it is easily reduced to metallic silver. Decomposed by nitric acid with the separation of sulphur; the addition of hydrochloric acid causes the precipitation of silver chloride. In places it is an important silver ore. Found in silver-bearing veins with proustite, galena, sphalerite, argentite, tetrahedrite, and silver sulpho-salts. Present in many Nevada localities including Austin, Como, the Comstock Lode, Good Hope, Mountain City, Lewis Canyon, Tonopah, and Tuscarora.

PROUSTITE (*Light Ruby Silver*), Ag_3AsS_3 ($Ag = 65.4$ percent). H. 2–2½. G. 5.6. Hexagonal.

Crystals are six-sided prisms showing steep rhombohedrons and scalenohedrons. Color ruby-red and the streak is vermillion. Transparent to translucent. Luster is brilliant adamantine. Brittle. Fuses easily, giving odor of sulphur and the garlic-like odor of arsenic. Other tests are similar to those of pyrargyrite. Its occurrences are like those for pyrargyrite. One of the common silver minerals at Austin, Como, Dean Mine, Gold Hill in the Keystone mine, Seven Troughs, Tonopah, and Tuscarora. Excellent crystals have come from Tonopah.

HEMATITE, Fe_2O_3. H. 5½–6½. G. 5.3. Hexagonal.

Specular hematite may crystallize in flat rhombohedrons of brilliant black and micaceous hematite in thin plate-like rhombohedrons. Luster is metallic, sometimes splendent, also may be earthy. The common red variety has little or no luster. The streak is cherry-red to Indian-red. Becomes magnetic on heating in the reducing flame. Slowly soluble in hydrochloric acid. From this solution reddish ferric hydroxide will be precipitated by ammonium hydroxide. Hematite is the most important iron ore. Found in minor amounts in many localities. Commonly associated with magnetite, limonite, siderite, and quartz. In Nevada occurs in contact deposits of considerable size. Found in the Buckskin district, Dayton, Brunswick Canyon, Las Vegas, Lovelock, Pinenut Mountains, Safford, Sonoma Range, and elsewhere.

TETRAHEDRITE, $Cu_8Sb_2S_7$. H. 3–4½. G. 4.6–5.1. See p. 48.

BRAUNITE, $3MnMnO_3.MnSiO_3$. H. 6–6½. G. 4.8 ±. See p. 49.

SPHALERITE, ZnS. H. 3½–4. G. 4. See p. 61.

REALGAR, AsS ($As = 70.1$ percent). H. 1½–2. G. 3.5. Monoclinic.

The crystals are short prismatic and finely striated vertically. Also may be granular, compact, or as incrustations. Color and streak is orange to red. The luster is resinous. Crystals, or crystalline masses, are translucent to transparent. There is a fair cleavage parallel to the clinopinacoid. Realgar decomposes on exposure to light due to the loss of some of the arsenic and with the formation of orpiment and As_2O_3. It is easily fusible and completely volatile giving reactions for sulphur and arsenic. Found associated with orpiment and stibnite, in lead, gold, and silver ores. Gold, associated with realgar or arsenopyrite, may not be seen when concentrated with a miner's pan and is then detected only through fire assay. Several deposits of this nature have been discovered in the State during recent years. Many others may well have been overlooked. Realgar is present at Eureka, Getchell mine, Manhattan, Mill Canyon, and in Secret Canyon. Minute amounts have been found in the hot pools at Steamboat Springs. Exceptionally well-crystallized specimens have come from the Getchell mine.

ERYTHRITE (*Cobalt Bloom*), $Co_3(AsO_4)_2.8H_2O$ ($Co = 29.5$ percent). H. 1½–2½. G. 2.95. Monoclinic.

Occasionally in minute crimson or peach-red prismatic crystals which are vertically striated. Usually occurs, however, as pinkish crusts or powder. The streak is lighter colored than the mineral. Perfect clinopinacoidal cleavage. Luster pearly or adamantine to vitreous. Gives a blue bead with borax and a rose-red solution with nitric or hydrochloric acids. It is of secondary origin and therefore associated with other cobalt minerals such as smaltite, cobaltite, and the oxides heterogenite and stainerite. Not a common Nevada mineral but fine specimens have come from Cottonwood Canyon in the Stillwater Range. Found in the Copper Chief district, in prospects east of Chalk Mountain, and in Cottonwood Canyon in the Stillwater Range. Probably there are other occurrences in the State which have not been reported.

F. MINERALS WITH YELLOW OR YELLOWISH BROWN STREAKS

GOLD (*Native Gold*), Au. H. 2½–3. G. 19.33 when pure, lower when alloyed with silver. Isometric.

As nuggets, grains, flakes, wire, leaf, sometimes dentritic, and rarely crystalline. Color golden yellow. With increasing amounts of alloyed silver the color becomes quite pale. Commonly contains considerable silver, is then pale yellow, and known as *electrum.* Luster metallic. Ductile and malleable to a high degree. Streak yellow and shining. Occurs in quartz veins and in sulphide ore bodies, also commonly as flakes, grains, and nuggets, in placer gravels. A great variety of minerals are found in gold-bearing lodes. Pyrite, galena, sphalerite, and chalcopyrite are commonly present. At the present time the Getchell mine is the largest producer of lode gold in Nevada, while the largest placer production is from the dredge at Manhattan. Other important districts are Aurora, Bullfrog, Edgemont, Eldorado, Gold Circle, Goldfield, National, Pioche, Seven Troughs, Tuscarora, and Virginia City. Placer mining has been carried on in Copper Canyon, Gold Run, Gold Canyon, Osceola, Rawhide, Rosebud, Round Mountain, Van Duzer, and many other districts.

VANADINITE, $Pb_5Cl(VO_4)_3$ (Pb = 72 percent). H. 3. G. 6.7–7.2. Hexagonal.

The crystals are usually small, sharp, sometimes hollow, hexagonal prisms. Also occurs massive and as incrustations. Color, yellow, brown, or bright red. The streak is pale yellow. Luster is resinous and the mineral is quite brittle. Soluble in strong nitric acid and giving a yellow solution; strong hydrochloric acid gives a dark brown coloration. Decrepitates in a closed tube and yields a sublimate of lead chloride. Found in gold, silver, and lead ores. Found at Chalk Mountain in Churchill County, in the Crescent and other districts in southwestern Nevada.

PYROMORPHITE, $Pb_5Cl(PO_4)_3$ (Pb = 76.2 percent). H. 3½–4. G. 6.5–7.1 (lower when containing lime). Hexagonal.

Crystals are prismatic, often in barrel-shaped forms, also in tapering groups of parallel prisms, and as crusts with a moss-like structure. Luster resinous. Brittle. The color is usually green, brown, or gray. The streak is pale yellow. May contain some arsenic. Gives white sublimate of lead chloride in a closed tube. Fuses on charcoal to a globule, which becomes crystalline upon cooling, and gives a yellow lead oxide coating. Soluble in nitric acid. A secondary mineral in lead deposits with cerussite, limonite, galena, malachite, etc. A minor ore of lead. Occurs in the Aura district in Elko County, the Comstock Lode, Cornucopia, Cortez, Eureka, Goodsprings, Mineral Hill, Mountain City, and in many other localities.

HUEBNERITE, $MnWO_4$ (and Wolframite). H. 5–5½. G. 7±. See p. 46.

RUTILE, TiO_2. H. 6–6½. G. 4.2–4.3. Tetragonal.

Crystals are brownish red to black prisms striated vertically. Also knee-shaped twins. Sometimes crossed, or parallel, groups of needles. May be hair-like. Luster adamantine. Pale brown streak. When fused with sodium carbonate, dissolved in hydrochloric acid and metallic tin added, the solution assumes a violet color upon boiling. Rutile is common in schists and on contacts. Occurs with mica, sphene, ilmenite, quartz, hematite, and feldspar. It is a fairly common metamorphic mineral.

SPHALERITE (*Zinc Blende*), ZnS (Zn = 67 percent). H. 3½–4. G. 4. Isometric.

Commonly in tetrahedral crystals sometimes with cube, dodecahedron, and tristetrahedron. Perfect dodecahedral cleavage and conchoidal fracture. Color yellow, brown, or black. Luster is resinous, adamantine, to submetallic. Streak yellow to light brown; always lighter than the mineral. Soluble in hydrochloric acid with the evolution of hydrogen sulphide. In the reducing flame of the blowpipe gives zinc oxide sublimate; yellow while hot and white when cold. Heated in the oxidizing flame, after moistening sublimate with cobalt solution, gives greenish coloration. The black variety (*marmatite*) is high in iron, up to fifteen percent, and is sometimes called *black jack.* Sphalerite occurs as replacements of limestone and in veins together with galena, pyrite, siderite, fluorite, dolomite, calcite, and quartz. Common in many ore deposits in Nevada. Especially plentiful at Pioche.

LIMONITE (*Bog Iron Ore*), $Fe_2O_3.x(H_2O)$. H. 5–5½. G. 3.6–4. Amorphous.

May be earthy, encrusting, botryoidal, massive, or porous. Luster submetallic to dull. Colors reddish, brown, yellowish brown, to black. Yellowish brown streak. Gives water in a closed tube.

Found in nodular masses in clays, ore outcrops, etc. Common alteration product of pyrite, other iron-bearing sulphides, and ferruginous rocks. Bog iron ore commonly occurs bedded where it has been precipitated from iron-bearing solutions. A very common mineral.

Siderite, $FeCO_3$. H. 3½–4. G. 3.8–3.9. See p. 71.

Orpiment, As_2S_3 (As = 61 percent). H. 1½–2. G. 3.5. Monoclinic.

Crystals are small and tabular to prismatic, often rather complex. Usually in foliated masses. Color and streak is lemon yellow. Luster pearly to resinous. Translucent. One very perfect clinopinacoidal cleavage. Completely volatile before the blowpipe and reacts for sulphur and arsenic. A secondary mineral from the alteration of realgar and other arsenic-bearing minerals. Found at Eureka, Getchell mine, Manhattan, Mason Valley mine, Mill Canyon, and small amounts in the sinter at Steamboat Springs.

Jarosite, $KFe_3(OH)_6(SO_4)_2$. H. 3. G. 3.15–3.26. Hexagonal-rhombohedral.

Often as minute crystals in druses but also in disseminated grains and as earthy masses. The crystals are usually of microscopic size although megascopic crystals are not uncommon. Color yellow to brown. Luster vitreous, and brilliant to dull. Streak is yellow and shining. One good cleavage. A very common sulphate in the oxidized portions of sulphide ores. Sodium may take the place of potash giving natrojarosite; replacement by lead forms plumbojarosite; in some occurrences potash is replaced by silver, forming argentojarosite. The jarosites are of widespread occurrence in Nevada. Present in the Arabia district, Chief district, Clifford, Copper Canyon, Cortez, Ellendale, Eureka, Golconda, Goldfield, Goodsprings, Luning, Rosebud, Simon, and in many other districts.

Ocher (a limonitic clay). H. 1–2. G. 2.8 ±. Amorphous.

Brownish to ocher-yellow. An earthy residual product of weathering. Used as a paint pigment.

Jasper (chalcedony with impurities). H. 6–7. G. variable, about 2.6. Cryptocrystalline.

Colors red, brown, yellow, greenish to bluish. Opaque. Shows conchoidal fracture. Takes a good polish. Of very common occurrence.

Copiapite, $2Fe_2O_3.5SO_3.17H_2O$. H. 2½. G. 2.1. Triclinic.

Occurs in yellow finely-granular masses; often as encrustations. Under the microscope it usually shows tabular rhombic, or six-sided, crystals. The color is sulphur yellow. Gives a pale yellow streak. The taste is astringent. It is probably the most common ferric sulphate. Soluble in water and decomposed by boiling, giving an orange-colored precipitate. Soluble in acid. Gives ferric hydroxide precipitate with ammonia and a white (sulphate) precipitate with barium chloride. Readily identified by its taste, color, and decomposition in boiling water. A common sulphate formed through the oxidation of iron sulphide in the upper parts of sulphide deposits and in old mine workings. Noted in many localities in the State. Particularly abundant in the mine workings of the Comstock Lode, near Coaldale, and at the old quicksilver mine west of Steamboat Springs.

Sulphur, S. H. 1½–2½. G. 2–2.1. Orthorhombic.

Crystals are pyramidal but it usually occurs as irregular masses and as incrustations. Color yellow but may be green, gray, or red, due to impurities. Luster resinous. Brittle. Transparent to translucent. Imperfect cleavage, fracture conchoidal to uneven. Occurs in sedimentary rocks with gypsum and calcite. Commonly as a sublimate from volcanic activity, as a fine powdery coating from partial oxidation of sulphides, and also deposited from hot springs. Fine delicate crystals may be observed forming at Steamboat Springs; both where the steam is now issuing in the sinter terraces and also in the open cuts and adits at the old mine to the west. Common as an incrustation on sulphides such as cinnabar, galena, stibnite, etc. Burns with a blue flame and the characteristic odor of sulphur dioxide. Notable occurrences are Blair Junction, Cuprite, Humboldt House, Luning, Steamboat Springs, and Sulphur.

