<u>Gold Mining in California</u>

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Final Paper

Formation of the Sierra's

The earth's crust is broken up into many different pieces called plates. Some plates compose continents while others compose sea floor. Sea floor plates are dense and about 3 miles thick while continental plates are lighter and about 40 miles thick. Underneath the crust is a semi-molten layer called the mantle. Roughly 750 million years ago all of the continental plates were adjoined forming one supercontinent known as Rodina. Rodina began splitting apart around 550 million years ago due to convectional currents underneath the mantle.[1]

The creation of Sierra Nevada started nearly 400 million years ago as subduction between two sea floor plates occurred. Subduction occurs as two plates collide and one is pushed underneath the other. The rubbing of the plates and seawater created magma and in eventually volcanoes. The volcanism created an island chain or island arc, which would eventually collide with North America creating low mountains. About 215 million years ago the Farallon plate, began subducting under the North American plate.[2] It is believed that this occurred after the split of another supercontinent called Pangea. About 270 million years ago the continents had collided to form the supercontinent Pangea. As Pangea began to break apart the rate in which the North American plate moved west increased. This increased speed in conjunction with seawater is believed to have created volcanoes in the region.[3] The majority of eruptions in the Sierra Nevada's occurred from about 150 million years ago to about 70 million years ago.[4]

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[1] *A Regional History* chapter 2 pg.25
[2] *A Regional History* chapter 2 pg.26
[3] *Plate Tectonics* chapter7 pg.181
[4] *A Regional History* chapter 2 pg.27

The eruptions released massive amounts of sediments such as pumice, rhyolite, tuffs, and obsidian. This created a sedimentary zone that laid over the mountain range. As time passed erosion took place and removed much of the sedimentary zone. This created uplift through isostacy and the granite core rose to form batholithic formations. Batholiths or "deep rock" is used to describe rock such as granite, which extends far into the crust. As the granite batholiths began to cool and contract they also cracked. These cracks then filled with water and dissolved silica and metallic sulphides from the rock.[5] As the left over minerals began to concentrate lode deposits were formed. These lode deposits many miners were in search for during the gold rush.

Rock types

Rocks can be classified in many different ways. The most basic way is by how they were formed, this is known as genetic classification. There are three basic genetic classifications of rock, igneous, sedimentary, and metamorphic. Igneous rocks were formed when molten rock or melt solidified. Sedimentary rock could be formed by either the fusing together of preexisting rock fragments or the extraction of mineral crystals from water. Metamorphic rock was formed when preexisting rock changed into new rock due to an increase in pressure and temperature. Rocks are also classified by the speed in which they were cooled which is directly related to their silica content. Rocks with higher silica contents cool slower and those with lower silica content cool faster. Slower cooling allows for the formation of crystal and minerals. There are three classifications of rocks based on silica content and rate of cooling they are Igneous, Andesite, and Ryholite. Figure one is an example of igneous granite rock, which has a high silica

[5] Young E Otis, *Western Mining*, 1970 University of Oklahoma press, pg.10

content and slow cooling rate.[6] Notice the granular form and the number of minerals and crystals that have formed. Figure two and three on the other hand are examples of rocks that have very little mineralization. Figure two is an Andasitic rock; there are some minerals but not nearly as many as the igneous rock. Figure three show a Rhyolitic rock, which has the highest cooling rate and silica content of the three classifications. Notice that this rock has very little mineralization at all except for a few small specks. Another classification is the distinction between volcanic and plutonic rock. Volcanic rock was formed during a volcanic explosion and is typically fine grained and has minerals to small to distinguish. Plutonic rock on the other hand was not formed by volcanoes and has much coarser grained minerals.

Figure 1

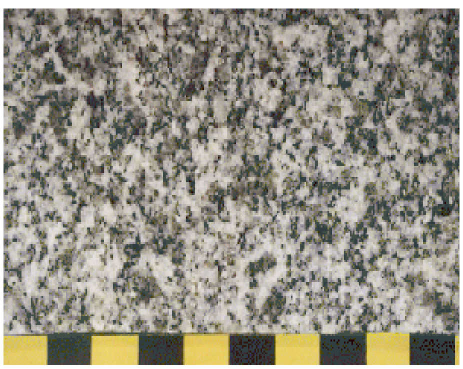
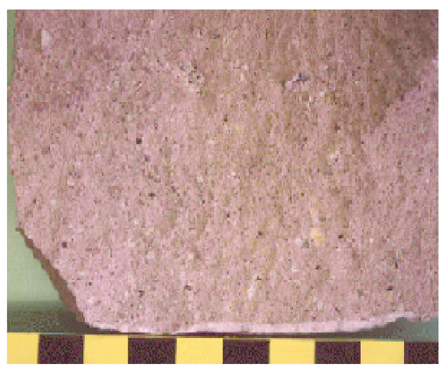


