



Gravel Pump Tin Mining in Malaysia

By: Ir. Yap Keam Min, FIEM, MICE, MIEAust, P.Eng, C.Eng (A former tin miner)

Abstract

This paper gives a review of gravel pump tin mining in Malaysia. Most of the major operations of gravel pump mining are highlighted. Although most of the information provided is historical in nature, the operations can still be adopted today. Malaysia has the technology and experience in alluvial mining but we do not have that much more prospective land for profitable tin mining.

INTRODUCTION

Gravel pump was the most common method of tin mining in Malaysia. The Chinese have been using this method for decades in Perak and Selangor. The Kinta valley in Perak was once the richest tin ore field in the world and practically every low lying land in the region contained tin. The tin deposits in Selangor were generally located deep in the ground, some up to 100m.

Gravel pump was popular because of its low capital cost and its effectiveness in alluvial mining. A lot of people could and did venture into mining especially in the Kinta valley where tin ore occurred in shallower depths. Gravel pump could mine grounds with irregular bedrocks which the dredge could not. The deposits between the limestone pinnacles were usually rich in tin.

The obvious principle in mining is to extract as much tin as possible in the early stages of operation so as to cover the capital cost. One problem that miners faced was the short mining lease. The lease was usually for five years and the miner might not get renewal after the lease expires.

Most of the mining equipments such as pumps, liners, impellers and steel pipes were manufactured locally, mainly in Perak.

Since the collapse of the world tin market in 1985, the tin mining industry has been on a very steep decline. The number of tin mines now operating in Malaysia is less than 25, a far cry from the 1000's in the 1970s, producing a mere 3000 tonnes.



Figure 1: A gravel pump tin mine in Tronoh, Perak (1952). The engine used was large in size but low in capacity. Interestingly one engine run both the water and gravel pumps. The engine had to be housed in a big hut.



Figure 2: Prospecting for tin using the wash boring method

PROSPECTING FOR TIN

Wash boring (Figure 2) was the most common method used to prospect for alluvial tin ore. It was less expensive compared with drilling for primary tin deposits. Samples were collected for every 1.5m and washed for tin ore. The tin would then be weighed, dried and kept in plastic bags (Figure 3). The type of soil for every layer would also be recorded.

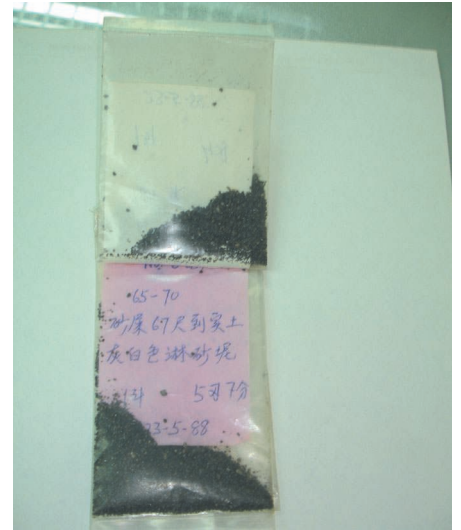


Figure 3: Tin ore samples from prospecting works



Figure 4: Wet stripping of the overburden by gravel pump

OVERBURDEN STRIPPING

The removal of non ore bearing earth or overburden could be done either by dry or wet stripping. In dry stripping, the earth would be excavated by tractors and moved by trucks to the dump site. It is similar to earthworks in construction but only in massive scale and minus the compaction.

Wet stripping would normally be done by monitors and gravel pump,

and would be similar to actual mining except that the earth materials were pumped directly to the tailings dump (Figure 4). It would be more expensive and time consuming than dry stripping. However, in very soft ground such as peat soil where the trucks cannot work, wet stripping had to be used.

GRAVEL PUMP MINING

Gravel pump method evolved from the ground sluice used in gold mining. Early ground sluice for gold mining involved diverting a stream of water from the river along wooden ground sluice. Earth was shovelled into the sluice and agitated; the flow of water would carry the lighter materials leaving behind the heavier gold.

Early tin mining was also along the river banks and when mining had to go inland, pump was used to provide water and for dewatering the mine pit. Chinese miners used chain pump which was operated by a water wheel. The British introduced centrifugal pumps run by steam engines of 8-12 H.P. Later diesel engines were used. The size of the pumps was 100mm diameters in the early years, steadily progressing into larger ones (up to 450mm) due to higher capacity engines. Electrical engines were also common especially in shallower mines or where power was available.

