MINING RESOURCES OF OREGON

(By Frank V. Drake, Portland.)

Gold Belt in the Eastern Part of the State Has an Area of 14,000 Square Miles of Development in Other Sections.

STANDING on the summit of the Seven Devils Mountains, on the western verge of Idaho, with the Snake River thousands of feet below, a seeming thread of blue, and looking westward, you may see range beside range of majestic mountains, bald of head, their faces gashed and wrinkled with canyons and gorges and bearded with dense, dark firs, cedars and pines, the unshorn growth of the centuries. These are the thousand giants that hold and shield the treasure vaults of Eastern Oregon.

Climb the steeps of the Calapooia and from Bohemia's rugged crest you may look upon another array of sentinels, whiskered, like their brothers, with ample beard 200 feet in length. These are the keepers of the gold in central Western Oregon.

Master Mount Pitt, 10,500 feet in altitude, and from this ice-crowned monarch of the Cascades you may review all the multitude of treasure keepers of Southern Oregon, that, wrinkled and bearded and silent, await the coming of the dauntless captains who hold the keys to the adamant doors; the cheerful, hopeful, tireless men who have learned the secret springs and dare to break resisting bars.

Much of the mystery of the uplifting of these hills and the phenomena of their enrichment with the metals which makes human progress possible, remains unsolved; much still surpasses mortal understanding. Through the centuries the delvers in the deeps have slowly, often at points far removed, and like turning the massive leaves of a mighty book, uncovered stratum after stratum, leaf after leaf, of Nature's records as written in the rocks, until somewhat of the great problem is known to men. And this unfolding of the strata, with contemplation and comparison of their constituent elements, position, structure and the embedded fossils tells something of the origin, growth, decay, degredation and rebuilding of the rocks. So the men, learned and unlearned, co-operating through past centuries, who delved in and studied the deeps have established the foundations of a science, still far removed from perfection, and named it geology.

Rocks are decaying, their elements taking new forms in growth of other rocks. The sun, the air, the waters, heat, cold, electricity and the incomprehensible chemical laboratory of the earth are at work unceasingly in destroying old forms and building new. Not long since geologists and miners practically agreed that the precious metals existed in available quantities only in connection with a few pretty well defined rock formations and under limited conditions. Explorations of recent years have enlarged the number and areas of metallic "habitats" and now when the eagle-eyed prospector encounters unfamiliar conditions he does not stop investigation. He subjects each showing of mineral he finds to test of knife, acid and blow pipe, and to assay, if available. He heeds the aphorism, "Gold is where you find it." However, the "likely" formations are well known, and experience in the field is indispensable to him who seeks for the precious metals in the fastnesses of the mountains. He knows that some of the rocks don't carry gold.

Nearly every known mineral is found in the hills of Oregon. To enumerate them would be outside the province of this writing, which is chiefly directed to an extremely abbreviated presentation of the copper, silver and gold product and prospects in the state.

Eastern Oregon Belt 14,000 Square Miles.

The Eastern Oregon gold fields, lying principally in Union, Baker and Grant counties, embrace an area of about 14,000 square miles, an extent of country nearly as large as the combined areas of the states of Massachusetts, Rhode Island and Connecticut.

The mineral area herein designated as Central Western Oregon lies in the Counties of Linn and Lane. Much of the area of these counties includes the upper portion of the Willamette Valley; while the mineralized portions lie chiefly in the Cascade range and its western foothills. This mineral section, however, exceeds in extent at least one of the wealthy and populous Eastern States.

What is denominated herein as the Southern Oregon gold fields covers the counties of Douglas, Josephine and Jackson, having an area of approximately 25,000 square miles, again surpassing in size several of the Eastern States combined.

These comparisons are made for the purpose of accentuating and making readily clear to the hurried reader, the relative size of Oregon's vast mineral domain, full of wealth and opportunities, yet with a population of barely more than 400,000.

What power caused those mountains to be exalted? Why and how were the veins of metals so deeply laid, like arteries and veins in animal organisms, through the bodies of the hills? Whence came the metals for gain of which men sacrifice health and life—and, after coinage, honor?

Man, physically, is insignificant, but he has accomplished much, considering he is but an atom in the universal economy. He has no place whereon to rest a fulcrum for the lever with which the mountains can be lifted, and the long continued and continuing process of uplifting the hills proceeds without his help or hindrance. He removes the lesser hills, and penetrates the mountains, but he cannot raise them up. To get possession of the metals he prizes he, with power drills and dynamite, probes the treasure-bearing veins to the very hearts of the ranges. With hydraulic giants he removes cement and gravel hills, robbing them of their gold, but he cannot restore them to their places.

Beginning of Mountains and Land.

