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Deposits of gold in three Southern America countries

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Thanks to my job, I had the chance to cruise around the geological features of the world. This time, I visited the mines in the three countries of South America, Colombia, Brazil and Bolivia, especially the mines of rare metals and gold. I would give a short description of the geology and the gold deposits in these countries separately.

Colombia- regional setting

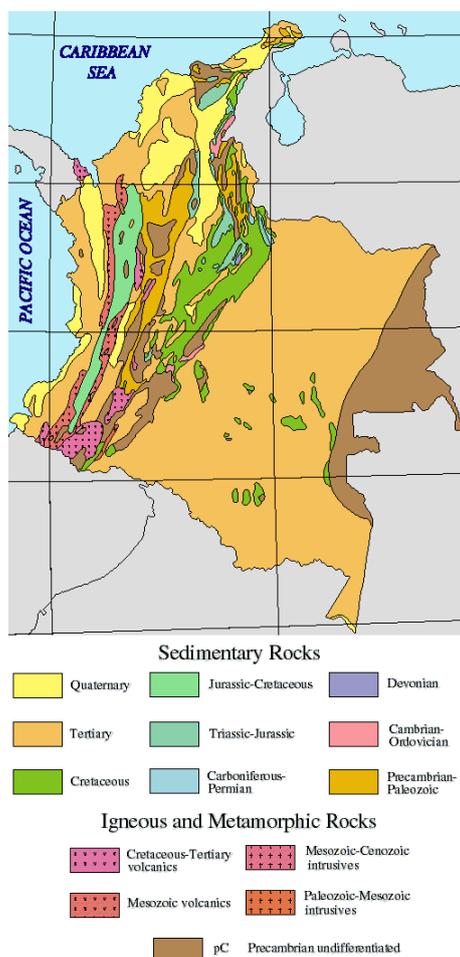


Figure 1- Geological map of Colombia

Colombia is formed by two territorial zones, one submerged in Pacific Ocean and Caribbean sea, the other is the emerged land formed by Andes mountain range and the Llanos plains which is shared with Venezuela.

The Nazca plate collapsed with South America plate pushing it under the Caribbean plate in Paleozoic era. Colombia is dominated by the famous Andean region which is split into three mountain ranges, cordillera central, cordillera oriental and cordillera occidental. The visitors to Bogota, the capital will never lose their way if you remember two numbers, one is for carrera and another is for calle as all roads are built either perpendicular or parallel to the cordillera.

From the geological map above (figure 1), we see the north-west side of the country is pressed by the subduction of the Pacific ocean, the orogenic activities resulted in the raise of Andes mountain which extends along the coast of the ocean throughout several countries. We expect we should see some typical minerals in this area, such as copper, gold etc.

I visited several small gold sorting plants near the country side of the second biggest city. They collected the ores from the same mountain which has been sold to a big Canadian company.

The gold deposit has been mined for more than one hundred years.



Figure 2- Inside the tunnel of gold mine

The miners use the primitive method to upgrade gold. They make their own crushers and shaking tables. The mine is located on the mountain top. They use mercury and cyanide to extract gold which is getting more attention from environment department of the government nevertheless the government seems not able to close the plants as they can not provide the residents another choice to earn live.



Figure 3- Shaking table

One of the miners told me he is using his father's machines which were made thirty years ago. I told him just give me 3 years, I will return a new plant for him. The flow chart of sorting gold has remained the same for hundred years. The miners drain the effluents of chemicals to the river at the mountain foot. The government has no proper policy to control the effluents or tailings. I was afraid to take any fish at a restaurant near the river.

The recovery rate is not high, I believe they lose more than half composition of gold in the process. I found out the gold exits in the form of sulphide or oxides. They use naked eyes to get gold, so they do not know what they have thrown away. They welcome me because I would provide them the latest machines and techniques, I ask them to sell the gold concentrate to me before they put in any chemicals. Unfortunately, it is a dilemma for me because my friend who introduced the miners to me is selling chemicals.

I came to another site with open pit mining. It is alluvial gold, the owner is a geotechnician who use more than 20 caterpillars to extract gold (figures 4 & 5). He is looking for cooperation with me, he speaks very little English except Spanish which is the major language in Latin America. I was forced to master the language in 6 months for daily conversation.