Gravel pump mining involved using high pressure water jets known as 'monitors' (Figure 5) to break the ore bearing stratum (or karang); and the slurry would then be washed to a sump in the pit floor. The ground would normally be kept steep so that the slurry could slide easier to the sump. The monitors were usually located near to the working face to be effective. A gravel pump (Figure 6) would pump all the material up to an elevated 'palong'. The common size of the gravel pump would be 350mm and driven by a 620 H.P. diesel engine. The maximum lift of the pump would be about 30m and deep mines would require several gravel pumps.

Excavators would be used to dig and break up the clayey material. Clayey deposits are tough for the monitors to break down. Further more



Figure 5: Monitors and the gravel pump



Figure 6: The gravel pump; Gravel pump method is named after this equipment

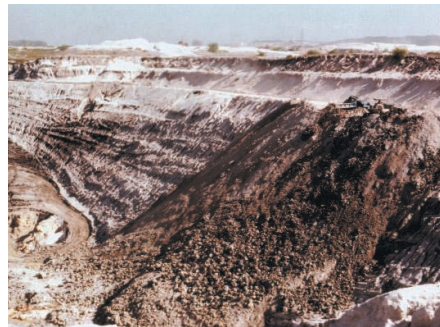


Figure 7: Mining slopes can be steep

tin ore could stick to lump of clay and flow to the tailings. Excavators were also used to dig tin deposits lying between limestone pinnacles. Bull dozers were used to push the materials dug by the excavators to the sump for the gravel pump.

The mine face could be steep especially near the land boundaries (Figure 7). Miners usually mine close to the border especially when the deposit is rich. Since mine face is usually temporary, miners do take risk.

PALONG

Palong is the most important structure in the tin mine because it is where the tin ore is saved. Figure 8 shows a classic palong which is a rarity nowadays. The efficiency of the ore recovery would depend on its design.

A poor design would result in tin ore ending up in the tailings.

The pumped materials from the gravel pump would have to go through a fixed (Figure 9) or a revolving trommel screen to discharge large gravel, stones and large lumps of clay.

Palong is essentially a big wooden sluice box and the early palong had single or twin lanes. Palong for gold mining normally has two lanes and a gentle slope (Figure 10). Typical dimensions of palong are 50m long, 2m wide lane of at least 12 lanes. Transverse timbers (100mmx50mm) are placed as riffles to agitate the slurry and form eddies as shown in Figure 11. As the heavy materials accumulate and when it



Figure 8: A Palong; a rare sight nowadays



Figure 9: A fixed screen to screen the large materials such as gravel and stones

becomes difficult to agitate, additional timbers are added on the original ones. The tin ore is trapped in the riffles.

The most important feature of palong is its gradient of the floor. A too steep slope will result in lower recovery of ores but a gentle one will reduce the flow of the slurry and will hamper the operation. The gradient of palong depends on the soil of the tin bearing stratum. For tin bearing layers in clay, gradient is normally 1:13 and for sandy karang, the slope should be steeper, 1:11. For dry stripping mining the slope is 1:9 because of the much larger volume of



Figure 10: An example of a gold mining palong materials needed to be treated. Most of the tin ore is caught at the top 10m of the palong. A well designed and managed palong can recover 80% of the tin ore.

DRY MINING

In the mid 1980s when the construction industry was in doldrums, many earthworks contractors had no projects. Instead of leaving their heavy equipments and trucks idle, some enterprising contractors ventured into tin mining. The contractors entered into joint venture with miners in a percentage of ore won basis.

The method they used is known as dry mining. Excavators were used to dig the tin bearing earth onto dump trucks to move to a collection area in front of the palong. Monitors were used to break, loosen and agitate the materials which flow to a palong by gravity. This method is known as dry mining because no gravel pump is used. (Hence, the gravel pump is now known as wet mining). This method is very ideal for sandy karang. This has proven to be a highly effective method of mining as large volume of tin ore bearing earth can be treated. The other operations are the same as gravel pump method.