The hills began to rise when the earth was young. A crust of crystalline, shapeless (amorphous) material, composed chiefly of quartz, feldspar and mica, fused by water and fire, encompassed a molten mass. This crust was the primary rock. All the elements which composed these and the later forms of rock existed from the beginning. From these primitive, granite rocks and the later erupted matter came all the material for the sedimentary rocks. Chemical and mechanical agencies acting on these materials have produced an almost infinite variety of rock formation.

Probably a relatively thin sheet of water, condensed vapors, covered this primary crust for a long period. The heat of the huge, globular mass began to radiate into space; the earth was cooling off. With this cooling shrinkage began. The contracting crust met resistance from the enclosed molten mass. As cooling and shrinkage progressed in the deepening crust it began to wrinkle, crumple, lifting a portion above the waters at some points and correspondingly depressing adjacent portions. Thus the formation of land, as small islands, or ridges began. Limited in extent at first, these upliftings were succeeded by subsidences, until some of the corrugations became at last permanent in the form of low islands of the primitive rocks. As the then plastic crust cooled and hardened, cracks or fissures occurred, sometimes above the waters, less frequently below. Through these cracks lava poured up, increasing the height and area of the land. This erupted matter filled the fissures, overflowed and supplied new material. Water attacked this new matter and the granite, both already in process of slow decomposition, and began the work of building sedimentary rocks. Water is the great universal eolvent. It attacks, absorbs and carries away elements of one rock to deposit them where conditions favor for the creation of new rocks. It has been doing this from the beginning; it is doing so still, and prodigiously.

Creation of the Gold-Bearing Ledges.

As the process of slow uplifting progressed, the waves worked steadily at the shores, disintegrating the granites and lavas to sand and sediments and depositing the tiny grains of quartz in long, submerged reaches, where the silica took the new form of gneiss, schists, quartzite, shales or slates. These were the first stratified rocks, and were formed on the bed of the primeval ocean.

There was no life in those early periods of the world's history. Ages passed; the cooling and shrinking processes continued; marine life appeared, seaweeds grew prodigiously; multitudinous millions of shell fish swarmed the seas, died and left their shells to be mixed by the waves with sediments torn from the low-lying shores and consolidated into solid rock, thereafter to be exalted for the coming of the then far-distant man. The pretty "animal flowers" of the sea, in myriads beyond comprehension, flourished in the yet warm waters, died and left their fairy skeletons as coral reefs, to become the limestone of today. And this wonderful process still goes on in the warm Southern seas. Pressure, heat and chemical action metamorphosed some of the ancient limestones into marble, and now men quarry it for its utility and beauty. Of these skeletons from the ancient seas art wins her greatest triumphs, and commerce makes a profit. Weird, wonderful story.

Slowly the crumpling granite rose until permanent islands appeared above the waves, the genesis of fixed and stable land. Some of these were the beginning of the continent of North America.

Cycle followed cycle; rock building went on multiplying forms in structure and mixture of elements. Oscillations between sea and land (more plastic then than now) disturbed the stratification in places. Gradually other sections of the corrugating crust rose out of the ocean, forming vast troughs or basins filled with bodies of sea water. By breaking of weak barriers some of these waters were returned to the place whence they came, and evaporation completed the removal of these saline floods, much of the salts being assimilated or taken up in the earth. Copious rainfalls filled the troughs with fresh water, forming vast lakes or inland seas. On the marshy shores and islands of these lakes vegetation prodigious and dense, unlike that of today, grew abundantly. Periodical floods brought silt, pebbles and sand from the adjacent lands and buried this vegetation, which became peat, then coal. The superimposed deposits became, under the pressure of other accumulated material, metamorphosed into shales, slates, sandstones. Successive layers of these deposits occurred, probably in part altered while covered by the water where subsidence had occurred. There were successive epochs, varying with localities, in the formation of coal deposits. Pre-adamite animals came in abundance, some attaining enormous size. All these were destroyed in some later cataclysm. Their skeletons, with remains of vegetation and shells of extinct shell fish, are frequently encountered by miners and scientists, widely dispersed on this continent. The most wonderful of these are found in Oregon and Wyoming.

And so, through successive ages, the rocks grew, water, heat, pressure, mechanical mixing and chemical action all operating to destroy old forms and make new. The crust still thickened, still contracted, lifted old mountains higher, raising new ones in cordilleras and transverse ranges and continents, chiefly made up of torn and ragged hills, became established. Volcanoes threw ashes, cinders and tufa high in air and spilled lavas down their sides. In the later movements, as crests of new corrugations rose, they necessarily lifted all the stratified sedimentary rocks and limestone beds resting upon them, tilting the strata upward at various angles. There was great crushing, breaking and folding at such times. Fissures, miles in length, cracks and seams between strata, and through granite and strata, were made. Faults descending to great depths, tapped reservoirs of molten rock which flowed out and over the land in vast sheets. The shocks, occasioned by breaking of the rocks and the settling to rest of the divided parts, must have produced earthquakes on the surface, and a breaking up of adjacent country into lesser parallel and cross fissures. Such conditions are most favorable for subsequent filling of the spaces by mineral matter.

