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12 June 2012

G188

## The Gold Standard

### Abstract

Gold is formed in a very unique way. Not many people can imagine Gold being able to dissolve similar to how their sugar dissolves in their tea, however if the pressure is high enough as well as the temperature, it occurs. This process occurs deep underground, but the magmatic water rises up higher in the crust. As it cools it deposits gold as well as trace minerals. These trace minerals hold the key to finding gold due to their abundance. The process of extraction gold has not changed much over the years since the large gold rush in the Sierra Nevadas, however it has become updated.

### Introduction

Gold has always been a high sought after material for most of recorded history. In recent, centuries it has ranged from a measure of wealth to a highly specialized industrial material. What makes it such a highly sought after material? It is very malleable, with one gram being able to cover a whole square meter. It is one of the best conductors of an electrical current. However it is not widely used for many of these industrial uses due to how scarce it is. This is the factor which largely controls the price, and puts such great pressure on the discovery and mining of gold. With a current price of around \$1,600 an ounce gold has changed a lot from the 1840s when it was first discovered in the Sierra Nevadas. I will give a general

overview of how gold is formed, the different types deposits, and the history of the gold extraction process. I will also discuss the large numbers of trace minerals that can be used to locate gold.

### How gold is formed

The geologic formation of gold was a largely unknown for most of the history of mining. It is a well understood system now; however advancement is still being made in order to better understand where gold can be found. Gold is deposited in areas around the world as the water solution it is present in cools and drops in pressure. There are certain conditions that must be present for substances such as Gold, silver, or Quartz to be dissolved in a water solution. The water must be at a high enough pressure as well as a high enough temperature. (Ralph) Other substances must be present in the solution as well such as certain acids and sulfur (which will be covered more later). (Ralph) Water that is heated in the earth will rise to the surface as it is driven by convection. As the water rises the pressure as well as temperature begins to drop, which lowers its ability to carry dissolved minerals. As this occurs the gold and sulfur that had combined when they were dissolved, then break apart. (Ralph) This releases the gold and sulfur to become solids. (Ralph) The solid formation of gold in bedrock is common in areas of faulting and volcanic activity. The cracks and openings in faulted areas allows for the movement of water as well as more defined and concentrated veins.

Where does the dissolved gold come from?

It is not known for certain exactly where the gold is coming from, however it most likely rises up from the mantle, present in magma. (Hill) The magma then comes into contact with sea water at mid ocean ridges which dissolves the gold and other minerals, then concentrates them near the surface. (Hill) This newly formed crust may continue its life as crust, or it may be subducted introducing the minerals into new hydrothermal systems related to subduction-related volcanism. (Hill) Areas in which old volcanic activity and fault took place created large fractures that provided the water needed to carry the minerals. Over time these fractures slowly became sealed off by the built up of minerals through this process. (Hill)

### Locating Gold

As discussed earlier, gold as well as other minerals are concentrated in areas of volcanic activity and faulting. These large features allow geologists to have a better understanding of what minerals may be present in the area. Figure 1 depicts in black where hydrothermal gold deposits are commonly found. The large granite and granodiorite intrusion beneath the surface is the driving force for the formation of gold. During the cooling of the intrusion, water and gases are released. The solid arrows show the introduction of magmatic water, rich in dissolved minerals, into the zones of faulting which allow them to escape upward. Naturally the water begins to cool and drop some of the minerals. The introduction of meteoric water (shown as dashed lines) through porous areas rapidly accelerates the cooling process. In the zones where magmatic and meteoric water converge there is a large amount of gold, and other minerals present in rich veins. These veins are the primary deposits of gold in bedrock. These areas can be discovered by looking at the geologic features present at the surface.

Visible faulting nonactive faulting can be a large indicator of subsurface gold being present. Natural hot springs and geysers are current indicators that this process is taking place beneath them. These natural hot springs, faulting, and traces of volcanism are all indicators present in the Sierra Nevada area that point to large amounts of gold present. This was greatly confirmed with large amount gold removed from areas such as Bodie in California.