Figure 2



(Paula J.W. Gore http://www.dc.peachnet.edu)

Figure 3 (John Francis http://www.seis.natsci.edu)

[6] *Part II: Earth Materials* pg.131-132

The main factor that contributes to igneous rocks having a high metallic mineral content is silicon dioxide. Silicon dioxide in its purest form is known as quartz. Silicon dioxide entraps metals, so the higher the silicon contents the more mineralization. Some forms of quartz such as vitreous, cryptocrystalline have nearly 100% Silicon dioxide. Granite, which can also have high mineralization, typically has about 50% silicon dioxide.   Igneous plutonic rocks can hold the most precious metals. This is why the Sierra Nevada's was heavily mined because the entire core is igneous plutonic granite.[7]

The Gold Rush Begins

California experienced the first gold rush of the west in the mid 1800's. In 1939 John Augustus Sutter went to California to farm along the Sacramento River. Figure 4 shows a picture John Augustus Sutter. One of his employees James W. Marshall was the first to discover gold. On January 24, 1848 Marshall discovered some type of sediment collecting on the river by the wheel to saw mill.[8] Figure 5 shows a picture of James W. Marshall. Marshall knew right away that what he saw was gold. Later that evening one of the men in Marshall's crew wrote in his journal, "This day some kind of mettle was found in the tail of the race that looks like goald."[9] Sutter tried to prevent the news from getting out fearing it would ruin his plans for farming. It was already to late the news had spread to nearly every adult male in California. The commander of California's military force, Colonel Richard Barnes Mason had reported the findings to the War Department and soon President James K. Polk new about the discovery of gold. By the spring of 1849 fifty thousand people began making their way to California.

[7] Young E Otis, *Western Mining*, 1970 University of Oklahoma press, pg.103
[8] Sutter A. John *The discovery of Gold in California* pg.2
[9] Young E Otis, *Western Mining*, 1970 University of Oklahoma press, pg.104

Figure 4

John A. Sutter

Figure 5

James W. Marshall

(Museum of the City of San Francisco   http://www.sfmuseum.org)

Placering

One of the first methods for finding gold was dry washing. This method was used where water or materials were scarce. The basic idea was to take a bed sheet and hold it at each end by two miners. Then shovel dry sand onto the blanket, when a breeze comes toss the sand into the air. The wind will separate the sand from the gold. This practice was eventually abandoned since it was slow and wasteful and was replaced by panning.

Panning was fairly simple and much more effective than dry washing. The practice entailed filling a pan with about two inches of sand and some water. The pan was then shaken so that the sand fell over the edge and hopefully the gold chips stayed at the bottom. Figure 6 is an example of a modern day panner. At the beginning panners used woven baskets, which were eventually replaced by a standardized sheet of metal eighteen inches in diameter and four inches deep. The sides were slanted at a thirty-degree angle allowing the water to pass over the edge. An area of sand high in gold dust content was referred to as a pay streak. Many times a pay streak was hidden under several feet of sand in a sand bar or low-lying gravel bank. To get to the pay streak panners would many times have to dig down several feet. To speed up this process many 49ers resorted to "coyoting". This involved digging one shaft down until one hit bedrock and then digging tunnels outward. This method was more effective but also more dangerous since it was common for cave-ins to occur.[10]

Figure 6

(Joshua J. Vick http://www.goldfun.com)

A problem soon arose after the emergence of "coyoting" which was that one person shoveling could remove sand faster than two or three men could pan. This led to the development of the cradle or rocker and the four-man system. The four-man system had two men digging while the other two worked the cradle. Although the cradle was a fairly simple invention it revolutionized panning. The cradle consisted of a box with a mesh screen on the bottom attached to two rockers. Below the box sat a canvas angle downward allowing sand to run off. As sand was put in the box water was poured and the cradle was rocked simultaneously. The mesh caught the gold and the sand was washed through the system. After solving the problems of digging and washing 49ers