These various lines of fracturing afforded channels for eruptive rock and mineral waters. The igneous matter soon hardened to rock and became a part of the "formation." Sometimes metal-bearing quartz seems to have accompanied the porphyries, or, at least, to have intruded therein previous to hardening of the mass.

Theories Regarding Metal Deposits.

How and when these metals became deposited in the fissures, forming what is known as lodes, ledges or veins, has been a subject of much research, speculation, argument and theorizing. The matter has not been determined to the satisfaction of all. It seems that more than one "theory" is necessary to account for all the deposits. It is conceded that the primitive rocks contained all the chemical elements forming, the earth's crust, including the metallic minerals, gold, silver, copper, lead, etc. Water is nature's great solvent of the minerals. When heated and under pressure, and alkaline, it may be said to be all-powerful. It has always been an active agent in dissolving elements from one system and transporting them to other places for combination with other elements. Sea water contains gold, silver, copper, lead, zinc, cobalt, nickel, manganese, iron and many other elements in solution. Carbon and organic matter act as precipitants of these into their various salts, sulphides, tellurides.

Some arguments support the theory of metallic deposits in the veins (fissures), which were created before the general upheaval turned them edge up into their present position, the exponents claiming this to be true particularly of the older veins; but the frequent presence of auriferous true fissure quartz veins, which have cut through and across all strata and formations in their localities, cannot be explained on this hypothesis. Until recently denunciations, hot as the theory, were fulminated against all doubters of the doctrine of fire—that gold came up from the deeps molten, or sublimated, then condensed on reaching the moist and cooler upper regions in the veins. There are several conditions inexplicable by this theory, not necessary to mention here. Some argument is made that the metals are derived from adjacent rocks and deposited in the veins by the action or movement of water, etc.

The "thermo aqueous" theory meets known conditions more completely than do the speculations above referred to. Water, more or less heated and alkaline, takes gold, copper, silver, silica and all veinstone materials into solution. The fissures in the rocks afford channels for the flow of this burdened liquid. Whether the materials were absorbed from the depths, or upper rock formations, or both, is undetermined. Silica is almost invariably a constituent veinstone where gold, silver or copper is found; often it comprises practically all the gangue of these metal-bearing veins. In this quartz gangue the pure metals are often most intimately intermingled with the densest crystalline material, the metals finely disseminated all through the body of the quartz. Both the silica and metal must have been precipitated at the same times and through the same agency—water. Similarly, such deposition could have been made in the cases where the metallic salts occur. It is well known that copper is rapidly precipitated on iron from the waters of copper veins. The "theory" is that the mineralized water, on reaching upper zones, is relieved of pressure and heat, and, particularly in the presence of reagents, precipitates the minerals in practically one operation.

In many places iron, and silica and copper, have been found on walls and roofs of old workings. Instances can be seen in this state. Gold, iron and silver have been extracted from solid mine timbers which have been submerged for a long time. Hundreds of persons, including the writer of this, have observed the growth of regular quartz veins carrying precious metals, at Steamboat Springs, in Nevada. In a bare, rocky valley, at the base of the foothills of Mount Davidson, some 12 miles from Virginia City, several fissures traverse the locality for a half mile. They carry hot, mineralized water. Some of these were still over a foot wide in the early 60s. Steam and hot water jets then issued, geyser-like, from vents along the fissures, with a sound, appearance and regularity of the exhaust of a steamboat. The fissures are numerous (some short), and nearly parallel. Their activity is decreasing, and some of the once open fissures have been closed by quartz deposited by the waters, forming true quartz fissure veins. Some are partly filled with quartz, and are being perceptibly closed from year to year, as the observers can testify. The hot water can be seen in violent agitation, and its rumbling heard at points where roofed with quartz. The spouting steam and water have deposited a bed of quartz along the field of fissuring some 30 feet deep. The quartz is distinctly banded—ribbon quartz—and contains free gold, cinnabar and sulphides of iron and copper. The hot sulphur springs at Sulphur Bank, Colusa County, California, are depositing silicious matter, containing cinnabar and gold, in some features quite similar to those in Nevada. Truly the building of new rocks and deposition of metals continues uninterruptedly. Mayhap the process is slower than in ages gone—but who knows?

However the earth was formed and the hills exalted, when man came due preparation had been made for him, and the mountains were practically as we now find them, save that time and his servants have been busy in the high places, and where gold is. They labored long to fit the world for human habitation.

Action of Water.