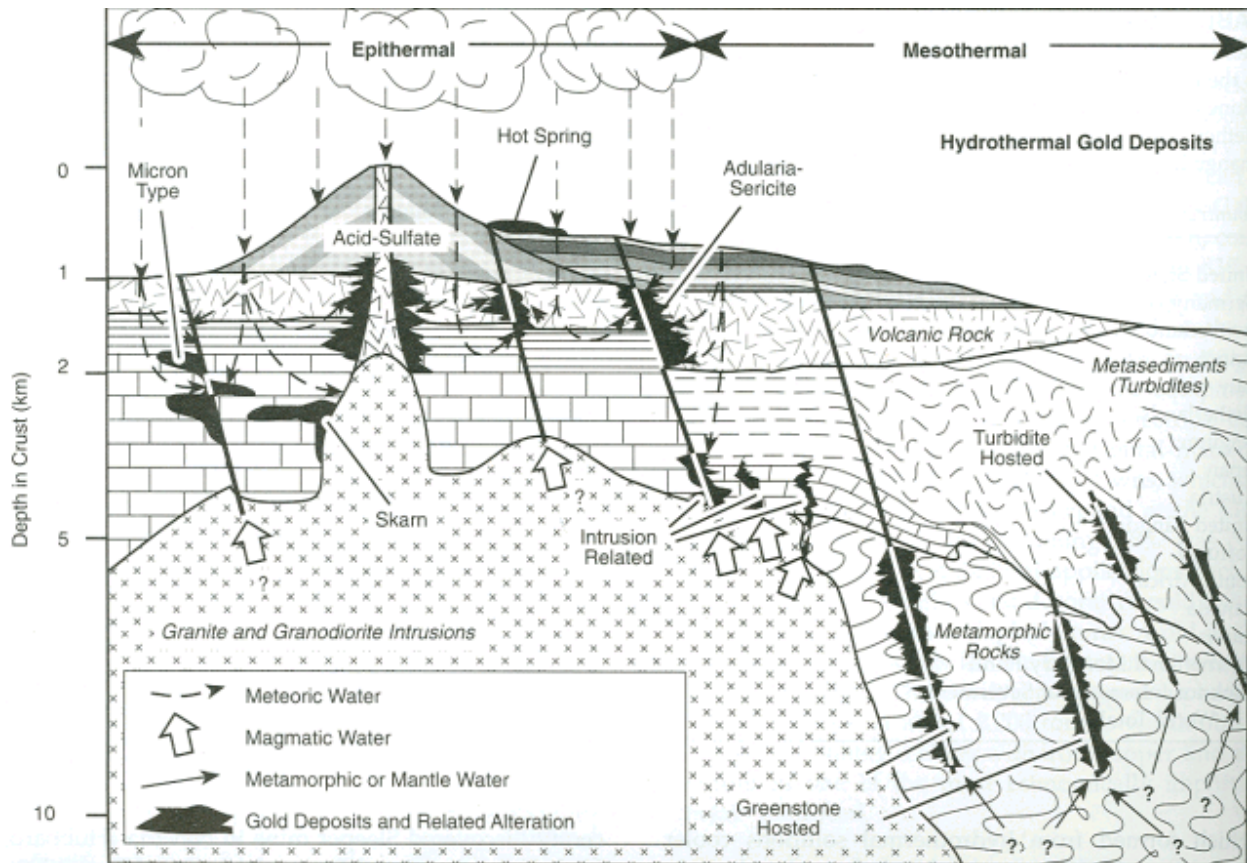


Figure 1  
<http://www.freeclimate.com/gold/GoldDepo.gif>

## Placer Deposits

The gold located in bedrock, will eventually be exposed, eroded, transported, and the deposited. The area where the gold is then deposited is known as a placer deposited. Placers are further classified by the process that transported the gold, such as stream and glacier deposits. (Southern) These processes allow the gold to become well concentrated due to the most significant property, its density. Figure 2 shows the densities of so common elements and compounds. With gold having a density of 19.3, it is significantly heavier than anything present in the streams or glaciers that are transporting the gold. This causes the gold to drop off in areas of reduced energy in the stream profile. However due to the rapidly changing profile of a stream, explorationists must greatly consider the ancient profile of the stream and how it has changed over the years. A glacier forms placers much in the same way as a stream. The glaciers' large physical force transports and breaks up the gold, while the streams stemming from the glacier may carry the gold and concentrate further from the glacier. ( Southern) These placer deposits as well gold being actively transported in streams were what all started the gold rush in California and the Sierra Nevada area. Over time the miners, discovered that the gold must be coming from a source because it cannot be forming in the stream conditions.