II. Colored Minerals Giving Colorless Streaks

A. BLACK OR NEARLY BLACK MINERALS

Iron, Fe(Ni). H. 4–5. G. 7.3–7.8. See p. 45.

Cassiterite, SnO_2. H. 6–7. G. 6.8–7.1. See p. 42.

Garnet, $R''_3R'''_2(SiO_4)_3$. H. 6½–7½. G. 3.5–4.3. See p. 43.

Barite, $BaSO_4$. H. 2½–3½. G. 4.3–4.6. See p. 79.

Rutile, TiO_2. H. 6–6½. G. 4.2–4.3. See p. 61.

Marmatite (*Black Jack*), $(Zn,Fe)S$. H. $3\frac{1}{2}$–4. G. 3.9–4.1. See p. 61. (Black resinous-appearing sphalerite containing iron. Has perfect cleavage and light brown streak.)

Augite, $RSiO_3$. H. 5–6. G. 3.2–3.6. See p. 65.

Hypersthene, $(Mg,Fe)SiO_3$. H. 5–6. G. 3.4–3.5. Orthorhombic. Good crystals are rare. Usually foliated masses. Luster pearly to metalloidal on fresh cleavage surface. Color black, sometimes copper-red. Brittle. Fuses with difficulty to a black magnetic enamel on charcoal. (Also see pyroxene below.) Found in certain basic igneous rocks with plagioclase, olivine, magnetite, but seldom with quartz. A common mineral in Nevada andesites.

Sphene, $CaTiSiO_5$. H. 5–$5\frac{1}{2}$. G. 3.4–3.6. See p. 72.

Epidote, $HCa_2(Al,Fe)_3Si_3O_{13}$. H. 6–7. G. 3.3–3.5. See p. 65.

Amphibole, $RSiO_3$. H. 5–6. G. 3–3.6. (See hornblende, actinolite, and tremolite.)

Andalusite, Al_2SiO_5. H. 7–$7\frac{1}{2}$. G. 3.2. See p. 42.

Calcite, $CaCO_3$. H. 3. G. 2.7. See p. 81.

Biotite, $(OH)_2K(Mg,Fe)_3(AlSi_3O_{10})$. H. $2\frac{1}{2}$–3. G. 2.8–3.2. Monoclinic (pseudo-hexagonal).

Tabular or short prisms, also scaly and micaceous. Luster splendent. Color dark green to black; thin laminae pale to dark brown. Cleavage highly perfect. Easily separated into thin elastic folia. Found in igneous rocks, crystalline schists, and in metamorphic contact zones. Alters to chlorite. A very common mineral and the principal mica in the igneous rocks of Nevada. Of very widespread occurrence.

Serpentine, $H_4Mg_3Si_2O_9$. H. 2–5. G. 2.2. See p. 69.

Opal, $SiO_2.nH_2O$. H. $5\frac{1}{2}$–6. G. 1.9–2.2. See p. 78. (When powdery may appear to be soft.)

B. GREEN, BLUE, AND VIOLET MINERALS

Pyromorphite, $Pb_5Cl(PO_4)_3$. H. $3\frac{1}{2}$–4. G. 6.5–7.1. See p. 60.

Embolite, $Ag(Br,Cl)$. H. 1–$1\frac{1}{2}$. G. 5.3–5.4. Isometric.

Luster adamantine. Usually massive. Color green to grayish green and yellow. Resembles cerargyrite. Heat a fragment of the mineral with some pure pulverized galena in a closed tube; yellow lead bromide is formed, yellow when hot and colorless when cold. Associated with cerargyrite, bromyrite, iodobromite, etc. Found in Nevada at Broken Hills, Tonopah, Wonder, and other silver-bearing regions.

Cerargyrite, $AgCl$. H. 1–$1\frac{1}{2}$. G. 5.55. See p. 56. (Thin gray or greenish crusts which darken upon exposure to sunlight.)

Smithsonite, $ZnCO_3$. H. 5. G. 4.4. See p. 73.

Garnet, $R''_3R'''_2(SiO_4)_3$. H. $6\frac{1}{2}$–$7\frac{1}{2}$. G. 3.5–4.3. See p. 43.

Celestite, $SrSO_4$. H. 3–$3\frac{1}{2}$. G. 4. See p. 80.

Sphalerite, ZnS. H. $3\frac{1}{2}$–4. G. 4. See p. 61.

Kyanite (*Cyanite*), Al_2SiO_5. H. 5 and 7. G. 3.6–3.7. Triclinic. Luster vitreous to pearly. Very perfect cleavage. Usually in long-bladed crystals, also coarsely-bladed masses. Color blue, white, gray, green, or brownish. Infusible. Easily scratched with a knife parallel to the length of the crystals, harder than a knife at right angles to this direction. The bladed crystals, cleavage and hardness, sets kyanite apart from all other minerals. Occurs in gneiss and schists with garnet, corundum, staurolite, or micas. In Nevada found in many places in small amounts, Beatty, Las Vegas, Leonard Creek, also in northern Elko County, etc.

Hemimorphite, $(ZnOH)SiO_3$. H. $4\frac{1}{2}$–5. G. 3.4–3.5. See p. 74.

Sphene, $CaTiSiO_5$. H. 5–$5\frac{1}{2}$. G. 3.4–3.6. See p. 72.

Pyroxene, $RSiO_3$.[14] H. 5–6. G. 3.2–3.6. Monoclinic and orthorhombic.

Commonly in pale green, dark green, and black stubby prismatic crystals with a vitreous luster. There are many varieties including enstatite, hypersthene, augite, diopside, hedenbergite, and others. The cleavage is prismatic at 89 to 93 degrees which distinguishes pyroxenes from amphiboles. Enstatite, $(Mg,Fe)SiO_3$, and hypersthene, $(FeMg)SiO_3$, are orthorhombic, while the others, mentioned above, are monoclinic. Diopside, $CaMg(SiO_3)_2$, and hedenbergite, $CaFe(SiO_3)_2$, form a gradational series. Augite is a calcium, magnesium, iron, aluminum silicate which may contain titanium. The pyroxenes commonly alter to amphibole, chlorite, or serpentine. Fusible at about 3, depending on the variety, and relatively insoluble. If the iron content is high they become magnetic when fused in the reducing flame. Pyroxenes are common rock-forming minerals occurring in igneous rocks. Also in contact-metamorphic rocks with garnet, scapolite, feldspars, etc. An abundant mineral at Adelaide, Contact, Ludwig, Railroad district, Yerington, etc.

Epidote, $HCa_2(Al,Fe)_3Si_3O_{13}$. H. 6–7. G. 3.3–3.5. Monoclinic. Crystals prismatic, also fibrous or granular. Commonly striated parallel to the length of the crystal. Luster vitreous.

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[14] R may be calcium, aluminum, magnesium, or iron.

Brittle with fair cleavage. Pistachio green color, also yellowish to brownish green. Fuses with intumescence to a magnetic mass. After ignition it is readily soluble in hydrochloric acid and gives silica gel. A common metamorphic mineral, found in gneiss, schist, also in quartzite, limestone, and sandstones which have been altered. Associated with garnet, amphibole, feldspar, pyroxene, copper (contact deposits), etc. Very abundant in many metamorphic areas.

IDOCRASE (*Vesuvianite*). (A basic calcium aluminum silicate.) H. 6$\frac{1}{2}$. G. 3.3–3.5. Tetragonal.

Luster vitreous to resinous. Brittle. Color yellowish green to brown. Recognized by its tetragonal prismatic form and easy fusibility. A contact mineral formed by alteration of impure limestone, sometimes in schist and serpentine. Associated with garnet, epidote, pyroxene, diopside. Found at Adelaide, Contact, Humboldt Range, Kinkead, Ludwig, Trinity Range, Wellington, etc.

ENSTATITE, $(Mg,Fe)SiO_3$. H. 5$\frac{1}{2}$. G. 3.2–3.5. Orthorhombic.

Luster pearly to vitreous, metalloidal in bronzite variety. Usually massive, fibrous, or lamellar. Color olive-green, greenish white, or brown. Almost infusible, insoluble in hydrochloric acid. Found in basic igneous rocks. A common mineral in metallic and stony meteorites. Associated with serpentine, other pyroxenes, and olivine. Occurs in some Nevada intrusions and lavas. (Also see pyroxene above.)

OLIVINE (*Chrysolite*), $(Mg,Fe)_2SiO_4$. H. 6$\frac{1}{2}$–7. G. 3.3–3.4. Orthorhombic.

Luster vitreous. Conchoidal fracture, brittle. Color green, to pale yellowish green. Soluble in hydrochloric acid yielding gelatinous silica on evaporation. Occurs as grains, masses, or in sands. Found in basic igneous rocks and common in lavas, also with chromite, pyroxene, garnet, and plagioclase. Alters to serpentine. A very common mineral.

ZOISITE and CLINOZOISITE, $HCa_2Al_3Si_3O_{13}$. H. 6–6$\frac{1}{2}$. G. 3.3–3.4. See p. 74.

DUMORTIERITE (basic aluminum borosilicate). H. 7.[15] G. 3.3–3.36. See p. 44.

FLUORITE (*Fluorspar*), CaF_2. H. 4. G. 3.2. Isometric.

Luster vitreous. Brittle. Perfect cleavage. Color blue, greenish blue, white, yellow or brown. Common as cubes or massive, also octahedrons and other forms. Decrepitates in closed tube. Fused with potassium bisulfate gives reaction for fluorine. A very common mineral. Found with many other minerals in veins, with gold, silver, lead, and zinc ores. Also found in contact deposits, igneous rocks, and with limestone or dolomite. Used in the steel industry and for making hydrofluoric acid and enamels. In Nevada at Basalt, Beatty, Broken Hills, Bullfrog, Ely, Manhattan, Osceola, Stillwater Range, Regan, Round Mountain, etc.

APATITE, $Ca_5(Cl,F)(PO_4)_3$. H. 5. G. 3.2. Hexagonal.

Crystals are prismatic-hexagonal. Also occurs columnar and massive. Commonly minute colorless crystals in igneous rocks and in some ores. Luster vitreous or resinous. Brittle. Color usually brown, sea-green, blue-green, or white. Difficultly fusible. Soluble in nitric or hydrochloric acid. On addition of sulphuric acid calcium sulphate (gypsum) is precipitated. Ammonium molybdate precipitates yellow molybdenum phosphate. Upon moistening with sulphuric acid, and placed in the edge of a flame, gives a pale bluish green flame; test for phosphorus. A widely distributed mineral found in igneous and sedimentary rocks, and in metamorphosed limestones, schists, and in some veins. Found in small amount in many places in Nevada.

ACTINOLITE, $Ca_2(Mg,Fe)_5(OH)_2(Si_4O_{11})$. H. 5–6. G. 3–3.2. Monoclinic.

Bladed, radiating, or fibrous crystals. One of the amphiboles. Luster vitreous to pearly. Brittle. Cleavage highly perfect in two directions; at 124 and 56 degrees; differentiation from the pyroxenes. Color light to dark green due to ferrous iron. Tests similar to those for pyroxene. See p. 55. Occurs in metamorphosed rocks. Commonly associated with (and grades into) tremolite, etc. Found in numerous localities in the State.

BIOTITE, $(OH)_2K(Mg,Fe)_3(AlSi_3O_{10})$. H. 2$\frac{1}{2}$–3. G. 2.8–3.2. See p. 64.

ANHYDRITE, $CaSO_4$. H. 3–3$\frac{1}{2}$. G. 2.9–3. Orthorhombic.

Luster pearly, vitreous, or greasy. Brittle. Sky-blue to pale blue, sometimes reddish or gray, also white. Cleavage in three directions at 90°. Occurs in beds with gypsum and rock salt, or sulphur, and frequently associated with calcite. Occasionally in metallic ore deposits. Most of the gypsum deposits grade downward into anhydrite. The gypsum has resulted from the hydration of anhydrite. Of no economic value. Abundant at Arden,

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[15] Fine fibrous masses appear to have a hardness less than quartz.

Gerlach, Hawthorne, Lovelock, Ludwig, Mound House, Yerington, etc.

Muscovite, $(OH)_2KAl_2(AlSi_3O_{10})$. H. 2–2½. G. 2.8–3. See p. 82.

Aragonite, $CaCO_3$. H. 3½–4. G. 2.95. See p. 80.

Dolomite, $CaMg(CO_3)_2$. H. 3½–4. G. 2.8–2.9. See p. 81.