The fervent sun, daily, through the ages, with active zeal, expanded, opened somewhat, the crystalline doors in the exposed peaks and crags for admission of water. No quartz is so dense but water crowds among its crystals. The water, raised as vapor from convenient seas and brought to its allotted places, fell as dew and rain on crag and peak, and, entering the open doors, crept in among the crystals. It brought carbonic acid from the air, and attacked the minerals. There was daily expansion, and nightly contraction. Frost came, made tiny wedges of the water drops, breaking down the minute crystals of quartz, prying up little slabs of mica, splitting mineral particles everywhere. All these were carried down the mountainsides by the ever-willing water. When vegetation appeared, organic acids gave aid to the work of disintegration, dissolving minerals by chemical action, and saxifrages, with intrusive and swelling roots heaved under the rocks to throw them down upon others below, to break and grind their lesser fellows into pebbles and sand. Glaciers came and carved vast gorges and canyons in the ranges; they broke down huge masses of material and ground them into dust.

The tops of mountains and hills were worn down, and in this wreckage and removal of material the upper portions of metal-bearing veins were involved. The gold resisted the action of the acids and water—there was relatively no heat or pressure—and remained intact in substance. Freed from its gangue, and being heavier, its movement toward the feet of the hills was slower than that of the sand, pebbles and detritus of the broken rocks. Water could not transport it far, so it lodged in the bottoms of the gulches and streams and was buried with the gravels and sands that finally settled into place as bars and narrow valleys. Here are found the placer mines. Very fine, flaky gold is carried long distances by rapid streams in times of flood, and widely distributed; but when finally deposited do not form what is known as placers.

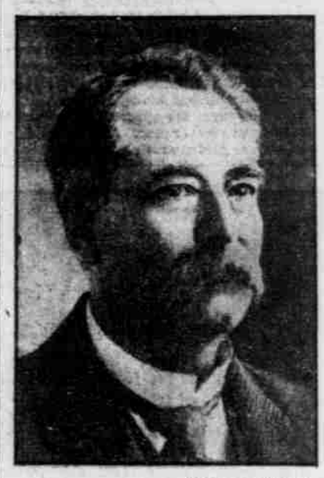
Vegecation decayed into loams, and soils are formed on the tops of gravels and sandy beds in the low places, all brought into place by the industrious waters. Sea beaches and valleys, prairies and plains expanded; grasses, flowers and fruits came; the Garden of Eden grew and the earth was ready for man.

Placer Mining.

Copper and silver are mined from the veins; gold is mined from placers and veins. The development of practical and scientific work in exploitation of mines in recent years has never been rivaled or approached in the history of civilization. The recital of achievements obtained requires libraries. Ores, lode and placer, but recently unavailable, can now be mined and worked profitably to a surprising extent. It foretells the production of values by many hundred millions of dollars, heretofore unanticipated.

It is but a generation since the placer miner toiled singly with pick, shovel and pan in his work of getting the gold from bedrock. Nothing but richest deposits paid. He dug a pit or an open cut to bedrock, where the coarse gold lay. Gathering the auriferous gravel into his pan and carrying it to a pool of water, he with dextrous skill separated the gold from the gravel, saving the gold; and repetitions of this process constituted his daily toil. This was placer mining, sometimes, and temporarily, profitable. He wanted a dollar's worth of gold to the pan—and he deserved it. When the gravel was buried under deep deposits, he dug a hole, bottomed on the best bedrock channel, or depression, under the bank, gathering and panning the bottom gravel deposit as he went. This was "drifting on bedrock," and often the drifts—holes—extended long distances under the banks. It was slow, tedious work, and the pay streaks gave out. Everything that did not pay satisfactorily for this work was left.

The rocker, a simple machine, easily constructed and operated, was an improvement on the pan, and generally



—Browning Photo.

Col. Frank V. Drake.

adopted. To save the fine gold quicksilver was used in this machine.

Ground sluicing, where water was plentiful and the fall or declivity of the ground considerable, was a great step in advance. The water was diverted by wing dams against the banks. The miner with pick and bar broke down the banks and the dirt and gravel, falling into the running water, were carried away, leaving the particles of heavy gold lodged in crevices and depressions in the bedrock. When the banks were removed the gold was gathered out of its hiding places, with tools for the purpose, then finally cleaned in rocker or pan. By these means ground which would not pay for drifting was profitably worked.

Sluices, long, square-built troughs, laid at uniform inclination in the bedrock or bottom of the ravine, were often more effective still. Strips, or blocks of woods, or poles, laid lengthwise, or small stones of uniform size, were secured in the bottom of the sluices, forming riffles for lodgment of gold. Water was turned into these sluices, and the gravel shoveled into their upper ends; the rushing water carried away the dirt and gravel, leaving the gold in the riffles; sometimes quicksilver was sprayed into the head of the sluices for saving of fine gold, which might otherwise be carried away.

The long tom was a sort of combination of rocker and sluice.