The advantages of the dry mining are as follows:

1. Selective mining; only workable grade of tin bearing materials are transported to the palong.
2. Reduction in tailings slime which results in the water being less turbid. Clearer water is essential for ore dressing
3. Larger volume of ore bearing earth per month can be mined. The dry method can treat twice as much karang as the wet method.
4. Much reduced machinery and equipment down time as compared



Figure 11: A naked palong-showing the riffles for trapping tin ore



Figure 12: Tailings retention ponds



Figure 13: Tailings dumped into ex-mining pool by gravity

with the wet method.

5. Safer operation for mines workers. Flooding of the mine hole is not crucial as mining equipments and workers are not in the pit.

TAILINGS

Gravel pumps produce tremendous amount of tailings sand and slime. They are pumped from the tail end of palongs to retention ponds (Figure 12) which usually consists of a series of sedimentation ponds. Slime is contained in the initial pond and water can overflow into the next pond. Sand is at the apex of the tailing and slime is stored in sedimentation ponds. As the volume of the tailings increases, the

heights of the bunds are increased, usually with dry stripping overburden.

Tailings can also be dumped in ex-mining pool as shown in Figure 13. There would be a lot of saving from pumping cost as the tailings goes to the pool by gravity. Tailings dumps have to be maintained and inspected daily.

DRAINAGE

Drainage is one of the most important operations in gravel pump mining. Closed-circuit system of drainage is normally practised. Water is re-cycled for use. One of the common problems in open cut mining is ground water control. Mine has to be drained by pumps and in deep mine, dewatering can be non stop. For this reason, some deep mines work 24 hours.



Figure 14: Washing of the palong using jigs



Figure 15: Rough concentrates recovered from the jigs

TIN ORE WASHING AND DRESSING

Tin ore is normally recovered by a palong-jigs plant as shown in Figure 14. The recovered concentrates or rough concentrates from the palong (Figure 15) are transported to the tin washing plant locally known as "tin shed". This is also the 'safe' where tin ores are kept before transporting to the smelters. The recovered concentrates are washed using small palong known as lanchute. There is a premium for higher



Figure 16: Concentrating or shaking table for tin ore dressing



Figure 17: Magnetic separator to dress tin ore

concentrates when the ore is sold to the smelters. Nitric acid is often used to remove impurities. The more efficient mines have concentrating tables (Figure 16) for dressing the materials which give a higher recovery rate. Tin ore is then dried in a furnace and packed into bags for sale. The residual after extracting the tin ore is known as amang which contains other heavy minerals and a small percentage of tin ore. Coarse tin ore has more impurities and has to be crushed and grinded. Larger mines process their own amang utilising crushers, grinding and magnetic separators to extract the tin ore. Figure 17 shows a typical magnetic separator.

TIN ORE BY-PRODUCTS

Sand is the most common by-product of the tin mining operation and the construction industry has for many years benefited from the abundant supply of it. The closure of the tin mines has caused supply problem. Some of the by-products of tin are rare earth minerals such as monazite and xenotime. These heavy minerals are radioactive; uranium and thorium can be extracted from them. Zircon is another by-product of tin ore. These minerals are extracted from the amang. These minerals were initially unknown

to tin miners and amang factory owners alike and for many years these were left as waste. The discovery of these minerals had made a few amang owners rich.

STEPS TO VENTURE INTO TIN MINING

1. Identification of land based on local knowledge or known deposits
2. Apply for prospecting permit from the state government
3. Start prospecting for ore
4. Application for mining lease.
5. Apply to the mines department for Hydraulic Licence
6. Start mining

State governments will only issue mining lease if the project is viable and the environmental consideration is taken. A proposed rehabilitating programme should be provided. Miners will also have to give a guarantee (usually in the form of a bank guarantee) to fulfill the filling and leveling condition.

CONCLUSION

Gravel pump method is very effective for mining alluvial tin ore. It has been developed through years of experience. The three most important items in gravel pump mining are tin ore content, water and tailings dumps. Without any of the items, the mine cannot operate. Obviously the land must be workable and profitable. Water is crucial for hydraulic mining and closed circuit system of drainage is practised. There should be adequate dumps for tailings and overburden earth. Gravel pump may not be effective in areas where there are a lot of boulders. Dry mining which has evolved from gravel pump is now the preferred method. It has the advantages of selective mining, larger volume of materials can be treated and reduction in tailings slime. Malaysian miners are the most efficient hydraulic miners in the world and they should export their expertise. ■

REFERENCE

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