Talc, $H_2Mg_3(SiO_3)_4$. H. 1. G. 2.7–2.8. See p. 83.

Chlorite, $H_8Mg_3Al_3Si_3O_{18}$. H. 2–2½. G. 2.6–2.8. See p. 55.

Turquois (hydrous copper aluminum phosphate). H. 5–6. G. 2.6–2.8. See p. 55.

Plagioclase (sodium, calcium, and aluminum silicates). H. 5–6. G. 2.6–2.76. See p. 76.

Calcite, $CaCO_3$. H. 3. G. 2.7. See p. 81.

Microcline, $KAlSi_3O_8$. H. 6. G. 2.5–2.6. See p. 76. (The green variety of microcline is known as *amazonite.*)

Chrysocolla, $CuSiO_3.2H_2O$ ($Cu = 36.2$ percent). H. 2–4. G. 2–2.4. Cryptocrystalline.

Commonly resembles opal, or turquois, but is usually greener than the latter. Sometimes as black masses due to the inclusion of impurities. Luster vitreous to earthy. Conchoidal fracture. The brown, to black, variety which contains various impurities is called *copper pitch ore.* Soluble in acid. Chrysocolla is a secondary mineral usually found associated with limonite, azurite, linarite, malachite, cuprite, etc., in the upper portions of copper-bearing deposits. It is a very common mineral and a minor ore of copper. Sometimes used as a semi-precious gem. It was once mined for this purpose at Oak Springs and sold as turquois. Found at most all copper mines and many of the gold and silver mines of Nevada. Very abundant at Contact, Oak Springs, Railroad district, and elsewhere.

Brucite, $Mg(OH)_2$. H. 2½. G. 2.4. See p. 84.

Chalcanthite (*Blue Vitriol, Bluestone*), $CuSO_4.5H_2O$ ($Cu = 25.4$ percent). H. 2½. G. 2.1–2.3. Triclinic.

Occurs usually as an incrustation with fibrous structure, or as flat crystals. Luster vitreous. Brittle. Color glassy blue, sometimes greenish. Soluble in water from which it will precipitate copper on iron. Found in mine water and on walls of mine workings. Associated with other oxidation products such as sulphates and oxides. Commonly with melanterite, copiapite, etc. It is a minor ore of copper. Occurs at Comstock Lode, Ely, Majuba Hill, Steamboat Springs, Yerington, and other districts. At one time large quantities of *bluestone* were shipped from the Bluestone mine at Yerington, to the Comstock Lode for use in reduction of the silver ores.

Gypsum, $CaSO_4.2H_2O$. H. 2. G. 2.3. See p. 84.

Serpentine, $H_4Mg_3Si_2O_9$. H. 2–5. G. 2.2. Monoclinic.

Often as pseudomorphs after olivine, pyroxenes, or amphiboles; sometimes micro-crystalline or amorphous. Luster greasy. Fracture splintery or conchoidal. Feels smooth and greasy. Color green, brownish, black, and sometimes nearly white. Fibrous variety may be commercial asbestos if found in sufficient quantity and quality. Gives water in a closed tube. Reacts for silica and magnesium. Usually has some iron as an impurity. Serpentine is a common alteration product of other minerals but is not known to occur in large quantity in Nevada. Found at Candelaria, Eureka, Mina, Key West mine, Paradise Range, Pine Forest Range, Winnemucca, and elsewhere.

Opal, $SiO_2.nH_2O$. H. 5–6. G. 1.9–2.2. See p. 78.

Melanterite, $FeSO_4.7H_2O$. H. 2. G. 1.9. Monoclinic.

Usually capillary, fibrous, also massive. Color green to white. Luster vitreous. Perfect basal cleavage. Brittle. Easily fusible in a match flame. Easily soluble in water. Tastes sweetish, astringent, and metallic. Very common in mine workings or in mineral deposits where pyrite or marcasite are present. Occurs at Coaldale, Comstock Lode, Gold Acres, Goldfield, Peavine Mountain, Pyramid Lake, and many other localities in Nevada.

Halite, $NaCl$. H. 2½. G. 2.16. See p. 84.

C. RED, BROWN, AND YELLOW MINERALS

Vanadinite, $Pb_5Cl(VO_4)_3$. H. 3. G. 6.7–7.2. See p. 60. (A drop of concentrated hydrochloric acid produces a deep brown coloration indicating vanadium.)

Cassiterite, SnO_2. H. 6–7. G. 6.8–7.1. See p. 42.

Pyromorphite, $Pb_5Cl(PO_4)_3$. H. 3½–4. G. 6.5–7.1. See p. 60.

Wulfenite, $PbMoO_4$ ($MoO_3 = 39.3$, and $PbO = 60.7$ percent). H. 3. G. 6.7–7. Tetragonal.

Thin square or tabular crystals; sometimes very thin but usually fairly thick. Also massive. Luster resinous to adamantine. Color yellow, green, brown, red, to very pale yellow. Fuses easily giving a coating of yellow lead oxide on charcoal. Fused with soda yields a bead of metallic lead. Decomposed upon evaporation with hydrochloric acid. If the residue is moistened with water, and metallic zinc added, the solution assumes a blue color which does not fade. If a drop of strong hydrochloric acid is applied to the mineral, and then rubbed with iron, a blue color forms. These tests are applicable to any oxidized molybdenum mineral. Occurs as a secondary mineral in oxidized lead and zinc ores, together with cerussite, anglesite, limonite, etc. Occurs at Eureka, Round Mountain, Searchlight, Tecoma, Tonopah, etc. Excellent crystals have been found at Eureka, and also in the Lucin district in Elko County.

Cerussite, $PbCO_3$. H. 3–3½. G. 6.5–6.6. See p. 79.

Scheelite, $CaWO_4$ ($WO_3 = 80.6$ percent). H. 4½–5. G. 6. Tetragonal.

Luster vitreous. Brittle. Color white, pale yellow, brownish, green, and reddish. If well crystallized may show square pyramids. Soluble in hydrochloric acid leaving a yellow powder which is soluble in ammonia. The solution gives a calcium test; white precipitate with ammonium oxalate. Acid solution when boiled with tin assumes a deep blue color, later changing to brown. Occurs in contact zones, veins, and pegmatites, often associated with wolframite, powellite, garnet, and epidote. Molybdenum is usually present in small amounts. Powellite may be present and is frequently mistaken for scheelite due to its similar fluorescence under ultra-violet light. In Nevada there are good crystals at Oak Springs, Osgood Mountains, Nightingale district, and in the Snake Range. The principal production comes from the Eugene Mountains near Mill City and from the Snake Range. It is found in numerous localities throughout the State. At present (1941) Nevada is the leading producer of tungsten in North America.

Cerargyrite, AgCl. H. 1–1½. G. 5.55. See p. 56. (Turns very dark upon long exposure to sunlight.)

Embolite, Ag(Br,Cl). H. 1–1½. G. 5.3–5.4. See p. 64.

Stibiconite, $Sb''Sb^{v}_2O_8.H_2O$ (Sb about 75 percent). H. 4–5. G. 5.2. Amorphous.

Stibiconite occurs as an alteration product of stibnite. May be massive or as a coating, often pseudomorphous after stibnite. Color is pale yellow to yellowish gray. It is infusible and is insoluble in hydrochloric acid. Associated with stibnite, also with cervantite and other antimony oxides. In some localities it is an inconspicuous, but valuable, ore of antimony. It has been found in many places: Battle Mountain, Chalk Mountain, Empire district, Humboldt Range, Manhattan, south end of the Pinenut Range, and in the Virginia Range northeast of Reno.

Barite, $BaSO_4$. H. 2½–3½. G. 4.3–4.6. See p. 79.

Garnet, $R''_3R'''_2(SiO_4)_3$. H. 6½–7½. G. 3.5–4.3. See p. 43.

Sphalerite, ZnS. H. 3½–4. G. 3.9–4.1. See p. 61. (Resinous luster. Perfect cleavage; streak lighter than the mineral.)

Siderite, $FeCO_3$. H. 3½–4. G. 3.8–3.9. Hexagonal.

Commonly in rhombohedrons with curved faces, also granular, and massive. Luster vitreous. Prominent rhombohedral cleavage. Brittle. Color brown, yellow, or sometimes black. Light brown to colorless streak. Decrepitates, turns black, and becomes magnetic on heating in a closed tube. Soluble in hot hydrochloric acid. Occurs in sedimentary deposits or in veins with rhodochrosite, pyrite, chalcopyrite, galena, etc. Found in the Augusta Mountains, also at Klondike, Steptoe, and as a minor constituent in gold and silver deposits.

Kyanite, Al_2SiO_5. H. 5 and 7. G. 3.6–3.7. See p. 65.

Rhodonite, $MnSiO_3$ ($MnO = 54.1$ percent). H. 5½–6. G. 3.6–3.7. Triclinic.

May show rough tabular crystals but is usually massive to compact. Cleavage is distinct in two directions at 92½°. Very tough when compact. Conchoidal fracture. Color in various shades of pink and red; commonly coated with black manganese oxides due to alteration. May contain some iron and calcium. Commonly occurs in high temperature veins and frequently associated with rhodochrosite and manganese oxides. Fuses to a dark glass. The finely-ground material is slightly attacked by hydrochloric acid leaving a colorless residue. Gives manganese beads with soda or borax. Rhodonite is distinguished from rhodochrosite by its greater hardness and specific gravity and by its reaction to acids; from pink feldspars by its high specific gravity. Found in many mines in the State and is particularly abundant at Charleston and in the mountains south of Golconda, where it is associated with manganese oxides.

Rhodochrosite, $MnCO_3$. ($MnO = 67.1$ percent). H. 4. G. 3.5–3.6. Hexagonal-rhombohedral.

Occurs in rhombic crystals or in fine, to coarse-grained, cleavable masses, also botryoidal or in fine grains. Luster is vitreous, sometimes pearly. Color pink, red, brownish red, or reddish gray. Streak is white. Iron and calcium may be present in considerable amounts. Common as a gangue mineral in many silver mines.

Soluble in hot hydrochloric acid with effervescence. Infusible before the blowpipe. Gives a violet bead with borax and a greenish blue bead with soda. Distinguished from rhodonite by its inferior hardness, rhombohedral cleavage, and solubility in acids. Found as a vein mineral at Austin, Betty O'Neil, Eureka, Fairview, Hilltop, Peavine, Pioche, Silver City, Tonopah, and other mining districts.

Sphene (*Titanite*), $CaTiSiO_5$. H. 5–5½. G. 3.4–3.6. Monoclinic.

Crystals often flat, wedge-shaped, tabular, also occurs massive. Luster adamantine to resinous. Color brown, gray, yellow, green, red, and also black. Fuses to a brown or black glass. Slightly soluble in hot hydrochloric acid. If tin is added to the hydrochloric acid solution a fine violet color is produced. Sodium phosphate bead is violet in the reducing flame. Completely soluble in sulphuric acid. Found in crystalline limestones and schists, also in igneous rocks and pegmatites. Associated with pyroxene, amphibole, chlorite, rutile, smoky quartz, etc. It is a common accessory rock-forming mineral. In minor amounts in most granular rocks. Good crystals have been found in the pegmatites of Granite Mountain, about twenty miles north of Reno.

Pyroxene, $RSiO_3$. H. 5–6. G. 3.2–3.6. See p. 55.

Hemimorphite, $(ZnOH)_2.SiO_3$. H. 4½–5. G. 3.4–3.5. See p. 74. (Pale yellow to brown masses with colorless crystals showing.)

Epidote (complex Ca, Al, Fe, silicate). H. 6–7. G. 3.3–3.5. See p. 65.

Idocrase, $Ca_6Al_3(OH,F)(SiO_4)_6$. H. 6½. G. 3.3–3.5. See p. 66.

Enstatite, $(Mg,Fe)SiO_3$. H. 5½. G. 3.2–3.5. See p. 66.

Zoisite and Clinozoisite, $Ca_2Al_3(OH)(SiO_4)_3$. H. 6–6½. G. 3.2–3.4. See p. 74.

Axinite, $H(Ca,Mn,Fe)_3Al_2B(SiO_4)_4$. H. 6½–7. G. 3.3. Triclinic.

Crystals are of variable habit but are usually broad with acutely beveled edges. The color is brown, plum-blue, pearl-gray, honey-yellow, to greenish yellow. Highly vitreous luster. Colorless streak. Axinite is brittle and has a conchoidal fracture. It is easily fusible to a dark green to black, glass. Gives a green (boron) flame. Insoluble in acid. Occurs in cavities in granite and other intrusive rocks, also in contact-metamorphic zones. Associated with other contact minerals. Found near Contact, Ludwig, Luning, Stillwater Range, and in other localities.

Fluorite, CaF_2. H. 4. G. 3.2. See p. 66.

Apatite, $Ca_5(Cl,F)(PO_4)_3$. H. 5. G. 3.2. See p. 67.