"Hydraulicking" was introduced in California by the never-satisfied Americans. The business of picking and shoveling was hard work. Worse still, it was slow. So ditches, for pressure of water, were constructed. The head or upper end of each ditch was commenced well up the rapid mountain streams, continued on grades for easy flow around the hill sides, and across gulches by flumes on trestling, until the desired point was reached above the placers to be worked. Here a penstock, a huge box, was set, into which the water flowed. To a hole cut low down on the side of the penstock a hose was fixed. It was made of heavy canvas, well sewed, and long enough to reach the claims to be worked. At the lower end of the hose a nozzle, somewhat similar to those used by city firemen, was attached, and the water turned in. The results were satisfactory for a time. It was a big thing; the water rushing through the nozzle under the pressure and directed against the obstinate banks, tore up things in grand style, and great profits resulted, with little use of pick or shovel. Where boulders were few and dump room ample, things were "exceedingly lovely." Dump is the accumulated rocks and gravel at the lower end of the workings. When the ground for dump fell off, pitched downward steeply, there was no trouble on this score. The water and materials were usually conducted by sluices, riffled as before, from the point of operation to the dump.

But troubles came at times in the form of boulders too big to move; they covered good bedrock, and interfered with the use of the hose. Men could move the small boulders, the derricks larger ones, and some required blasting. This meant hard work and expense, and when the dump room failed, things were serious. Furthermore, the hose would leak, buck and wriggle the nozzle out of the hands of the men, and thrash wildly about, to the danger, and occasional destruction of life; and it would burst at times, suspending operations for repairs. All these difficulties and obstacles were to be overcome in good time.

Hydraulic Machinery That Displaces Boulders.

Iron pipes closely fitted and carefully laid supplanted the hose, and the bucking nozles were displaced by the firm-fixed giants, which quietly control the course of streams, that kill like a cannon shot and toss boulders like feathers in the air. The giant is an ingenious iron machine, constructed with a nozzle pipe fitted to a globe-shaped chamber on a ball-and-socket principle, so that the pipe with nozzle atttached can be easily turned in any desired direction. The water flows into this chamber and through the pipe with force proportioned to the pressure. The giant is made of different sizes and is a great success.

The hydraulic gravel elevator, a recent product of American determination to overcome obstacles; and to be described in connection with later reference to Oregon mines, has to a great extent supplied the place of natural dump room. With adequate pressure it can do almost anything in the way of piling rocks and boulders to a half-ton weight in heaps and banks 70 or more feet in height. And it does this automatically; all it needs, when set, is water and an occasional visit from its master to look after repairs.

The gold-dredging machines, one of which is now being brought to a high degree of efficiency, on the John Day River, near to and below Canyon City, Grant County, of this state, are effectively overcoming the difficulty of getting the gold from gravel beds where no dump room exists and water is scarce. The capacity of the best of these modern machines is quite surprising. Floating in a pond, or reservoir, from which pumps draw the water for washing the material brought up by the ponderous steel buckets, the quantity of earth, gravel and bedrock handled by a dredge daily is astonishing. The water, as used, flows back into the pond to be utilized again and again, so that a small inflow is sufficient for the biggest machine, and the saving of gold is quite equal to that of the best sluices; in fact, the material, after being thoroughly disintegrated in a huge revolving trommel which disposes of the larger rocks by a simple device, is "sluiced" in much the same way as in the best hydraulic mines. The detritus is "dumped" behind the machine as it progresses, eating its way through the gravel bed. There are thousands of acres in each of the several mining districts of the state which are susceptible to treatment by these modern machines. Some of the river beds of the state have been tested by small machines, with varying success, at several points. The gold which has reached the main water courses is generally very fine and difficult to save.

The Ruble elevator is a very late device for overcoming the difficulties existing in "flat" sections, where the slope of the ground is too slight for sluicing and for dumps. It is an adaptation of the principles of the "undercurrent," often used with the common sluice, and of the hydraulic gravel elevator, and is, or certainly will be, made a success. It is a new thing, inexpensive, and the product of Oregon genius. It can probably be improved in some matters of detail, but the principle is all right. Roughly described, it is a stout, deep and very wide sluice box, some 20 feet long, placed near the foot of the bank to be worked, one end resting on or in the bedrock, the other raised to an angle of about 30 degrees from horizontal, so that an elevation approximating 20 feet is attained at the upper end. Heavy riffles, steel-capped, about one inch apart, are fixed transversely the full length of the box, the lower half of the riffle frame resting tightly on the bottom of the box. At the upper half the bottom of the box is "dropped" or set down some 10 inches below the bottom line of the riffles, which are maintained rigid and on the same grade throughout. This forms a grizzly of the upper half of the machine. At the lower end of this depressed half of the bottom of the box a suitable trough is fixed, which discharges at one side of the machine into an ordinary sluice riffled to catch gold. Material falling through the grizzly is caught in this depressed bottom and flows down and backward to the trough, thence to the sluice proper. This contrivance, therefore, is designed to get both the necessary "pitch" for the sluice proper and a dump for coarse material. One giant washes the gravel, movable rocks and dirt to the foot of the "elevator," where another giant is manipulated to force all the material and water from the first giant up the inclined sluiceway. When the water, rocks and disintegrated material is half way up the incline, it passes on to the section where the bottom has been "dropped" below the line of riffles, so that from this point upward all the fine material, with most of the water falls between the riffles onto the depressed bottom of the elevator; thence down and out over the sluice set to receive it and save the gold. The coarse material is carried on and over the upper end of the elevator and "dumped."