Figure 4- Three caterpillars in a group to extract gold



Figure 5- a gold vein in the same area

I came to another site which has a combination of rock and alluvial gold. The surface ground veins extend for more than 200 meters (figure 6). They have no proper exploration, they just follow the direction of the veins. The living condition is not good, the owner has experienced 8 times malaria. No proper road to go there, no mobile signal. This site has a high percentage of gold but the gold concentrate has 13% Arsenic and 6% sulfur. The use of cyanide seems not satisfactory in this plant. Besides, silver is about two times of gold. The final product of the site is a

mixture of gold and silver which is sold to local buyers.

Gold exists as small fine particles in nature, seldom big blocks of gold have been found. A big portion of gold associated in sulphide products, we usually classify this kind of gold as “hard to process” gold ore, they are hard to be separated by usual gravitational methods due to the reasons that, gold element is wrapped by sulphide to a very fine state which is hard to break down by grinding, the existing carbon in the ores usually brings the gold particles to tailing after leaching with cyanide, the impurity substances affect the recovery rate of gold and consume more cyanide or mercury.

A sample of the above site was analysed in China refinery plant, we found the recovery rate is only 40% which means the operation of the site is not economical.



Figure 6- Another gold vein which extends for 200 meters



Figure 7- Final product of the whole day operation (gold & silver)

According to Customs regulations of China, ores with more than 0.5% needs special permit to import. Arsenic is usually associated with gold, whenever there is high percentage of gold, arsenic is also high. Nature gold is easily separated by gravitational method, such as shaking tables or spiral chutes; High arsenic and high sulfur is separated by floatation method after some pre-treatment; while oxide type of gold is separated by cyanide. Floatation method can get the last gm of gold from the ore.

I have an expression that most of the gold deposits in South America are of epithermal models We can easily find gold from the surface of the ground. No precise exploration has been done in the last fifties due to the instability of political situation of the country. The alluvial gold was formed by the sediments of palaeo- rivers, the ground was uplifted by the orogenic activities and subduction. I expect a big gold mine would be traced in the area, especially in the area of amazon river. I would

probably do some research in this area for my PHD programme.

Aside from gold, Colombia is famous for its precious stones, such as emerald. The mining of emeralds are controlled by some families. It seems the reserve is going down, the two famous sites, Chivo and Muzo have been exhausted due to irregular mining.

The biggest country in SA- Brazil

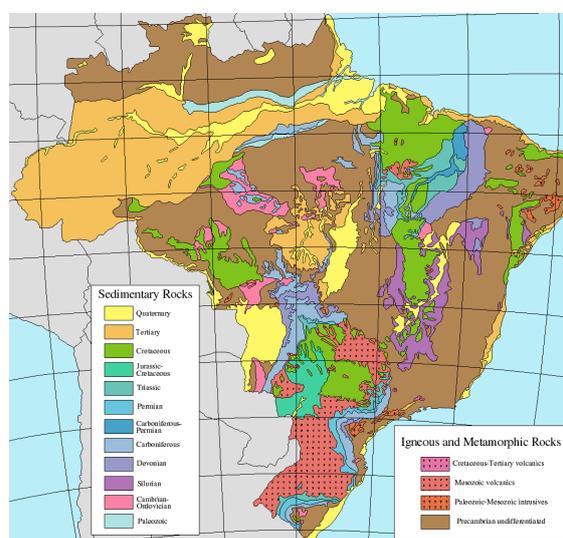


Figure 8- Geological map of Brazil

Brazil is divided into two plateaus and three plains, namely plateau of Guyana, Brazilian plateau, plains and Amazon lowlands, plain of the Pantanal and, plains and coastal lowlands.

The whole Brazil is within the South American platform which had been undergone complex geological evolution starting from Archean period..

Brazil is the biggest country in Latin America and the only Portuguese speaking country whereas most of the

neighboring countries speak Spanish. I visited the northern portion of the country where no Chinese or few has been there.

I entered the rain forests to look for gold and rare metals. I found the gold mines are of small scales, which are mostly alluvial gold. The extraction is very simple, just flush the sand with the water, then pass the sludge into a wooden chute covered with mercury. Gold is then deposited at the bottom (figures 9 &10).



Figure 9- The laborers are spraying water to the alluvial sand



Figure10-Wooden chute to separate gold



Figure 11- The gold shop is buying and analyzing gold purity

A small town is located near the mining area, the whole town is engaged in gold concerned business, the social security seems to be good as everyone has enough income and, they know each one. A shop is using fire method to determine the gold purity for individual sellers. The selling grade is usually 99.5% Au. Gold is not easily detected by portable XRF equipments.