Anhydrite, $CaSO_4$. H. 3–3½. G. 2.9–3. See p. 67.

Muscovite, $(OH)_2KAl_2(AlSi_3O_{10})$. H. 2–2½. G. 2.8–3. See p. 82. (Yellowish to white mica, sometimes in masses or scales. Cleaves into thin elastic plates.)

Aragonite, $CaCO_3$. H. 3½–4. G. 2.95. See p. 80.

Dolomite, $CaMg(CO_3)_2$. H. 3½–4. G. 2.8–2.9. See p. 81.

Phlogopite, $(OH)_2KMg_3(AlSi_3O_{10})$. H. 2½–3. G. 2.9. Monoclinic.

Crystals with six-sided outline. Thin laminae are tough and elastic. Pearly luster, often submetallic on cleavage surface. Perfect cleavage and micaceous. One of the less common micas.

Alunite, $KAl_3(OH)_6(SO_4)_2$. H. 3½–4. G. 2.6–2.8. See p. 81.

Calcite, $CaCO_3$. H. 3. G. 2.7. See p. 81.

Microcline, $KAlSi_3O_8$. H. 6. G. 2.6. See p. 76.

Orthoclase, $KAlSi_3O_8$. H. 6. G. 2.6. See p. 77.

Kaolinite, $H_4Al_2Si_2O_9$. H. 2–2½. G. 2.6. See p. 83.

Zeolites (hydrous silicates of Na, Ca, and Al). H. 3½–5. G. 2–2.4. See p. 77.

Gypsum, $CaSO_4.2H_2O$. H. 2. G. 2.3. See p. 84.

Soda Niter, $NaNO_3$. H. 1½–2. G. 2.2–2.3. See p. 85.

Serpentine, $H_4Mg_3Si_2O_9$. H. 2–5. G. 2.2. See p. 69.

Opal, $SiO_2.nH_2O$. H. 5–6. G. 1.9–2.2. See p. 78.

Halite, NaCl. H. 2½. G. 2.16. See p. 84.

Sulphur, S. H. 1½–2½. G. 2–2.1. See p. 63.

III. Colorless, White, or Gray Minerals Giving Colorless Streaks

A. MINERALS ABOVE 4 IN HARDNESS

Scheelite, $CaWO_4$. H. 4½–5. G. 6. See p. 70.

Stibiconite, $Sb''Sb^{v}_2O_8.H_2O$. H. 4–5. G. 5.2. See p. 70.

Smithsonite, $ZnCO_3$ ($Zn = 61.4$ percent). H. 5. G. 4.4. Hexagonal.

Luster vitreous. Brittle. Color white, greenish, grayish, sometimes blue or brown. Decrepitates on heating. Effervescence in acid indicates presence of carbon dioxide. Gives zinc test. A secondary mineral found in veins and also in beds of calcareous rocks. Associated with hemimorphite, calcite, and limonite, in lead and zinc ores. In Nevada at Candelaria, Eureka, Goodsprings, Grand Deposit mine, and in numerous other zinc ores.

Garnet, $R''_3R'''_2(SiO_4)_3$. H. 6½–7½. G. 3.5–4.3. See p. 43.

Kyanite, H. 5 and 7. G. 3.6–3.7. See p. 65. (A hardness of 5 lengthwise, and 7 crosswise of the crystal, is typical.)

Rhodonite, $MnSiO_3$. H. 5½–6½. G. 3.6–3.7. See p. 71.

Hemimorphite (*Calamine*), $(ZnOH)_2SiO_3$ ($Zn = 61.8$ percent). H. 4½–5. G. 3.4–3.5. Orthorhombic.

Crystals often tabular or prismatic, sometimes stalactitic or fibrous. May occur as drusy surfaces in cavities. Luster vitreous to sub-adamantine. Colorless, white, sometimes bluish, brownish, or yellowish. Perfect cleavage and brittle. Strongly pyroelectric. In a closed tube decrepitates, whitens, and gives off water. Very difficultly fusible. On charcoal, with soda, gives a coating that is yellow when hot but becomes white upon cooling. If the coating is moistened with cobalt nitrate solution and heated in the oxidizing flame, it will turn green (indicating the presence of zinc). Gelatinizes upon solution with acid. Occurs with smithsonite, jarosite, etc., in veins or other deposits containing zinc. It has been found at Candelaria, Cortez, Eureka, Gass Peak, Goodsprings, Grand Deposit mine, and elsewhere. Hemimorphite is a common secondary mineral in many zinc-bearing deposits.

Zoisite and **Clinozoisite**, $Ca_2Al_3(OH)(SiO_4)_3$. H. 6–6½. G. 3.2–3.4. Orthorhombic and monoclinic.

Zoisite and clinozoisite are minerals of the same composition. The former is orthorhombic and the latter is monoclinic. Either may contain some iron. Their modes of occurrence are similar. In columnar or embedded crystals and as granular masses. The color of zoisite is white, gray, yellowish-brown, red, and green; clinozoisite is gray, yellowish-brown, and greenish. *Thulite* is a pink to red, manganiferous variety. Luster is vitreous. One perfect cleavage parallel to the length of the crystal. Zoisite is insoluble in hydrochloric acid while clinozoisite is but slightly attacked. Either is fusible with intumescence to a clear, or brown, glass which is soluble in hydrochloric acid with the formation of gelatinous silica. Clinozoisite is more common than zoisite but microscopic tests are necessary to discriminate between them. Distinguished from epidote by the color, and from tremolite by the 56° cleavage of the latter. Common in metamorphic rocks and as a hydrothermal alteration product; particularly in rocks rich in calcium. Found at Contact, Nightingale, in the Humboldt Range near Oreana, Ludwig, Peavine Mountain, Toy, Wellington, Yerington, etc. Excellent crystals of clinozoisite occur at Nightingale.

Diopside, $CaMg(SiO_3)_2$. H. 5–6. G. 3.2–3.4. See p. 65. (One of the pyroxene group.)

Tremolite (an amphibole), $CaMg_3(SiO_3)_4$. H. 5–6. G. 2.9–3.4. Monoclinic.

Tremolite is white to dark gray in distinct bladed or fibrous crystals. Luster silky or glassy. Grades into actinolite. A contact metamorphic mineral found at Copper Basin, Contact, Dolly Varden, Quartz Mountain, Railroad district, Yerington, and elsewhere. Very common in Nevada. See also p. 67.

Axinite (a boro-silicate of Al and Ca). H. 6½–7. G. 3.3 See p. 72.

Enstatite, $(Mg,Fe)SiO_3$. H. 5½. G. 3.1–3.5. See p. 66. (Commonly olive-green to pale green in lamellar to fibrous masses. One of the pyroxene group.)

Apatite, $Ca_5(Cl,F)(PO_4)_3$. H. 5. G. 3.2. See p. 67.

Fluorite, CaF_2. H. 4. G. 3.2. See p. 66. (Occurs as cubes and octahedrons with good cleavage in four directions. May be white, green, blue, yellowish, or brownish. Color may vary in the same specimen.)

Magnesite, $MgCO_3$ ($MgO = 47.6$ percent). H. 3½–4½. G. 3–3.2. Hexagonal-rhombohedral.

Crystals are rare, usually rhombohedral but also prismatic. May be massive or earthy, very compact, or granular and cleavable. Perfect rhombohedral cleavage. Flat conchoidal fracture on some varieties. Brittle. Vitreous luster, sometimes silky in fibrous varieties. Color white, yellowish, grayish white, or brown. May contain small quantities of iron carbonate; frequently with impurities of various kinds. Occurs as an alteration product of serpentine, in bedded sedimentary deposits, and in deposits due to hydrothermal replacement. Slightly soluble in cold acid but quite readily in warm hydrochloric acid. Solution gives little or no test for calcium but strong reaction for magnesia. No deposits are known in Nevada resulting from the alteration of serpentine. Sedimentary magnesite occurs in the Muddy Valley district in Clark County and large high-grade magnesite deposits, associated with brucite, were formed through hydrothermal activity on the dolomites of the Paradise Range. This magnesite is being used for the production of magnesium metal. Other deposits are known in the State.

WOLLASTONITE, $CaSiO_3$. H. 5–5½. G. 2.8–2.9. Monoclinic.

Crystals are tabular, sometimes fibrous and divergent; also in compact masses. Luster vitreous. Perfect cleavage. Brittle. Color white, gray, yellowish, and brown. Fuses quietly to a white enamel. With hydrochloric acid decomposes with separation of silica. Most varieties effervesce due to the presence of calcite. Occurs chiefly as a contact mineral in crystalline limestone. Forms at comparatively low temperature; lower than pyroxenes and amphiboles. Associated with calcite, garnet, diopside, etc. A common mineral in contact-metamorphosed limestones. Very abundant at the Getchell mine and near Gerlach.

FELDSPAR. H. 6–6½. G. 2.6–2.8. Monoclinic and Triclinic. (See microcline, orthoclase, and plagioclase.)

PLAGIOCLASE, $n(NaAlSi_3O_8).m(CaAl_2Si_2O_8)$. H. 6–6½. G. 2.6–2.76. Triclinic.

Plagioclase feldspars range from albite, nearly pure $NaAlSi_3O_8$, to anorthite, pure $CaAl_2Si_2O_8$. Intermediate varieties consist of a combination of these two molecules. As prismatic or tabular crystals, sometimes massive. Luster vitreous. Brittle. Two good cleavages, nearly at right angles. Usually shows striations (fine parallel lines) on the best cleavage face. Color gray, white, or greenish. Difficultly fusible; insoluble. Gives reactions for calcium and aluminum. Sodium flame (persistent yellow) and calcium flame (reddish yellow). Occurs in igneous rocks, in well-formed crystals (phenocrysts) in lavas, also in gneisses, and metamorphic rocks; with pyroxene, amphibole, orthoclase, mica, quartz, etc. Very plentiful in some pegmatites. The most abundant igneous rock-forming mineral.

MICROCLINE, $KAlSi_3O_8$. H. 6. G. 2.5–2.6. Triclinic.

In crystals in igneous rocks, pegmatites, etc. Luster vitreous, perfect cleavage in two directions, nearly at right angles, brittle. Color white, reddish, and greenish. Resembles orthoclase, from which it can be distinguished by very fine microcline twinning on the best cleavage face; in some cases only by microscopic study. Gives same chemical tests as orthoclase. Present with other feldspars in pegmatites together with quartz, beryl, mica, and many other minerals. A very common rock-forming mineral and particularly characteristic of pegmatites. Good crystals come from Clear Creek south of Carson City, Granite Mountain north of Reno, the Ruby Range, and in many other pegmatite areas of the State. *Amazonite* is a green variety.

ORTHOCLASE, $KAlSi_3O_8$. H. 6. G. 2.6. Monoclinic.

Usually in well-formed crystals or shapeless masses. Luster vitreous to pearly. One perfect cleavage and a good cleavage at right angles to the first. Color flesh-red, pink, pale yellow, gray, or clear and colorless. Sanadine, a clear glassy variety of potash feldspar, is common in rhyolites and quartz latites. Another potash feldspar, adularia, is a common vein material. Some sodium is commonly present. Powdered material, mixed with gypsum, and heated on a clean platinum wire gives a violet (potassium) flame. Heated strongly, but without fusion, with a drop of cobalt nitrate the mineral assumes a fine blue color indicating the presence of aluminum. Found in igneous and metamorphic rocks and in pegmatites. Usually associated with quartz, other feldspars, mica, pyroxene, amphibole, etc. Orthoclase is a very common mineral, especially in igneous rocks.

COLEMANITE, $Ca_2B_6O_{11}.5H_2O$. H. 4–4½. G. 2.42. Monoclinic.

Crystals are usually short prismatic with a highly-perfect cleavage and another that is distinct. May also be massive, granular, or compact. Luster is brilliant vitreous to adamantine. Colorless to yellowish white, milky white, and gray. Soluble in hot hydrochloric acid with the separation of boric acid upon cooling of the solution. When heated it exfoliates and decrepitates. Fuses imperfectly, giving a yellowish green flame (indicating borax). Occurs in beds of sedimentary rocks in white compact to chalk-like masses with gypsum, and usually with other borax minerals. Once the principal source of commercial borax. There are large deposits at White Basin and Callville Wash in the Muddy Mountains of Clark County.

ZEOLITES (Na, Ca, Al, hydrous silicates with K, Sr, Ba, etc.). H. 3–5½. G. 2–2.4.