Some of the auriferous gravel deposits are very deep, and in localities form vertical hills covered with soil, bearing forests of trees from 100 to 300 feet in height, and dense growths of other vegetation. Many valuable deposits have been and are being found in the uplifted channels of great, ancient rivers, much larger than any of the present streams.

Many thousands of acres of gravel beds, with situations and environment indicating deposits of gold, remain unprospected in each mineral section of the state.

The amount of gold which has been taken from the placers of Oregon can never be known, but the total is enormous. In the early years nearly all of it was taken directly to San Francisco, where the Government has assay office and mint, where commerce centered and "fun" was plentiful. Tons of it went there. Banks received it on deposit to be checked against as coin; merchants received it in payment of bills; faro bankers gave blue chips for it; landlords received it, and real estate agents accepted it. It was a satisfactory "circulating medium"—got mixed with California gold and California got credit for its production. This is how Oregon's output seemed small, when, in fact, it was great.

Railroads have come at last to fetch supplies and machinery to the camps, and, mark the prediction, Oregon's near future will be bright with gold.

Unless all the "signs" mislead, and "prospects" fail and geology is at fault, the demand for copper will meet a quick and big response from Oregon.

Beginning of Quartz Mining.

The gold of the placers came from veins in the hills. Time and his servants broke down, disintegrated and removed to gulches, bars and valleys the upper parts of the quartz veins (or ledges), in the work of destruction on mountains and hills; the remainder still lies encased in the rocks, some of them rich with the metals. Some ledges, harder than the adjacent rock, and better resisting decay, stand as reefs on the hills, and are easily found; others have been eroded with the general formation. Formation is a term in general use when referring to the character and mineralogical structure of rocks in a given locality.

Accumulated detritus, soil and vegetation have buried the greater number of veins far out of view from the surface, and prospecting for mines bearing precious metals has grown to be, in a sense, a profession or calling. The words vein, ledge, lead, lode, are in general, indiscriminate use in designating mineralized filling of fissures.

The Prospector.

The largest mine ever opened was, at first, a mere "prospect." The business of the prospector is to find a vein large enough and rich enough to be developed into a mine. When a vein is found and sufficient work done on it to disclose its character and probable dimensions, and it carries valuable ore, it is, in common parlance, called a "prospect." If he is able, singly or with assistance, to "open it up," and put it in condition for extracting ore in quantities sufficient for shipment or for milling at a profit, he has a mine, and usually it is exceedingly good property. If he is unable to develop his find, he has a prospect for sale, and is ready to enter into a contract with others on terms or conditions mutually advantageous. Here is opportunity—and there are many of them—for the judicious but fearless use of money. The niggardly doling out of petty sums for development of a prospect to a mine is as senseless and often as futile as attempting to build a steamboat with the price of a yawl, or to establish a department store with a stock of haberdashery. It is not necessary to squander money on studs, fancy vehicles, packs of hounds and wine cellars to open a mine, as has so often been done to the ruin of many splendid properties. What is needed is ample funds at hand to push and pay for hard work sensibly directed. Heavy expenditures are very rarely necessary to determine whether a prospect can be made a mine; whatever expenditure is determined upon should not be doled out, like dropping nickles in a slot machine, by a board of far-distant directors, rivaling each other in dissertations of economy in the administration of—to them—unfamiliar affairs. If a competent manager cannot be had and trusted, keep out of the business; but if one is secured, back him up as is done in other lines of business. Failures will not be frequent; he will quit if the "prospect" doesn't "develop." If a mine is opened out the investment will promptly pay four-fold, or better.

Furthermore, many good properties have been left unproductive for years through intrigues of cliques in boards of directors, or among stockholders, to "get control" and absorb small holdings. It is a critical time for the management when big pay ore is struck and the prospect proven to be a mine.

Opening a Prospect.