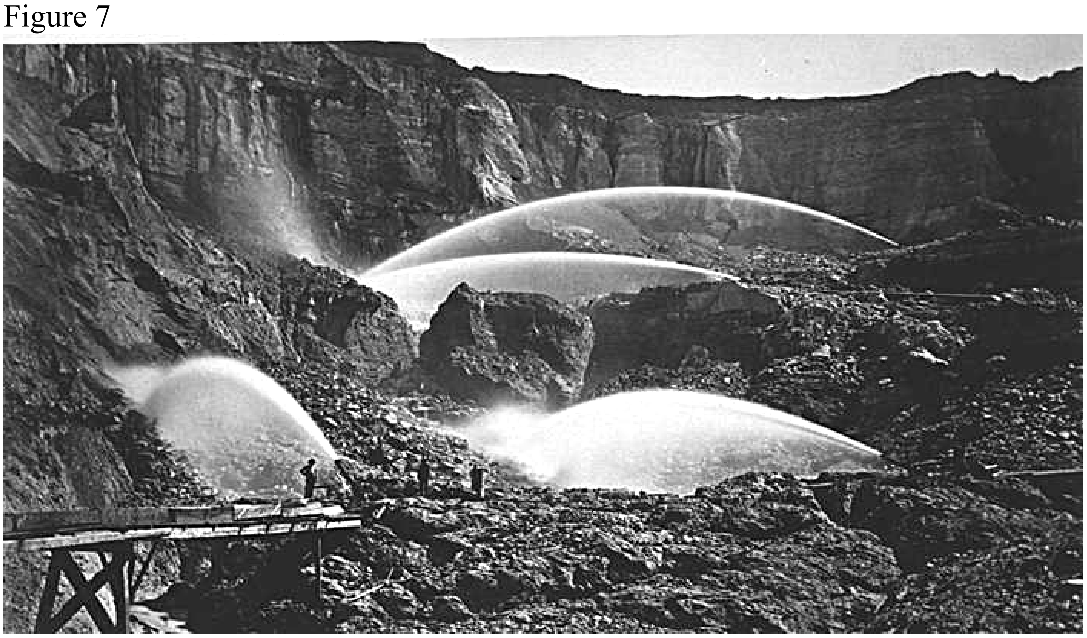
[10] Young E Otis, *Western Mining*, 1970 University of Oklahoma press, pg.113

now faced the problem of getting adequate amounts of water. Independent water companies soon built dams, canals, and fumes. The longest of these water systems was the Eureka Canal in El Dorado County, California that spanned over 247 miles. The companies would then charge either a flat rate or percentage of 49ers income.[11]

Hydraulicking

After nearly being killed by a cave-in Edward E. Matteson wanted to try and wash out rather than dig out the pay streak. On March 7, 1853 with the help of a sail maker and tinsmith Matteson constructed a pressure hose and Hydraulicking was born. Figure 7 shows the high-pressure hoses used during hydraulicking in action. Even though the initial investment was high and the amount of gold per-ton sorted was low Hydraulicking was still quite profitable. The reason for this was its low operating cost and the huge amounts of sand that could be handled.[12]

Figure 7



(2000 California Historical society http://www.californiahistory.net)

[11] Young E Otis, *Western Mining*, 1970 University of Oklahoma press, pg.115
[12] Crouch E. Craig, *Hydraulic Mining in California* 2002 pg.3

Once a promising gravel bank was found a dam was constructed up stream. A flume was then built to carry the water to the gravel bank. As the water reached the end of the flume it came to a head box. The headbox caught the water and sent it through a hose. At the top of the headbox was an overflow gate, which allowed water to be sent back down the stream. As the gravel bank was hosed the debris and water would run into a sluice. A sluice was basically a man-made trench or flume that filtered sand and gravel. The sluice had large grates that filtered out large rocks and pebbles. The water and sediment was then sent down another sluice where the more refined filtering took place.[13]

Not everyone favored hydraulicking practices taking place in California. The debris dumped down rivers was creating flooding and severely hurt farming. This was quite evident on the Sacramento River in which nearly all the agriculture had been ruined. In 1884 a court ruling put restrictions on hydraulic dumping and virtually eliminated the practice.[14]

Dredging

Placering in California was on the decline until 1898, when a new technique was introduced, by W.P. Hammon and Thomas Couch. The technique was dredging an idea first developed in New Zealand in 1882. A floating dredge would scoop up sand from the riverbed and then sort the gold on the dredge. This enabled the 49ers to placer anywhere along the river not just sandbanks. Dredging also solved the problem of river flooding since they weren't putting extra materials in the river and the sand they did take out was put back where it came from. Dredging was ideal at the foot of mountains were