The zeolites are hydrous silicates which are closely related in composition and in their conditions of formation. They crystallize in various crystal systems, but are frequently monoclinic. Frequently in beautiful and attractive crystal masses in cavities and seams, in andesites and basalts. Some of the finest specimens in many collections are zeolites. A characteristic of some of the more common species is their intumescence, or boiling, when strongly heated. They are rather readily decomposed by boiling acid, commonly with the separation of gelatinous silica. The specific identification of the various zeolites is frequently quite difficult. Advanced texts on mineralogy should be consulted. The zeolites usually form in groups of well crystallized white, pink, colorless, gray, or brown crystals which are usually radiating, acicular, or flattened in form. Two or more species are generally found together. The luster is commonly vitreous, sometimes pearly. The zeolites are of widespread distribution. Found near Bristol Silver in Lincoln County, in the Comstock district (in the Gould and Curry, Solid Silver, Union, and Yellow Jacket mines, also at the Sugar Loaf and in the canyon leading south from the Sugar Loaf), in andesite at Fulton's quarry north of Reno, Miners Canyon in the Truckee Range, Mount Airy, Muddy Mountains, Nightingale tungsten deposits, Lime Kiln Canyon south of Carson City, Pilot Mountains, Whiskey Flat, northern Washoe County, and other localities.

OPAL, $SiO_2.nH_2O$. H. 5–6. G. 2.1–2.2. Amorphous.

Opal is a mineral gel, common in deposits from hot springs, and may also be deposited from ground waters. Never crystalline. Vitreous luster. Conchoidal fracture. Colors white to brown and may exhibit a play of colors. Yields water upon intense heating but is infusible, being rendered opaque. This distinguishes opal from some volcanic glasses which will partially fuse. Soluble in caustic alkalies. The variety *hyalite*, in glassy-clear crusts, is often found in vesicles, or coating seams, in basalts and andesites; it is less soluble. Opal is found in cavities and veinlets in either igneous, sedimentary, or metamorphic rocks. Replaces altered rocks, wood, bone, and other material. Excellent precious opal is found in Virgin Valley in Humboldt County, in the Trinity Range west of Lovelock, and near Nigger Wells in Churchill County, also in other localities. Silicified wood, mostly opal, is found in every county in the State. Common opal is very abundant as silicified wood, rock replacement, opalite, siliceous sinter, diatomite, etc. An 18-ounce black opal, found in Virgin Valley, is valued at $250,000 and is now in the United States National Museum.

B. MINERALS FROM 3 TO 4 IN HARDNESS

SILVER, Ag. H. 2½–3. G. 10.5. See p. 56.

PYROMORPHITE, $Pb_5Cl(PO_4)_3$. H. 3½–4. G. 6.5–7.1. See p. 60.

WULFENITE, $PbMoO_4$. H. 3. G. 6.7–7. See p. 69. (Usually in thin tetragonal plates from pale yellow to deep orange.)

CERUSSITE, $PbCO_3$ (Pb = 77.5 percent). H. 3–3½. G. 6.5–6.6. Orthorhombic.

Usually massive or in clusters of crystals. Crystals are tabular, prismatic, and sometimes pyramidal. Also occurs granular, massive, compact, or earthy. Has distinct cleavage and conchoidal fracture. Brittle. Color white, gray, or brownish. Luster adamantine to pearly. Heated in a closed tube turns yellow, then red, and back to yellow upon cooling; also decrepitates. Reduces easily to metallic lead. Differs from anglesite by being easily soluble in nitric acid with effervescence. On the addition of a soluble chloride to the solution, white lead chloride is formed. The precipitate is soluble in a hot solution but precipitates upon cooling. Cerussite is one of the common lead minerals in the upper portions of lead-bearing deposits. It usually occurs with galena, also with anglesite, pyromorphite, and other alteration products. Abundant at Eureka and Goodsprings, also found at Jersey Valley, Montezuma, Oak Springs, Searchlight, Wedekind, and many other districts.

ANGLESITE, $PbSO_4$ (Pb = 68.3 percent). H. 3. G. 6.2–6.4. Orthorhombic.

Crystals are prismatic or tabular. Also granular, massive, compact, or nodular. Luster highly adamantine, vitreous, or resinous. Very brittle. Conchoidal fracture, and distinct but interrupted cleavage. Color white, yellowish, gray, greenish, or bluish. Decrepitates and fuses in a candle flame, to a clear pearly bead. Upon cooling the bead becomes milk white. In the reducing flame it effervesces and gives a globule of metallic lead. Dissolves in nitric acid with difficulty, whereas cerussite dissolves readily with effervescence. Anglesite is a common mineral in oxidized lead ores where it is associated with cerussite, limonite, and other oxidation products. Common at Eureka, Galena, Goodsprings, Leadville, Tecoma, Wedekind, and in other lead-bearing localities.

BARITE (*Heavy Spar*), $BaSO_4$. H. 2½–3½. G. 4.3–4.6. Orthorhombic.

Tabular crystals showing a prominent cleavage; also fibrous, lamellar, granular, or massive. Luster vitreous. Brittle. Perfect cleavage in two directions, also an irregular fracture. Color white to yellowish, gray, blue, red, and brown. Gives a yellowish green flame of barium. When fused with sodium carbonate and charcoal and placed on a silver coin, will give a brown stain upon moistening; indicating the presence of sulphur. Insoluble in acids. Occurs in beds, pockets, and crystal groups. Found in many places in Nevada, especially in veins and as replacements of limestones. Produced in commercial quantities at Carson City, Battle Mountain, Cherry Creek, Eagleville, Hawthorne, Lone Mountain, Palisade, etc.

POWELLITE, $Ca(Mo,W)O_4$. H. 3½. G. 4.35. Tetragonal.

In minute, pale greenish yellow, tetragonal pyramids; also as thin coatings. Brittle. Usually rather inconspicuous. Formed through the oxidation of molybdenite and is also associated with scheelite. Until recently, powellite has been considered a rare mineral, however, its frequent association with scheelite has led to its detection in numerous places in the State. In many Nevada occurrences it has, because of its fluorescence in ultraviolet light, been confused with scheelite. When moistened with strong hydrochloric acid and rubbed with iron it gives a deep blue color (molybdenum). Found at Divide in fine large crystals. In contact metamorphic deposits with scheelite at Tungsten near Mill City, Luning, Nightingale, Oak Springs, Sonoma Range, Sweetwater, White Mountains, White Pine district, and in many other localities.

CELESTITE, $SrSO_4$. H. 3–3½. G. 4. Orthorhombic.

Crystals are tabular to prismatic resembling those of barite, also granular or fibrous. Luster vitreous to pearly. Color white to bluish. Insoluble in acids. Gives an intensely red flame of strontium. When fused with soda and placed on a moistened silver coin gives a brown stain; indication of sulphur. Associated with quartz, sphalerite, galena, halite, etc. Found replacing limestone, in bedded deposits, and also in ore veins. Found at Sloan in Clark County and elsewhere.

FLUORITE, CaF_2. H. 4. G. 3.2. See p. 66.

MAGNESITE, $MgCO_3$. H. 3½–4½. G. 3–3.2. See p. 75.

ANHYDRITE, $CaSO_4$. H. 3–3½. G. 2.9–3. See p. 67.

ARAGONITE, $CaCO_3$. H. 3½–4. G. 2.95. Orthorhombic.

Crystals are commonly pyramidal and often acicular. Sometimes twinned so as to give pseudo-hexagonal forms. Also globular, columnar, stalactitic, or incrusting. Frequently in radiating clusters. Luster vitreous to resinous. Distinct cleavage and subconchoidal fracture. Brittle. Color white, also gray, yellow, greenish, or with a violet tinge. Effervesces in cold hydrochloric acid and gives strong test for calcium. May contain strontium. Distinguished from calcite by lack of rhombohedral cleavage, and by the resinous luster on fracture surfaces. When immersed in cobalt nitrate solution the powder turns *lilac* which persists upon boiling. Calcite treated in the same manner remains uncolored or becomes *blue* only after prolonged boiling. Occurs in hot spring deposits, in veins, and in solution caverns in limestones. Associated with gypsum, calcite, limonite, etc. *Thinolite,* a crystalline variety of tufa, is abundant about the shores of Pyramid Lake and consists of paramorphs of calcite after aragonite. Present at Bristol, Eureka, Grand Deposit mine, in fine crystals at Leadville, and at Weepah, etc.

DOLOMITE, $CaMg(CO_3)_2$. H. 3½–4. G. 2.8–2.9. Hexagonal-rhombohedral.

Curved rhombohedral crystals, "saddle-shaped" twins, and massive. Lusty pearly to vitreous. Brittle. Color white, pink, reddish, greenish, brown, and black. Perfect rhombohedral cleavage. Slowly soluble in dilute, readily in hot, acid with effervescence. Gives magnesia test and frequently contains some iron. If dissolved in hydrochloric acid, rendered alkaline with ammonia, and ammonium oxalate added, a precipitate of calcium oxalate will form. If the precipitate is filtered off and ammonium phosphate added, a precipitate of magnesia phosphate results. Decrepitates upon heating and crumbles to a white powder. Occurs in veins and in sedimentary beds. Frequently formed through the dolomitization of limestones. A common mineral associated with calcite, etc., in ore veins.

ALUNITE (*Alumstone*), $KAl_3(OH)_6(SO_4)_2$. ($K_2O = 11.4$ per-cent). H. 3½–4. G. 2.6–2.8. Hexagonal-rhombohedral.

Occurs as small rhombohedrons resembling cubes, but usually massive with fibrous, granular, or powdery texture. Color white, gray, or reddish. Fracture is conchoidal, splintery, or earthy. Commonly as veins or disseminated through rock masses. Gives potash flame and, after roasting, water-soluble alum. Difficultly soluble in sulphuric acid. A possible source of potash and alumina. Soda may replace part of the potash and, when present in large amount, the mineral natroalunite results. Widespread in the altered lavas of Nevada, especially in the vicinity of epithermal veins, as at Alunite, Beatty, Bovard, Bullfrog, Cactus Springs, Cuprite, Goldfield, Steamboat Springs, Sulphur, and in other districts.

CALCITE, $CaCO_3$. H. 3. G. 2.7. Hexagonal-rhombohedral.

Crystals are rhombohedrons, scalenohedrons, and a variety of other forms. Also fibrous, compact, lamellar, granular, earthy, or massive. Highly perfect rhombohedral cleavage. Clear cleavage rhombs show strong double refraction giving double images of objects viewed through it. Vitreous luster. Color white to colorless, gray, blue, or yellow. Often reddish from iron oxides, and occasionally black. Readily soluble in cold dilute acid with effervescence. Gives test for calcium as oxalate and strong calcium flame. The transparent variety, *Iceland spar,* is used in optical instruments. Found in large masses as limestone, spring deposits, and as tufa domes and crags. Widely distributed and common in veins. About the shores of ancient Lake Lahontan there are large masses of calcite, as paramorhps after aragonite, in the crystalline variety of tufa known as *thinolite,* as massive tufa, and as a cement in Quaternary conglomerates.

ZEOLITES (hydrous silicates of Na, Ca, and Al). H. 3–5½. G. 2–2.4. See p. 77.

TRONA, $2Na_2O.4CO_3.5H_2O$. H. 3. G. 2.13. See p. 85.

C. MINERALS LESS THAN 3 IN HARDNESS

SILVER, Ag. H. 2½–3. G. 10.5. See p. 56.

ANGLESITE, $PbSO_4$. H. 3. G. 6.2–6.4. See p. 79.

CERARGYRITE, AgCl. H. 1–1½. G. 5.55. See p. 56.

BARITE, $BaSO_4$. H. 2½–3½. G. 4.3–4.6. See p. 79. (Barite is sometimes fairly soft. Common in many veins and replacement deposits.)

ALUNITE, $KAl_3(OH)_6(SO_4)_2$. H. 3½–4. G. 2.6–2.8. See p. 81. (Alunite may be powdery and then appears softer than indicated above.)

CELESTITE, $SrSO_4$. H. 3–3½. G. 4. See p. 80.

MUSCOVITE, $(OH)_2KAl_2(AlSi_3O_{10})$. H. 2–2½. G. 2.8–3. Monoclinic.

Crystals may be rhombic or hexagonal in outline. Perfect cleavage, separates into thin sheets which are flexible and elastic. Harsh feel although some varieties feel talc-like. The luster is vitreous. Muscovite is colorless to gray, light brown, pale green, yellow, or red. Insoluble in acids. Gives water in closed tube. Fuses on thin edges to gray or yellow glass. *Sericite* is fine scaly muscovite, in fibrous aggregates with a silky luster; frequently soft and talc-like. A common constituent of acid igneous, and metamorphic rocks. Abundant in some pegmatites. Found in pegmatites in the Ruby Range and also in southeastern Nevada. Rose-colored muscovite has been found in the Ruby Range.

ANHYDRITE, $CaSO_4$. H. 3–3½. G. 2.9–3. See p. 67.

TALC, $H_2Mg_3(SiO_3)_4$. H. 1. G. 2.7–2.8. Monoclinic.