With a vein of promising ore in good formation disclosed in the prospect hole sunk on the vein (or in open cut or tunnel if the vein be found on a steep hillside) the work of opening it up is commenced, always following the ore, if possible. With the prospect hole for a starter the explorer and his assistant, for he must soon have one, sinks the hole, which now becomes a shaft, deeper on the vein. At 10 to 15 feet a windlass, with rope and bucket attached, is adjusted and the dirt and rock raised from the bottom as work progresses, one man in the shaft, one at the windlass. Presently as depth is attained a whim is bought, or a rude one constructed and a horse taken into association. A whim is a simple machine, especially if not patented or is home-made, whereby a horse, the older and more crippled the better, is attached to a long sweep which revolves a drum as the horse pursues a circular track around and around. A rope, long enough to be extended or let out, as the shaft deepens, is fastened by one end to and wound about the drum, the other end, passing over a pulley or sheave above the shaft, is attached to a bucket. As the horse pursues his deliberate way in his allotted field the rope is wound around the drum and the laden bucket raised to be emptied and returned by the "partner" in charge at the top. Miners while working together and on the same shift are "partners." The veinstone and ore is carefully inspected and tested for values frequently as work progresses. Every change of mineralization is specially noted.

The whim suffices for a depth of 200 feet or more, unless water in considerable quantity is reached, but 200 feet is a fair limit for direct horse-power. Hoists, with steam or gasoline engines, are necessary if greater depth is determined on. If the vein shows well and the miner has followed it, drifts on the vein each way at points 50 or 100 feet from the surface are run as far as practicable, as well as others from the bottom of the shaft. By this time a pretty fair estimate of the prospect can be made. Of course, faults may be encountered, dikes may have cut off the vein, and many things, including the character and condition of the walls of the vein, must be considered, as well as its size and ore-bearing "habit"; but the foregoing will give an outline, indistinct because of abbreviation, of how prospects are prospected. Where tunnels can be run from the hillside and the vein followed and depth gained rapidly by reason of acclivity of ground above the tunnel level it is by far the best method of opening, testing and working a vein. With rare exception veins dip or descend at an angle from the horizontal, so that the prospect shaft is put down on an inclined plane, which may vary in its dip and render it unfit for working to the deep; but usually such work can be so planned as to render it available for air courses to later workings.

The Mine Opened.

One unfamiliar with the operations of a great mine being carried to the deep and where stoping of the ore is in progress can have at best but faint conception of the realities and conditions attending such enterprise.

Hundreds, a small army, of men, each skilled in his work, report for duty and go to their allotted stations underground where miles upon miles of tunnels, drifts, winzes, stopes ramify the heart of the mountain in labyrinthian maze, with the regularity and quiet of disciplined soldiers. The mighty engines, with scarcely audible exhaust, hoist the triple-decked cages, loaded with tons of ore, from the 2000 feet station below to the surface while you count 60. Meanwhile another three-storied cage descends the adjoining compartment of the huge shaft. Another engine moves the deep breathing compressors as they fill receivers, built like flueless great steam boilers, with air to be sent below, through miles of stout piping, there to run the lesser pumps, the small engines of underground hoists, the noisy machine drills and supply air for men when needed. Another engine, a monster machine, drives the great pumps which throw a river to the surface in steady flow. The engineers, silent and attentive, note every pulse beat of the giants which they control; quietude, precision, Titanic force everywhere. Step onto the cage. It is safe as the best elevator in your city, and drop a half mile in a minute to the station, roomy as a house. Electric lights do not dispel the blackness of these cavernous deeps, gloomy and silent as a tomb save for the far-away throbbing of the little air-driven engines in the distant drifts and the rataplans of the drills boring holes for dynamite. Men, bare to the waist, fair of skin as babes, but muscled like athletes, dispersed at faces of drifts and stopes, with well-schooled eyes and skillful hands are revealing some of Nature's mysteries, digging gold from the fissured rocks—rocks long ago fashioned under the waters of ancient seas. Each day's labor adds to the wealth of the world above; discloses some new mystery, some new beauty. There is no tint of rainbow or flowers, no color in sky or sea; no hue eye ever saw but is duplicated down deep in the mines. It is not all gloom; there is cheeriness here, and contentment and hope and kindness in the hearts of these men who do not stop to note your presence. A thousand dangers have proved their courage. Moreover, every skilled toiler here gives indirect employment to at least two workers in the forests, fields, factories and marts of the outer world. It has been estimated, probably correctly, that the quartz miner at work requires employment of four men in ordinary avocations to supply his machinery, tools, timbering, lumber, explosives and food, clothing and family needs. This industry, therefore, is both a producer of wealth and a patron of all the economic industries.

Reduction of Ores.

The Korean mill was probably the first device for crushing auriferous quartz to fineness sufficient for separation of gold from its gangue. It consisted of two large long, hard stones, one trough-shaped on its upper side, the other dressed so that one rounded face would fit into the trough of the other; the first was firmly bedded, trough face upward, and the second placed in it. Bamboo handles were fitted to the upper stone and manual power gave it a rocking motion. The ore, introduced in small quantities between the two, was ground to fineness between these rude upper and nether millstones.