Densities of Common Elements and Compounds	
Substance	Density grams per mL or cc
Water	1.00
Aluminum, Al	2.70
Iron, Fe	7.80
Gold, Au	19.30

Mercury, Hg	13.5
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Figure 2  
<http://www.elmhurst.edu/~chm/vchembook/125Adensitygold.html>

Trace Minerals

During the process in which gold precipitates from magmatic water, other minerals precipitate around those conditions. These trace minerals are critical in the process of locating gold, due the minerals are more common making them easier to locate. Hydrothermal fluids given off by magmatic rocks are very likely to deposit Au-Ag bearing sulphidies. (Corbett) This water is very rich in sulfur, and will be easily noticed if it makes contact with the surface to form hot springs. In addition, quartz with saline fluid inclusions will form in large quantities in the area. (Corbett) The pH of the water carrying the dissolved gold will also greatly affect the trace minerals present. Low pH acid sulphate waters are highly effective at carrying and thus deposition of Au. (Corbett) Kaolin and pure Kaolinite commonly occurs in these low sulphidation veins. (Corbett) Bicarbonate waters, which are created by the condensation of CO<sub>2</sub> from super heated hydrothermal fluids and cooling felsic intrusions. (Corbett) These are less acidic then low pH acid sulphate waters, this greatly changes the minerals that contain Gold and surround it. (Corbett) Carbonates rich in Mn such as Rhodochrosite and Kutnahorite will

be present in the ore. The grade level of the gold is directly related to the surrounding rock make up, Fe to Mn and Mg will be higher grades while Ca carbonates are lower grade. With most all magmatic waters that produce gold, containing sulfur it is one of the biggest hints if it is present in a surrounding mineral. Pyrite, Galena, and Arsenopyrite are a few that commonly surrounding gold veins. (Ralph) Veins of quartz are believed house gold, however the last quartz to form in the Sierra Nevada area is commonly the only quartz that contains gold. (Hill) Gold would tend to accumulate where the veins of quartz would dip or turn. (Hill)

### Sediment Hosted Gold

This is formed in a similar way as stated before however the magmatic water rises into overlaying sediment. (Corbett) These deposits commonly occur in the western U.S. in areas where there is a fluid source, extensional structures to allow for transport as well as host rocks that are favorable to the production of ore. (Corbett) The gold that is deposited from this method is a very small and most likely not visible. However the gold is commonly a higher grade, however processes such as cyanide leach must be used do to the small particle size.

### History of extraction

Gold has always been prized for thousands of years. It was traded and used as currency, as time evolved it the backing of the U.S. dollar. A lot has changed over the years of gold prospecting and mining as the demand has risen. Gold was first discovered and mined in large scale in California on January 24, 1848 by James Marshall. This marked the start of a long

history of mining that greatly changed the area. They began mining placer deposits in the area. There were many large mills in the area that worked to extract gold from large placer deposits while smaller groups and individuals mined stream and rivers in the area. This gold was actively being transported or more recently deposited. Many of the smaller operations would have individuals panning for gold, this is a simple way to separate gold from the soil and surrounding rock by using the gold's high density to settle it at the bottom of a pan. Larger operations at the time would use sluicing to separate the gold. This uses the same principle as panning, however it can handle much larger volumes per hour. A sluice box has small ripples and voids, which the gold will settle into when water and pay dirt is passed over top. This method of separation is still widely used today, however it has been updated with the use of diesel powered equipment. As the miners progressed and newer and newer discoveries were being made, prospectors searched for the sources of the gold present in placer deposits. With the discovery of gold veins in bedrock, subsurface mining had taken over. This required them to go deeper and further than before however the pay off was greater. Shafts would be created into mountain sides where the gold was present. The ore would then be hauled out, crushed, and then put through processes of extraction similar to those stated before. Over the years the process of extracting gold has become much more expensive, due to a few reasons. One of the larger reasons, is the yield of gold per ton has greatly declined, meaning that more material must be extracted to yield the same amount of gold. This means that mines are now going to the furthest extent in order to extract all of the gold from the tailings. Many mines are using cyanide in order to dissolve the gold, no matter how small the particle in order to extract it. This may seem like a great process to extract gold; however there is large debate over the



environmental impact of this process. There have been a few occurrences in which the cyanide has contaminated the soil and drinking water of the surrounding area, however accidents happen with any sort of industrial process.

## Conclusion

Gold has been a large part of human written history. Whether it was used for trade, or just as a factor of wealth it is largely sought after. Much of the gold mining is over in the Sierra Nevadas, however there are current day gold rushes taking place all over the world. Those gold rushes are much different than those seen back in the late 1800s with changes in the techniques for locating and extracting gold. Trace minerals along with new geologic technology may hold the key for the discovery of larger and new veins of gold in the years to come. No one knows how the demand or uses for gold may change in the coming years, however with the long history of gold I do not see anything negative in its future.

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