Usually foliated massive, granular massive, in stellated groups, or compact. Thin laminae flexible but not elastic. Sectile. Perfect cleavage. Luster pearly on cleavage face. Feels greasy. Color green, to white or gray. Difficultly fusible but whitens and exfoliates. Ignited, after moistening with cobalt nitrate solution, becomes pale red (indicating magnesia). A common mineral found with serpentine, dolomite, magnesite, actinolite, etc. Mined at Palmetto Canyon in Esmeralda County.

THENARDITE, Na_2SO_4. H. 2½. G. 2.7. Orthorhombic.

Usually in well-formed crystals of pyramidal habit; also short prismatic or tabular; sometimes twinned. May form as incrustations. Luster vitreous. One perfect cleavage; basal. Colorless to gray, or pale brown. Readily soluble in water. Easily fusible, giving a strong yellow (sodium) flame. Gives sulphate precipitate with barium chloride from acid solutions. The occurrence and crystals are distinctive. Thenardite is the common source of natural sodium sulphate. Common in lakes, marshes, and playas of desert regions. Associated with mirabilite, halite, glauberite, gaylussite, borax, etc. Found in many localities. Occurs at Buena Vista Valley, Buffalo Salt Marsh, Double Springs Marsh, Humboldt Lake, Railroad Valley, Rhodes Marsh, Wabuska, etc. Rhodes Marsh is a noted locality.

ASBESTOS. See serpentine, p. 69.

Common commercial asbestos is usually chrysotile, a fibrous variety of serpentine. Fibrous amphiboles are also known as asbestos, but amphibole asbestos is less valuable than the serpentine variety. Not found in commercial quantities in Nevada. Found in small amounts in many localities.

KAOLINITE, $H_4Al_2Si_2O_9$. H. 2–2½. G. 2.6. Monoclinic.

Usually as compact or earthy masses but sometimes in crystalline scales. Luster pearly to dull. Color white, grayish white, yellowish, sometimes brownish, bluish or reddish. Unctuous feel, plastic when wet. Gives water on intense heating. Infusible with the blowpipe. Insoluble in acids. Ignited, after moisteing with cobalt solution, becomes blue; indication of aluminum. Can be distinguished from other clay minerals only by microscopic or other tests. Occurs as sedimentary deposits, altered rocks, also in minor quantity in ore veins. Found in small quantities in many places. Deposits at Bare Mountain, Eureka, Jarbidge, Table Mountain, etc.

HALITE (*Rock Salt*), NaCl. H. 2½. G. 2.16. Isometric.

Crystals are commonly cubes; sometimes with hopper-like depressions on the faces. Luster vitreous. Perfect cubic cleavage and conchoidal fracture. Colorless, white, reddish, and bluish. Dissolves readily in water and gives white, curdly precipitate of silver chloride upon the addition of silver nitrate. Tastes salty. Readily fusible and gives a strong yellow (sodium) flame. Found in lake water, in sediments, and in playa deposits. Associated with gypsum, anhydrite, sulphur, and especially with other soluble salts. Abundant in Butterfield Marsh, Columbus Marsh, Diamond Valley, Dixie Valley, Eagle Salt Marsh, Leete Salt Flat, Rhodes Marsh, Virgin River, and in many other localities. From each of the above-mentioned places salt has been produced in commercial quantities. The deposit on Virgin River, now partly submerged under the waters of Lake Mead, was worked in prehistoric times by Indians. It is one of the earliest mineral deposits of Nevada to be mentioned in the literature, being referred to by John C. Fremont in 1845.

BRUCITE, $Mg(OH)_2$ ($MgO = 69$ percent). H. 2½. G. 2.4. Hexagonal.

Crystals are usually broad and tabular. May be foliated, granular, massive, or fibrous. The fibers are flexible. Sectile. Good basal cleavage, similar to that of the micas. Strong pearly luster on the cleavage faces. Colorless, white, grayish, bluish, or greenish. Sometimes quite green when in crystals. Infusible before the blowpipe but glows with a bright light. Soluble in acid. Gives water in a closed tube. Ignited with cobalt solution gives a pink color. Found in metamorposed limestone, dolomite, or with serpentine, together with magnesite, dolomite, chlorite, etc. Brucite is not known to occur widespread throughout the State but a large commercial deposit, of high purity, associated with a large tonnage of magnesite, is being worked in the Paradise Range in Nye County.

GYPSUM, $CaSO_4.2H_2O$. H. 2. G. 2.3. Monoclinic.

Crystals are commonly flattened, prismatic, or acicular. Also occurs massive granular, or as a fine powdery mass. Commonly twinned with fish-tailed crystals. One perfect cleavage gives thin flexible plates, while another causes a fibrous fracture. Luster subvitreous, but pearly and shining on the best cleavage face. Color usually white to gray, reddish, yellowish, or blue. Sometimes there are other colors due to impurities. Soluble in acids; and but slightly so in water. Gives yellowish red calcium flame. Strong tests for calcium and sulphate. The clear crystallized variety is known as *selenite;* the fibrous masses, *satin spar;* while the massive material is sometimes called *alabaster.* Calcined gypsum is used for plaster and known as *Plaster of Paris.* Gypsum is a very common mineral widely distributed throughout the State. Found in bedded deposits, usually due to hydration of anhydrite, in veins, in irregular masses, and as crystals in rocks altered through the action of sulphuric acid in sulphide deposits. Also found coating the walls of mine workings. Present in large quantities at Arden, Gerlach, Hawthorne, Lovelock, Ludwig, Moapa, etc. Excellent crystals from near Las Vegas.

SODA NITER (*Chile Saltpeter*), $NaNO_3$. H. 1½–2. G. 2.2–2.3. Hexagonal-rhombohedral.

Usually massive, or as incrustations. Luster vitreous. Perfect rhombohedral cleavage. Rather sectile. Color white, gray, yellowish, and sometimes reddish. Tastes cooling. Deliquesces. Readily soluble in water. Ignites strongly with carbon. Intense yellow flame. Occurs in caves, on cliffs, and in fissures in rocks, together with other salts. Found at Charleston, Leadville, and in the Niter Buttes about 25 miles southeast of Lovelock.

NITER (*Saltpeter*), KNO_3. H. 2. G. 2.1. Orthorhombic.

In incrustations or silky tuffs. Has one perfect, and two distinct cleavages. Colorless. Soluble in water. Very easily fusible. Deflagrates on charcoal more violently than does soda niter. Occurrences same as those for soda niter. Also found in a cave near Silver Peak.

TRONA (*Urao*). $3Na_2O.4CO_3.5H_2O$. H. 3. G. 2.13. Monoclinic.

In incrustations, often fibrous or columnar masses. Sometimes in platy crystals. One perfect cleavage, conchoidal fracture. Vitreous, glistening, luster. Translucent. Color gray or yellowish white. Alkaline taste. Yields water and carbon-dioxide when heated in a closed tube. Readily soluble in water. Effervesces readily in weak acids. Alkaline reaction to litmus paper. Easily fusible giving a strong yellow flame. Found in many of the saline lakes and marshes of the State. Once produced in Nevada in considerable quantity. Found in the Soda Lakes near Fallon, Double Springs Marsh, Butterfield Marsh, and in other saline lakes and marshes.

MELANTERITE, $FeSO_4.7H_2O$. H. 2. G. 1.9. See p. 69. (Acicular, white to pale green, efflorescences and masses in oxidized sulphide deposits.)

EPSOMITE (*Epsom Salt*), $MgSO_4.7H_2O$. H. 2–2½. G. 1.75. Orthorhombic.

In delicate crystals, also in finely fibrous or botryoidal masses. Perfect cleavage, conchoidal fracture. Luster vitreous to earthy. Color white, and either transparent or translucent. Tastes bitter and saline. Very soluble in water. Gives strong reaction for magnesia and sulphate. Widespread occurrence in Nevada as efflorescences in caves and old mine workings. Especially noted in sulphide-bearing deposits associated with igneous rocks or magnesian limestones. Also as saline surface deposits in playas. Found in the Comstock Lode, Buffalo Salt Marsh, Cortez, Gold Hill, Springers Hot Springs, Mill Canyon, and in many other districts.

BORAX, $Na_2B_4O_7.10H_2O$. H. 2–2½. G. 1.7. Monoclinic.

Crystals may be prismatic and large and well-formed, resembling those of pyroxene. One perfect and another fair cleavage. Conchoidal fracture. Rather brittle. Luster vitreous, resinous, or earthy. Color snow-white to gray, sometimes greenish to bluish. Transparent to opaque. Tastes faintly sweetish and alkaline. Fuses easily, with swelling, to a white globule. Fused with fluorite and potassium bisulphate gives a clear green flame indicating boron. Very soluble in water. Yields water upon heating in a closed tube. Found in the waters of saline lakes or in salt beds of playa deposits and marshes. Found near Fallon, in Fish Lake Valley, Rhodes Marsh, Teels Marsh, and other playa deposits in the State. In times past, large deposits of this mineral made Nevada an important producer of borax.

ULEXITE, $NaCaB_5O_9.8H_2O$. H. 1. G. 1.65. Monoclinic.

Usually in rounded balls or masses, composed of fine fibrous acicular crystals. Commonly known as *cottonball borax*. Luster silky when freshly broken. Color white. Tasteless. Gives water in closed tube. Easily fusible, with intumescence, to a clear, blebby glass. Gives a yellow (sodium) flame, when moistened with sulphuric acid the flame is momentarily green. Insoluble in cold water, and but slightly in hot water. Found in playas with halite, borax, gypsum, and other salts, in Big Smoky Valley, Columbus Marsh, Fish Lake Valley, Rhodes Marsh, Clayton Valley, White Basin, etc.

MIRABILITE (*Glauber Salt*), $Na_2SO_4.10H_2O$. H. 1½–2. G. 1.5. Monoclinic.

Crystals resemble those of pyroxene. Commonly in efflorescent deposits. Cleavage perfect. Luster vitreous. Color white, either transparent or opaque. Tastes cool, saline, and bitter. On exposure to dry air, mirabilite loses water and falls into a white powder. Very soluble in water. Gives much water in a closed tube. Fuses with a strong yellow flame. Deposited, through the evaporation of saline water, in playas where it is associated with halite, gypsum, and other salts. Found at Buffalo Salt Marsh, Rhodes Marsh, Soda Lakes, Wabuska, and elsewhere.

PART IV

PRELIMINARY LIST OF NEVADA MINERALS

INTRODUCTION

Nevada, in addition to its large output of mineral products, is noted for the number and variety of mineral species found within its borders. Surprisingly, however, only very incomplete lists of its minerals are to be found in the literature. Partial lists of Nevada minerals have been published from time to time; the most complete being that of Schrader,[16] in which about 100 minerals are mentioned. This publication, however, was primarily intended to cover minerals of economic importance and therefore many Nevada species were not included. Also, since that time many additional minerals have been discovered in the State, including several of economic importance.

During the past several years the writer has been compiling a list of all minerals found in Nevada, together with their more important occurrences. This study is still far from finished and much remains to be done before it will be ready for publication in completed form. It is thought advisable, however, to list at this time all minerals now known to have been found in the State. These minerals are arranged according to Dana's "System of Mineralogy" and also indexed. This list, although admittedly incomplete, should be of interest to mineralogists, collectors, and also to that large, and constantly increasing, number of persons who are taking a keener interest in the study of minerals. About 400 mineral species are included. It is the writer's wish that those interested in the mineralogy of Nevada will call his attention to minerals that should have been included, or to occurrences that may be of interest. It is only through such cooperation that a complete listing of the known minerals of the State can be compiled.

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[16] Schrader, F. C., Stone, R. W., and Sanford, S., Useful Minerals of the United States: U. S. Geol. Survey Bull. 624, pp. 190–200. 1917.