The arastra, another ancient device, is still in use in remote localities of this state where expensive machinery cannot yet be installed. It is an efficient saver of free gold, but a very slow machine. It is aiding in the development of rich veins, and in testing the various ores of localities for free gold. Omitting some variations in size and minor details of construction, the machine can be roughly described. A suitable place is cleared to a level, well hardened, smoothed surface. In the center a stout post some two and a half feet in height is firmly placed in the ground, the top of the post fitted with a strong pin. A circular floor some 10 feet in diameter made of flat, hard, carefully fitted stones, bedded and tightly tamped at all points, is laid on the place prepared for it. With equal care the outer edge of this floor is closely fitted with a rim of stones carefully selected and joined, resulting in a huge dish or basin of stone 10 feet in diameter and some 18 inches deep. Everything is made tight to prevent loss of quicksilver. A long pole or beam with a suitable hole, bored for the purpose, is placed horizontally on the post, the pin fitting the hole, the long arm of this beam extending beyond the outer rim of the basin, the short arm loaded to balance it. Two or more large, flat-faced, hard stones, dressed to proper shape for grinding, are placed in the basin and attached by ropes or chains to the beam above them. Now place in the basin a supply of ore, broken fine as means permit, introduce water, hitch a mule (for some inscrutable reason a mule is best) to the outer projecting arm of the beam, start him circling around and your machine is in operation.

The large stones attached to the beam are dragged over the bed as the mule hurries along his allotted path and slowly grind the ore to a pulp. Quicksilver is sprinkled in as needed during the grinding and the gold as freed from the pulverized quartz is amalgamated and settles at the bottom of the basin. At one point a piece of heavy board or plank, some 6 inches wide, forms a part of the rim. Holes at various elevations in this board are fitted with plugs. When the operation of grinding and amalgamation is complete, the plugs, beginning with the top one, are withdrawn and the pulp washed out of the basin by introducing more water. Care is exercised in this operation to prevent loss of amalgam and quicksilver. The amalgam is gathered, placed in a piece of buckskin or wetted cloth, and tightly squeezed and pressed; practically all the quicksilver not attached to gold oozes through the skin, or cloth, and is saved for further use. The remaining, (dry) amalgam is subjected to a low red heat, which drives the quicksilver off in vapor leaving the gold. By placing the dry amalgam in a deep iron bowl with tight fitting top, in which a bent tube is inserted and applying heat, this quicksilver can be saved; the vapors pass through the tube to its outer end, which is immersed in a basin of water. On reaching the water the vapors instantly condense to metallic form and pure quicksilver is the result. This process is the retorting of quicksilver.

The Chilean mill, a device in some respects similar to the arastra, has never been used in this country. Its distinguishing feature consists of large stone wheels, instead of the stone drag, of the arastra. These stone wheels shaped much like the wooden wheels of the logging camps, were rolled over the ore by the circling sweep of the axles, which, pivoted to the center post at one end, and projecting like the beam of the arastra, extended beyond the rim of the annular crushing bed, by application of animal power. It is supposed that oxen were used for these ponderous and clumsy machines rather than the speedy mules, which American miners find so useful in their hardy employments.

Of course, where water is available it is utilized for power in driving arastras; and the expense of running them is inconsiderable; but the best arastra is a slow crusher.

The Modern Stamp Mill.

It is a far step from the humble arastra and its long-eared power to the modern mill with 300 stamps weighing a half ton each, rising and falling nine inches 100 times a minute; supplied with rock-crushers, automatic feeders, kickers, jigs, vanning machines, copper plates, revolving barrels, amalgamating pans, mercury extractors, laboratory, retorting furnace, electric lights, and all the appliances incident to the operation of the great establishment.

In the arastra ore producing $25 to the ton is barely, if at all, profitable under favoring conditions. The big mill gives steady and liberal dividends from ore yielding less than $3 per ton.

Originally men broke one stone by striking it with another which was harder or tougher. A mass of iron was better. Hammers, bars and pestles were grand achievements. For fine crushing a heavy pestle for battering rock in a hollow vessel, was really necessary and was adopted, but the lifting of and striking with a vertical pestle was hard work and men found some relief in a prototype of the stamp mill, the "dolly." This consists of a simple contrivance. A beam of wood, shod with iron, fitted with a pin on either side for handles is suspended vertically from a suitably adjusted spring pole, or a flexible sapling. Under this, on a block set grain upright and well bedded, a tree stump is better, a mortar is placed so as to be a few inches lower than the iron shod end of the suspended beam. Ore placed in the mortar is crushed by apply-

15-STAMP MILL ON THE GREENBACK MINE, VICTOR, JR., GOLD MINING COMPANY, JOSEPHINE COUNTY.

This view shows the amount of timber within easy reach of every mine in Oregon.