[13] Crouch E. Craig, *Hydraulic Mining in California* 2002 pg.4

[14] Young E Otis, *Western Mining*, 1970 University of Oklahoma press, pg.125

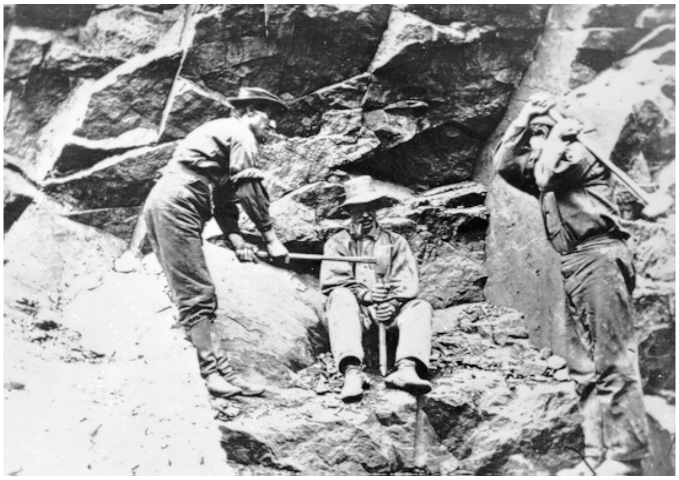
the land was at a low angle and the rivers current was not strong. The basic design of a dredge consisted of a large flat-bottomed rectangular barge. The mechanism that actually did the dredging was usually a pulley system that held buckets to scoop sand. The buckets poured the sand into a funnel, which traveled to a filter. This grate filtered out pebbles and the smaller sediments pass through. Once through the grate the sediments would pass through a finer filter, which would separate the gold.

Mine operations

There were two basic entrances to a mine, a basic tunnel or a shaft. A shaft had its disadvantages for the obvious reason of gravity. In order to bring materials to the surface they had to be pulled by winch or its counterpart the headframe. The majority of the work took place along the drifts or working tunnels. These tunnels followed the direction of the lode and this was where the majority of the mining took place. The actual mining was originally done with a pick-ax and shovel. Eventually the method of single jacking evolved which involved a single person hammering a steel rod into the rock. This then evolved into double jacking where one person held the steel rod as two people hammered it with sledgehammers. Figure 9shows an example of three men double-jacking. As technology evolved so did the methods of mining.[15]

[15]Young E Otis, *Western Mining*, 1970 University of Oklahoma press, pg.205

Figure 9



(Michigan Historical Museum
http://www.sos.state.mi.us/history/museum/explore/hismus/prehist/mining/iron.html)

Innovations

Two of the major innovations in mining in the middle 1800's were that of drilling and mining. Drilling prior to 1875 took two to three men and was called double-jacking. This method was very slow and exhausting method of drilling. However in 1870 railroad companies began experimenting with steam powered drills. The finished product never really got off the ground since it had several design defects. Experiments with the steam drill did however lead to the invention of the compressed air drill. The new drill used steam from a main steam plant and ran the steam with pipe to an air compressor. The compressed air was then run to the drill. This new invention made drilling much more efficient by being able to break through hard rock much faster than double jacking.[16]

The other major technological mining development was also introduced in 1870's with the development of high explosives. From 1866 to 1875 miners used "soda powder" which used sodium nitrate. This explosive was not very powerful and was replaced by nitroglycerine. Nitroglycerine was an extremely powerful and dangerous explosive.

[16] Young E Otis, *Western Mining*, 1970 University of Oklahoma press, pg.206

Only the largest of the mining companies were capable of handling the explosive due to its volatile state and the cost to preserve it. However for those who could use nitroglycerine it became quite a useful tool. Not only was it highly powerful but also the chemicals could be altered and its explosiveness modified depending on the rock type.[17]

Milling

There were two economic types of mills the "custom" and "intergrated" mills. Custom mills were created where there were several small mines not large enough to support their own mill. These mills bought ore based on its estimated value minus operating costs and profit. Integrated mills on the other hand received all their ore from one single mine. Although mine operations varied some from mine to mine the basic ideas were the same. The ore would be delivered from cart or in some cases on a pulley system directly from the mine. As the rocks entered the facility they would be broken into fist size pieces. This was originally done with a sledgehammer and latter by large crushers. The rocks then passed through a Blake jaw crusher or similar crusher that broke the rocks into tiny pieces. The small rocks then entered the stamp mill. During stamping the small rocks were compressed into sediment.[18] Large steel "shoes" slamming into the small rocks did this. Once the rocks were stamped into flour it was heated to remove sulfur and arsenic. The flour was then put into barrels where water and mercury were added.[19] Figure 10 is Standard Mill in Bodie California, which is an example of a stamping mill.

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[17] Young E Otis, *Western Mining*, 1970 University of Oklahoma press, pg.208

[18] Young E Otis, *Western Mining*, 1970 University of Oklahoma press, pg.155

[19] Young E Otis, *Western Mining*, 1970 University of Oklahoma press, pg.156-157

Figure 10

Standard Mill in Bodie (The Good The Bad and The Ugly www.fortunicity.com)