MINERALS OCCURRING IN NEVADA

NATIVE ELEMENTS

Graphite, C
Sulphur, S
Arsenic, As
Allemontite, $SbAs_3$
Antimony, Sb
Bismuth, Bi
Gold, Au
  Electrum, AuAg
Silver, Ag
Copper, Cu
Mercury (*Quicksilver*), Hg
Amalgam, Ag,Hg
Platinum, Pt
Palladium, Pd
Iron (meteoric), Fe,Ni

SULPHIDES, SELENIDES, TELLURIDES, ARSENIDES, AND ANTIMONIDES

Realgar, AsS
Orpiment, As_2S_3
Stibnite, Sb_2S_3
Metastibnite, Sb_2S_3
Bismuthinite, Bi_2S_3
Guanajuatite, Bi_2Se_3
Tetradymite, $Bi_2(Te,S_3)$
Molybdenite, MoS_2
Dyscrasite, Ag_3Sb
Galena, PbS
Argentite, Ag_2S
Hessite, Ag_2Te
Aguilarite, $Ag_2(S,Se)$
Naumannite, $(Ag_2,Pb)Se$
Chalcocite, Cu_2S
Stromeyerite, $Ag_2S.Cu_2S$
Sternbergite, $Ag_2S.Fe_4S_5$
Sphalerite, ZnS
Marmatite, (Zn,Fe)S
Metacinnabar, HgS
Alabandite, MnS
Pentlandite, (FeNi)S
Cinnabar, HgS
Wurtzite, ZnS
Millerite, NiS
Niccolite, NiAs
Pyrrhotite, $FeS.Sx$
Covellite, CuS
Bornite, Cu_5FeS_4
Violarite, $(Ni,Fe)_3S_4$
Chalcopyrite, $CuFeS_2$
Pyrite, FeS_2
Gersdorffite, $NiS_2.NiAs_2$
Smaltite-Chloanthite, $CoAs_3$-$NiAs_3$
Marcasite, FeS_2
Loellingite, $FeAs_2$
Arsenopyrite, $FeS_2.FeAs_2$
Sylvanite, $(Au,Ag)Te_2$
Kermesite, $2Sb_2S_3.Sb_2O_3$

SULPHO-SALTS

Zinkenite, $PbS.Sb_2S_3$
Andorite, $2PbS.Ag_2S.3Sb_2S_3$
Chalcostibite, $Cu_2S.Sb_2S_3$
Miargyrite, $Ag_2S.Sb_2S_3$
Benjaminite, $(Cu,Ag)_2S.2PbS.2Bi_2S_3$
Jamesonite, $2PbS.Sb_2S_3$
Dufrenoysite, $2PbS.As_2S_3$
Boulangerite, $5PbS.2Sb_2S_3$
Freieslebenite, $2Ag_2S.3PbS.2Sb_2S_3$
Bournonite, $2PbS.Cu_2S.Sb_2S_3$
Pyrargyrite, $3Ag_2S.Sb_2S_3$
Proustite, $3Ag_2S.As_2S_3$
Pyrostilpnite, $3Ag_2S.Sb_2S_3$
Xanthoconite, $3Ag_2S.As_2S_3$
Tetrahedrite, $5Cu_2S.2(Cu,Fe,Zn)S.2Sb_2S_3$
Freibergite (argentiferous tetrahedrite)
Tennantite, $Cu_3SbS_3.x(Fe,Zn)_6As_2S_9$
Meneghinite, $4PbS.Sb_2S_3$
Stephanite, $5Ag_2S.Sb_2S_3$
Goldfieldite, $6CuS.Sb_2(S,Te)_3$
Polybasite, $9Ag_2S.Sb_2S_3$
Enargite, $3Cu_2S.As_2S_5$
Famatinite, $3Cu_2S.Sb_2S_5$

HALIDES, CHLORIDES, BROMIDES, IODIDES, AND FLUORIDES

Calomel, HgCl
Kleinite, Hg,NH_4, chloride
Mosesite, (Hydrous Hg,NH_4SO_3, and chlorine)
Halite (*Rock Salt*), Na,Cl
Cerargyrite, AgCl
Embolite, Ag(Br,Cl)
Bromyrite, AgBr
Iodobromite, 2AgCl.2AgBr.AgI
Iodyrite, AgI
Fluorite (*Fluorspar*), CaF_2
Atacamite, $CuCl_2.3Cu(OH)_2$
Creedite, $2CaF_2.2Al(F,OH)_3.CaSO_4.2H_2O$

OXIDES

Quartz, SiO_2
Chalcedony, SiO_2
Lussatite, SiO_2
Tridymite, SiO_2
Cristobalite, SiO_2
Opal, $SiO_2.nH_2O$
Arsenolite, As_2O_3
Valentinite, Sb_2O_3
Bismite, Bi_2O_3
Tellurite, TeO_2
Tungstite, WO_3
Ilsemannite, $MoO_2.MoO_3$
Cervantite, $Sb_2O_3.Sb_2O_5$
Stibiconite, $H_2Sb_2O_5$
Stetefeldtite, Oxide of Sb, etc.
Cuprite, Cu_2O
Ice, H_2O
Massicot, PbO
Litharge, PbO
Tenorite (*Melaconite*), CuO
Montroydite, HgO
Corundum, Al_2O_3
Hematite, Fe_2O_3
Ilmenite, $FeO.TiO_2$

Spinel—
  Pleonaste, $(Mg,Fe)O.Al_2O_3$
  Picotite, $(Mg,Fe)O.(Al,Cr)_2O_3$

Magnetite, Fe_3O_4
Chromite, $FeO.Cr_2O_3$

Chrysoberyl, $BeO.Al_2O_3$
Hollandite (a manganate of Mn, Ba, and Fe)
Minium, $2PbO.PbO_2$
Delafossite, $Cu_2O.Fe_2O_3$
Braunite, $3MnMnO_3.MnSiO_3$
Cassiterite, SnO_2
Polianite, MnO_2
Rutile, TiO_2
Plattnerite, PbO_2
Anatase (*Octahedrite*), TiO_2
Brookite, TiO_2
Pyrolusite, MnO_2
Diaspore, $Al_2O_3.H_2O$
Goethite, $Fe_2O_3.H_2O$
Manganite, $Mn_2O_3.H_2O$
Limonite, $2Fe_2O_3.3H_2O$
Esmeraldaite, $Fe_2O_3.4H_2O$
Turgite, $2Fe_2O_3.H_2O$
Brucite, $MgO.H_2O$
Gibbsite, $Al_2O_3.3H_2O$
Psilomelane, MnO_2
Stainerite, $(Co,Fe,Al)_2O_3.H_2O$
Heterogenite, $CoO.2Co_2O_3.6H_2O$

CARBONATES

Calcite, $CaCO_3$
Dolomite, $CaCO_3.MgCO_3$
Ankerite, $CaCO_3.(Mg,Fe)CO_3$
Magnesite, $MgCO_3$
Mesitite, $(Mg,Fe)CO_3$
Siderite, $FeCO_3$
Rhodochrosite, $MnCO_3$
Manganosiderite, $(Fe,Mn)CO_3$
Smithsonite, $ZnCO_3$
Spherocobaltite, $CoCO_3$
Aragonite, $CaCO_3$
  Thinolite (crystalline aragonite tufa)
Witherite, $BaCO_3$
Cerussite, $PbCO_3$
Phosgenite, $PbCO_3.PbCl_2$
Malachite, $CuCO_3.Cu(OH)_2$
Azurite, $2CuCO_3.Cu(OH)_2$

Carbonates—Continued

- Aurichalcite, $2(Zn,Cu)CO_3.3(Zn,Cu)(OH)_2$
- Hydrozincite, $2ZnCO_3.3Zn(OH)_2$
- Thermonatrite, $Na_2CO_3.H_2O$
- Natron, $Na_2CO_3.10H_2O$
- Gaylussite, $CaCO_3.Na_2CO_3.5H_2O$
- Trona, $3Na_2O.4CO_3.5H_2O$
- Hydromagnesite, $3MgCO_3.Mg(OH)_2.3H_2O$
- Gajite (basic Ca-Mg carbonate)
- Zaratite, $NiCO_3.2Ni(OH)_2.2H_2O$
- Bismutite, $Bi_2O_3.CO_2.H_2O$

SILICATES

- Feldspar Group—
  - Potash Feldspars—
    - Orthoclase, $KAlSi_3O_8$
    - Adularia, $KAlSi_3O_8$
    - Sanadine, $KAlSi_3O_8$
    - Microcline, $KAlSi_3O_8$
    - Anorthoclase (*Soda-microcline*)
  - Plagioclase Feldspars. Minerals with various proportions of the albite ($NaAlSi_3O_8$), and the anorthite ($CaAl_2Si_2O_8$) molecules.
    - Albite
    - Oligoclase
    - Andesine
    - Labradorite
    - Bytownite
    - Anorthite

- Leucite, $K_2O.Al_2O_3.4SiO_2$

- Pyroxene Group—
  - Enstatite, $MgSiO_3$
  - Bronzite, $(Mg,Fe)SiO_3$
  - Hypersthene, $(Fe,Mg)SiO_3$
  - Clinohypersthene, $(Fe,Mg)SiO_3$
  - Pigeonite, $(Mg,Fe)SiO_3$ and $CaMg(SiO_3)_2$
  - Diopside, $CaMg(SiO_3)_2$
  - Hedenberdite, $CaFe(SiO_3)_2$
  - Diallage (near diopside in composition; contains Al)
  - Augite, $CaMg(SiO_3)_2$ with $(Mg,Fe)(Al,Fe)_2SiO_6$

- Rhodonite, $MnO.SiO_2$
- Fowlerite, $(Mn,Zn)O.SiO_2$

- Wollastonite, $CaO.SiO_2$
- Pectolite, $H_2O.Na_2O.4CaO.6SiO_2$

- Amphibole Group—
  - Anthophyllite, $(Mg,Fe)SiO_3$
  - Tremolite, $Ca_2Mg_5(OH)_2(Si_4O_{11})_2$
    - *Mountain Leather* (tremolite in thin flexible sheets)
  - Actinolite, $Ca_2(Mg,Fe)_5(OH)_2(Si_4O_{11})_2$
  - Hornblende (an aluminous amphibole)
  - Basaltic hornblende (a brown to black hornblende)
  - Crocidolite (*blue asbestos*)

- Beryl, $3BeO.Al_2O_3.6SiO_2$
  - *Emerald* (emerald-green beryl)
- Cordierite, $Mg_2Al_4Si_5O_{18}$
- Nepheline, $(Na,K)AlSiO_4$

- Sodalite Group—
  - Sodalite, $3Na_2Al_2Si_2O_8.2NaCl$
  - Hauynite, $3Na_2Al_2Si_2O_8.2CaSO_4$

- Garnet Group—
  - Grossularite, $Ca_3Al_2(SiO_4)_3$
  - Pyrope, $Mg_3Al_2(SiO_4)_3$
  - Almandite, $Fe_3Al_2(SiO_4)_3$
  - Spessartite, $Mn_3Al_2(SiO_4)_3$
  - Andradite, $Ca_3Fe_2(SiO_4)_3$
  - Uvarovite, $Ca_3Cr_2(SiO_4)_3$

- Olivine Group—
  - Olivine, $2(Mg,Fe)O.SiO_2$
  - Forsterite, Mg_2SiO_4

Silicates—Continued

- Willemite, $2ZnO.SiO_2$
- Dioptase, $H_2O.CuO.SiO_2$
- Belmontite (a lead silicate)

- Scapolite (*Wernerite*), $CaCO_3.3CaAl_2Si_2O_8-NaCl.3NaAlSi_3O_8$

- Idocrase (*Vesuvianite*), $Ca_6[Al(OH,F)]Al_2(SiO_4)_5$

- Zircon, $ZrO_2.SiO_2$
- Topaz, $(Al,F)_2SiO_4$
- Andalusite, $Al_2O_3.SiO_2$
  - *Chiastolite* (with carbon inclusions)
- Sillimanite, $Al_2O_3.SiO_2$
- Kyanite (*Cyanite*), $Al_2O_3.SiO_2$

- Datolite, $H_2O.2CaO.B_2O_3.2SiO_2$

- Epidote Group—
  - Zoisite, $HCa_2Al_3Si_3O_{13}$
  - Thulite (manganiferous zoisite)
  - Clinozoisite, $HCa_2Al_3Si_3O_{13}$
  - Epidote, $HCa_2(Al,Fe)_3Si_3O_{13}$
  - Piedmontite, $HCa_2(Al,Mn,Fe)_3Si_3O_{13}$
  - Sursassite (*Mangan-epidote*)
  - Allanite (cerium, yttrium epidote)

- Axinite (a boro-silicate of Al and Ca)
- Prehnite, $H_2Ca_2Al_2(SiO_4)_3$
- Ilvaite, $CaFe_2(FeOH)(SiO_4)_2$
- Hemimorphite (*Calamine*), $H_2O.2ZnO.SiO_2$

- Tourmaline Group (near $H_9Al_3(B.OH)_2Si_4O_{19}$)—
  - Rubellite (contains Na, Li, and K)
  - Schorlite (common iron tourmaline)
  - Dravite (magnesian tourmaline)

- Dumortierite, $8Al_2O_3.B_2O_3.6SiO_2.H_2O$
- Staurolite, $HFe_2Al_5Si_2O_{13}$

- Inesite, $H_2(Mn,Ca)_6Si_6O_{19}.3H_2O$
- Pumpellyite, $6CaO.3Al_2O_3.7SiO_2.4H_2O$