We had a hard time to approach the mines as there are no proper roads or transportation facilities except the small airplanes. The rivers are full of dangerous fish or crocodiles, the forests are full of mosquitoes and snakes, malaria is a common disease in this area. The miners whom I met had some kinds of sickness, such as kidney problem or cancers. I slept in a hammock in a mine in the midst of the forest (figure 12), which is the best bed to avoid the attack of any unknown animals. A snake entered the room beside us in the same night.



Figure 12- Hammocks in the forest

There are thousands of small miners in the area. Food is supplied from outside including water and drinks. Nature gold is found in alluvial layers or altered rocks in the shallow ground.

The owner showed me gold is everywhere in his mine, the tailing contains about ten grams of gold (figure 13), he suggested I bring in some machines to process his tailing, then he would give me 50% of the profit. Unfortunately, he died in less than one year after I left.



Figure 13- gold in tailing

The mirror of sky- Bolivia

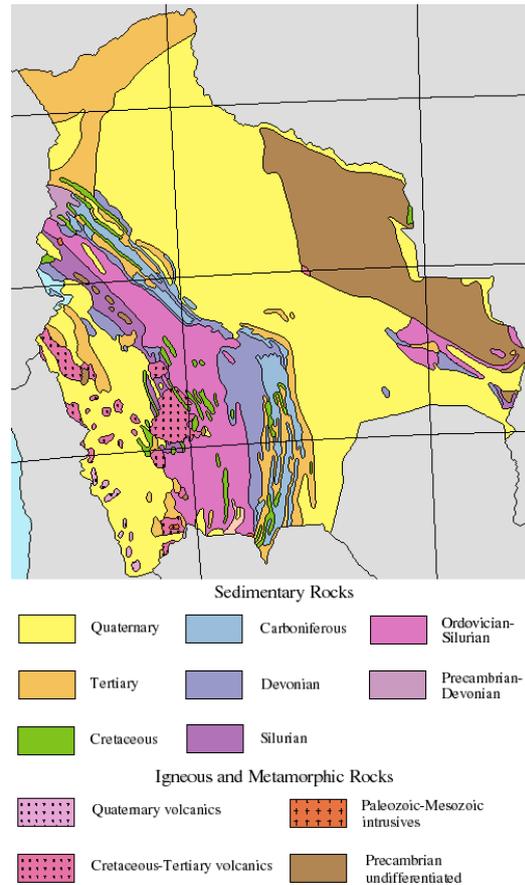


Figure 14- Geological map of Bolivia

Bolivia is located in the middle of Southern America that she has no exit port to ocean (figure 14). The country is mainly composed of two features, the mountains in the west which were created by subduction of the Pacific ocean and, the platforms and shields in the east.

I visited a gold mine (figure 15) where the owner has two caterpillars to dredge the ground, but he has no money to buy the processing machine, he uses only a primitive wooden pellet covered with screen to harass gold (figure 16), so he only gets average 2 gm /ton of gold.



Figure 15, Open pit gold mining



Figure 16- A wooden pellet covered with a screen to harass gold particles

Bolivia owns the biggest salt dessert of the world- Uyuni lake or known as “The mirror of sky”. Which is located near the border of Chile on the Andes mountain.



Figure 17- An abandoned gold mine

The application of visa to Bolivia is a hard job for all Chinese including HKSRA citizens. The Beijing Bolivia Embassy approved only 151 visas in 2009, 261 visas including about 100 Taiwanese in groups and 20 Bangladesh citizens in 2010. I spent 4 months to persuade the Chinese lady in the Embassy who said she has no name to accept my application, then another 2 months for the Bolivia government to reject my application. I am the only Hong Kong applicant this year. This is a ridiculous government, I go there to invest and provide them the latest technique in mining.

In conclusion, I would say most of the miners of the above three countries are in small scales, they lack proper exploration or investigation on the ground. They need capital and expertise. The miners use primitive machines or even manual method to get gold, a big lose of gold is inevitable. The pollution of environment is definite.

The governments are trying to ban the uses of chemicals, but how to settle the employment problems of the local residents is another problem. Some big guys in mining from Canada have already started their adventure in these countries. On the other hand, the franchise and unemployment problems have raised the conflict of the local residents against the government which further widen the gap and dissent between the interested groups.