- Zeolite Group—
  - Ptilolite, $(Ca,K_2,Na_2)O.Al_2O_3.10SiO_2.5H_2O$
  - Heulandite, $(Ca,Na_2)O.Al_2O_3.6SiO_2.5H_2O$
  - Brewsterite, $(Sr,Ba,Ca)O.Al_2O_3.6SiO_2.5H_2O$
  - Phillipsite, $(K_2,Ca)Al_2Si_4O_{12}.4\frac{1}{2}H_2O$
  - Harmotome, $(K_2,Ba)O.Al_2O_3.5SiO_2.5H_2O$
  - Stilbite, $(Na_2,Ca)O.Al_2O_3.6SiO_2.6H_2O$
  - Epidesmine, $(Na_2,Ca)O.Al_2O_3.6SiO_2.6H_2O$
  - Stellerite, $CaO.Al_2O_3.7SiO_2.7H_2O$
  - Laumontite, $(Ca,Na_2)O.Al_2O_3.4SiO_2.4H_2O$
  - Chabazite, $(Ca,Na_2)O.Al_2O_3.4SiO_2.6H_2O$
  - Natrolite, $Na_2O.Al_2O_3.3SiO_2.2H_2O$
  - Scolecite, $CaO.Al_2O_3.3SiO_2.3H_2O$
  - Mesolite, $(Ca,Na_2)O.Al_2O_3.3SiO_2.2\frac{1}{2}H_2O$
  - Thomsonite, $(Ca,Na_2)O.Al_2O_3.2SiO_2.2\frac{1}{2}H_2O$

- Mica Group—
  - Muscovite, $H_2KAl_3(SiO_4)_3$
    - *Damourite, Sericite*
  - Lepidolite, $(OH,F)_2KLiAl_2Si_3O_{10}$
  - Biotite, $H_2K(Mg,Fe)_3Al(SiO_4)_3$
  - Phlogopite, $H_2KMg_3Al(SiO_4)_3$

Silicates—Continued

Brittle Micas—
- Margarite, $H_2CaAl_4Si_2O_{12}$
- Chloritoid (*Ottrelite*), $H_2(Fe,Mg)Al_2SiO_7$

Chlorite Group—
- Penninite, $H_8(Mg,Fe)_5Al_2Si_3O_{18}$
- Clinochlore, $H_8Mg_5Al_2Si_3O_{18}$
  - *Leuchtenbergite* (contains little Fe)
  - *Delessite*

Vermiculites (hydrated silicates; near chlorite)—
- Jeffersite
- Vermiculite

Serpentine and Talc Division—
- Serpentine, $H_4Mg_3Si_2O_9$
  - Bastite
  - Antigorite
  - Chrysotile
- Deweylite, $4MgO.3SiO_2.6H_2O$
- Genthite, $2NiO.2MgO.3SiO_2.6H_2O$
- Garnierite, $H_2(Ni,Mg)SiO_4$ and water
- Talc, $H_2Mg_3(SiO_3)_4$
- Sepiolite, $H_4Mg_2Si_3O_{10}$
  - *Parasepiolite*
- Saponite (silicate of Mg and Al)

- Bowlingite (silicate of Fe, Mg, and Al)
- Iddingsite, $MgO.Fe_2O_3.3SiO_2.4H_2O$
- Celadonite (silicate of Fe, Mg, and K)

- Kaolinite, $Al_2O_3.2SiO_2.2H_2O$
- Dickite, $Al_2O_3.2SiO_2.2H_2O$
- Miloschite, $(Al,Cr)_2O_3.2SiO_2.2H_2O$
- Halloysite, $Al_2O_3.2SiO_2.nH_2O$
- Leverrierite (hydrous silicate of aluminum)
- Beidellite, $Al_2O_3.3SiO_2.4H_2O$
- Montmorillonite, $(Mg,Ca)O.Al_2O_3.5SiO_2.nH_2O$
- Pyrophyllite, $H_2Al_2(SiO_3)_4$
- Allophane, $Al_2SiO_5.nH_2O$

- Chloropal, $H_4Fe_2Si_2O_9$
  - *Nontronite*
- Hisingerite (a hydrated ferric silicate)
- Neotocite (a hydrated silicate of Mn and Fe)
- Chrysocolla, $CuSiO_3.2H_2O$

- Searlsite, $NaB(SiO_3)_2.H_2O$

- Sphene (*Titanite*), $CaTiSiO_5$

PHOSPHATES, ARSENATES, VANADATES, AND ANTIMONATES

- Monazite, (Ce,La,Di, etc.) PO_4

Apatite Group—
- Apatite—
  - Fluor-apatite, $(CaF)Ca_4(PO_4)_3$
  - Chlor-apatite, $(CaCl)Ca_4(PO_4)_3$
- Dahllite (*Podolite*), $3Ca_3(PO_4)_2.CaCO_3$
- Pyromorphite, $(PbCl)Pb_4(PO_4)_3$
- Mimetite, $(PbCl)Pb_4(AsO_4)_3$

- Vanadinite, $(PbCl)Pb_4(VO_4)_3$

- Triplite, $R_3P_2O_8RF_2$ (R stands for Fe, Mn, Ca, and Mg)

Olivenite Group—
- Olivenite, $Cu_3As_2O_8.Cu(OH)_2$
- Libethenite, $Cu_3P_2O_8.Cu(OH)_2$
- Adamite, $Zn_3As_2O_8.Zn(OH)_2$
- Descloizite, $2(Pb,Zn,Cu)O.V_2O_4(OH)_2$

Phosphates, Arsenates, Vanadates, and Antimonates—Continued

- Mottramite (*Cuprodescloizite*), $2(Pb,Cu)O.V_2O_4(OH)_2$
- Psittacinite (similar to mottramite)
- Calciovolborthite, $(Cu,Ca)_3V_2O_8.(Cu,Ca)(OH)_2$

- Clinoclasite, $Cu_3As_2O_8.3Cu(OH)_2$
- Erinite, $Cu_3As_2O_8.2Cu(OH)_2$
- Dihydrite, $Cu_3P_2O_8.2Cu(OH)_2$
- Lazulite, $(Fe,Mg)Al_2(OH)_2P_2O_8$
- Arseniosiderite, $Ca_3Fe(AsO_4)_3.3Fe(OH)_3$
- Synadelphite, $2(Al,Mn)AsO_4.5Mn(OH)_2$

Vivianite Group—
- Vivianite, $Fe_3P_2O_8.8H_2O$
- Erythrite, $Co_3As_2O_8.8H_2O$
- Annabergite, $Ni_3As_2O_8.8H_2O$
- Cabrerite, $(Ni,Mg)_3As_2O_8.8H_2O$

- Scorodite, $FeAsO_4.2H_2O$
- Barrandite, $(Al,Fe)PO_4.2H_2O$
- Variscite, $AlPO_4.2H_2O$
- Haidingerite, $HCaAsO_4.H_2O$
- Pharmacolite, $HCaAsO_4.2H_2O$
- Conichalcite, $(Cu,Ca)_3As_2O_8.(Cu,Ca)(OH)_2.\frac{1}{2}H_2O$

- Tyrolite, $Cu_3As_2O_8.2Cu(OH)_2.7H_2O$
- Chalcophyllite, $20CuO.Al_2O_3.2As_2O_5.3SO_3.25H_2O$
- Wavellite, $4AlPO_4.2Al(OH)_3.9H_2O$
- Turquois, $CuO.3Al_2O_3.2P_2O_5.9H_2O$
- Vashegyite, $4Al_2O_3.3P_2O_5.30H_2O$
- Pharmacosiderite, $6FeAsO_4.2Fe(OH)_3.12H_2O$
- Cacoxenite, $FePO_4.Fe(OH)_3.4\frac{1}{2}H_2O$
- Torbernite, $Cu(UO_2)_2P_2O_8.12H_2O$
- Metatorbernite, $Cu(UO_2)_2P_2O_8.8H_2O$
- Autunite, $CaO.2UO_3.P_2O_5.8H_2O$

- Carnotite, $K_2O.2U_2O_3.V_2O_5.2H_2O$

- Bindheimite (a hydrous antimonate of lead)
- Ecdemite, $Pb_4As_2O_7.2PbCl_2$
- Pitticite (hydrated arsenate and sulphate of ferric iron)
- Beudantite, $2PbO.3Fe_2O_3.2SO_3.As_2O_5.6H_2O$

NITRATES

- Soda Niter (*Chile Saltpeter*), $NaNO_3$
- Niter (*Saltpeter*), KNO_3

BORATES

- Ludwigite, $3MgO.B_2O_3.FeO.Fe_2O_3$
- Szaibelyite, $2Mg_5B_4O_{11}.3H_2O$
- Fluoborite, $3MgO.3B_2O_3.3Mg(F,OH)_2$
- Colemanite, $Ca_2B_6O_{11}.5H_2O$
- Paigeite, $30FeO.5Fe_2O_3.SnO_2.6B_2O_3.5H_2O$
- Borax, $Na_2B_4O_7.10H_2O$
- Tincalconite, $Na_2B_4O_7.5H_2O$
- Ulexite, $NaCaB_5O_9.8H_2O$

SULPHATES

- Thenardite, Na_2SO_4
- Glauberite, $Na_2SO_4.CaSO_4$
- Barite, $BaSO_4$
- Celestite, $SrSO_4$
- Anglesite, $PbSO_4$
- Anhydrite, $CaSO_4$
- Leadhillite, $PbSO_4.2PbCO_3.Pb(OH)_2$

Sulphates—Continued

Brochantite, $CuSO_4.3Cu(OH)_2$
Antlerite, $CuSO_4.2Cu(OH)_2$
Caledonite, $2(Pb,Cu)O.SO_3.H_2O$
Linarite, $(Pb,Cu)SO_4.(Pb,Cu)(OH)_2$
Lecontite, $(Na,NH_4,K)_2SO_4.2H_2O$
Mirabilite, $Na_2SO_4.10H_2O$
Gypsum (*Selenite*), $CaSO_4.2H_2O$
Epsomite, $MgSO_4.7H_2O$
Goslarite, $ZnSO_4.7H_2O$
Morenosite, $NiSO_4.7H_2O$
Melanterite, $FeSO_4.7H_2O$
Pisanite, $(Fe,Cu)SO_4.7H_2O$
Iron-copper chalcanthite (near pisanite)
Chalcanthite, $CuSO_4.5H_2O$
Siderotil, $FeSO_4.5H_2O$

Potash Alum, $KAl(SO_4)_2.12H_2O$
Kalinite, $KAl(SO_4)_2.12H_2O$
Mendozite, $NaAl(SO_4)_2.12H_2O$
Tschermigite, $(NH_4)Al(SO_4)_2.12H_2O$
Pickeringite, $MgSO_4.Al_2(SO_4)_3.22H_2O$

Halotrichite, $FeSO_4.Al_2(SO_4)_3.22H_2O$
Kornelite, $Fe_2(SO_4)_3.7\frac{1}{2}H_2O$
Coquimbite, $Fe_2(SO_4)_3.9H_2O$
Alunogen, $Al_2(SO_4)_3.16H_2O$
Sideronatrite, $2Na_2O.Fe_2O_3.4SO_3.7H_2O$
Voltaite, $3(K_2,Fe)O.2(Al,Fe)_2O_3.6SO_3.9H_2O$
Beaverite, $CuO.PbO.Fe_2O_3.2SO_3.4H_2O$
Copiapite, $Fe_4(OH)_2(SO_4)_5.18H_2O$
Cupro-copiapite (copiapite with Cu replacing Fe)
Rhomboclase, $Fe_2O_3.4SO_3.9H_2O$
Amarantite, $Fe_2O_3.2SO_3.7H_2O$
Fibroferrite, $Fe_2O_3.2SO_3.10H_2O$
Alunite, $KAl_3(OH)_6(SO_4)_2$
Natroalunite, $(K,Na)Al_3(OH)_6(SO_4)_2$
Jarosite, $KFe_3(OH)_6(SO_4)_2$
Natrojarosite, $NaFe_3(OH)_6(SO_4)_2$
Plumbojarosite, $PbFe_6(OH)_{12}(SO_4)_4$
Argentojarosite, $AgFe_3(OH)_6(SO_4)_2$

TELLURITES

Emmonsite (a hydrated ferric tellurite)
Durdenite, $Fe_2O_3.3TeO_2.4H_2O$

TUNGSTATES AND MOLYBDATES

Ferberite, $FeWO_4$
Wolframite, $(Fe,Mn)WO_4$
Huebnerite, $MnWO_4$
Scheelite, $CaWO_4$
Cuproscheelite, $(Ca,Cu)WO_4$
Powellite, $Ca(Mo,W)O_4$
Stolzite, $PbWO_4$
Wulfenite, $PbMoO_4$
Ferrimolybdite (*Molybdite*), $Fe_2O_3.3MoO_3.8H_2O$
Ferritungstite, $Fe_2O_3.WO_3.6H_2O$

MELLATES

Mellite, $Al_2C_{12}O_{12}.18H_2O$

HYDROCARBONS

Impsonite (a hydrocarbon)
Asphaltum

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