Mining History: The Bulletin of the Peak District Mines Historical Society. Volume 14, No. 4, Winter 2000.

AN EXAMPLE OF FIRE SETTING IN WEST AFRICA

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Abstract: While mining by the use of fire setting has been known for centuries, this may be one of the few actually observed in modern times.

Fire setting is the ancient mining process (Craddock 1992; 1995; Hoover and Hoover 1950) whereby a rock face is strongly heated by a brushwood or other fire and then suddenly cooled by having water thrown on it. The resulting thermal stress causes the rock to crack and shatter sufficiently that manual mining with simple tools can excavate the fractured pieces. The process is then repeated. It seems always to have been assumed that this method was slow and that penetration rates were low, a matter of a few tens of centimetres at the most. Under favourable conditions this is not necessarily true as this article describes. While fire setting in Ghana was noted in early reports (McCarthy 1882), details of the method have not been previously reported.

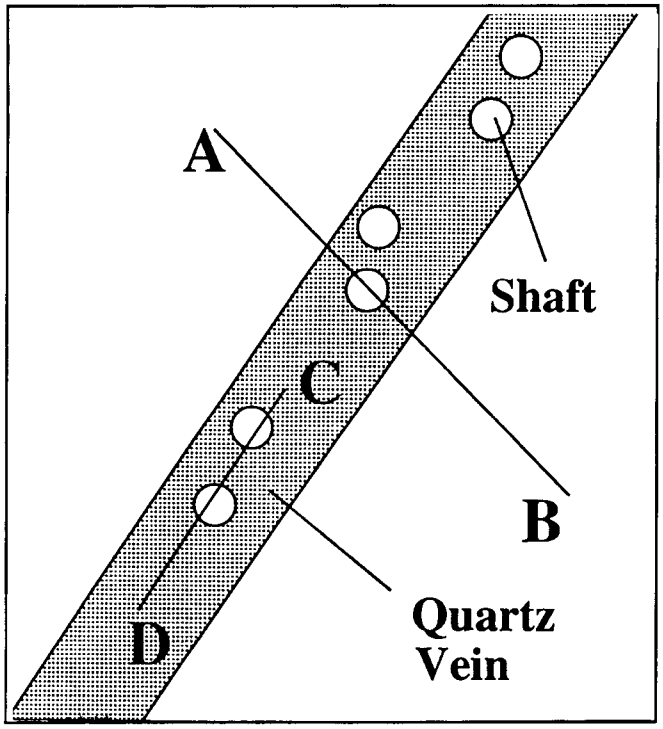
In 1994 the company, Obuasi Services Ltd., contracted to carry out the drilling of an alluvial gold deposit at Manso Nkran near Manso Nkwanta in the Adansi East District of the Ashanti Region of Ghana. The site is approximately 40 miles (64 km) southwest of Kumasi, the regional capital. The company holding the concession was a consortium of Kiwi Goldfields and Allied Goldfields of Australia. Their project manager, Mr Albert Perry of Tucson Arizona, is to be thanked for his assistance with permission to publish this article. The area is now being mined on a large scale by Amansie Resources Ltd. and unfortunately almost all traces of earlier workings have now been mined away. Gold mining in this area has a very long history; dateable artifacts from the 14th century have been found in one alluvial mine nearby. Our drilling on the Manso site went through 3 metres of tailings before entering the original alluvial channel and we calculated 18,000 tons of tailings in this particular area alone.

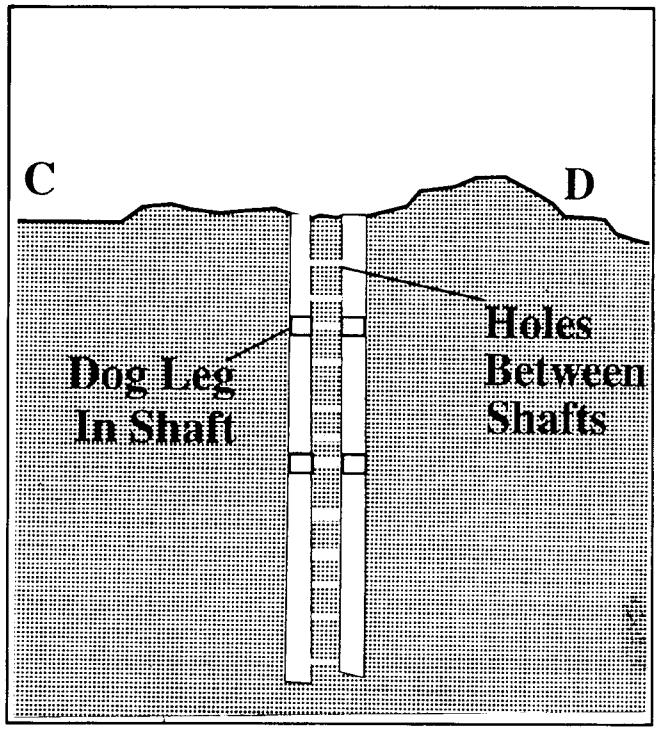
Plate 1. Two shafts on a quartz vein, Kumananta, near Twifu Prasu. (PW Ltd., Ghana)

The mineral deposit consists of small high grade veins of gold bearing quartz radiating from, and often enclosed in, a mineralized (gold bearing) potassic granitoid central mass. The local illegal miners called "Galamsays" (from Garimpieros, we think; others have suggested that it is a local contraction for "go and get me some") were working the quartz veins in the granites and surrounding Birimian phyllites and metavolcanics (Pre-Cambrian greenstone facies). Their method of sinking shafts involved fire setting and some of the shafts about 1 metre diameter were over 40 metres deep usually with a dog leg situated every ten to fifteen metres for safety and to provide standing room for hauling up rock. All of the shafts are in pairs separated by a common pillar between one and three meters thick. The pairs of shafts are situated on and parallel to the reef (vein) or in wide veins, across it.

Access in the shafts is by footholes made in the shaft walls for hand and foot support); ladders are rarely if ever seen. Bare feet and a pair of old shorts being dress for the day, lighting is a torch strapped to the side of the head by a bandana cut from an old automobile inner tube. Haulage of rock is carried out using plastic "jerry cans" (20 litre fuel containers) with a hole in the top and at one side of this is attached a knotted nylon rope.

The shaft sinking method observed is as follows. The overburden and easily removed quartz near the surface are first removed from the proposed shafts which can usually be sunk to two or three metres by hammer and chisel methods. When the quartz gets more competent a small interconnecting hole is made between the two shafts at floor level; this allows air to circulate and a fire to be lit in one shaft. The fire is fed from the surface by throwing in brushwood. This is usually done at night when the air temperature is lower and a better draft develops. The fire is continued all night, not a high flame type but rather one where a deep bed of glowing coals is encouraged, the aim being to heat the rock below the fire. In the morning two oil drums (200 litres each) of water are dumped down the shaft, this leads to a spectacular eruption of steam and ashes and the shaft is left to cool for 24 hours. On re-entering, the quartz is found to be reduced to a sugary powder for a depth of 1 to 1.5 metres; a further 0.5 to 0.8 metres are very well cracked and can be wedged out by hand tools. Using the same interconnecting hole a fire is then started in the other shaft and the process is repeated. When the shafts are both cleaned to the same level, another connecting passage is made. The old





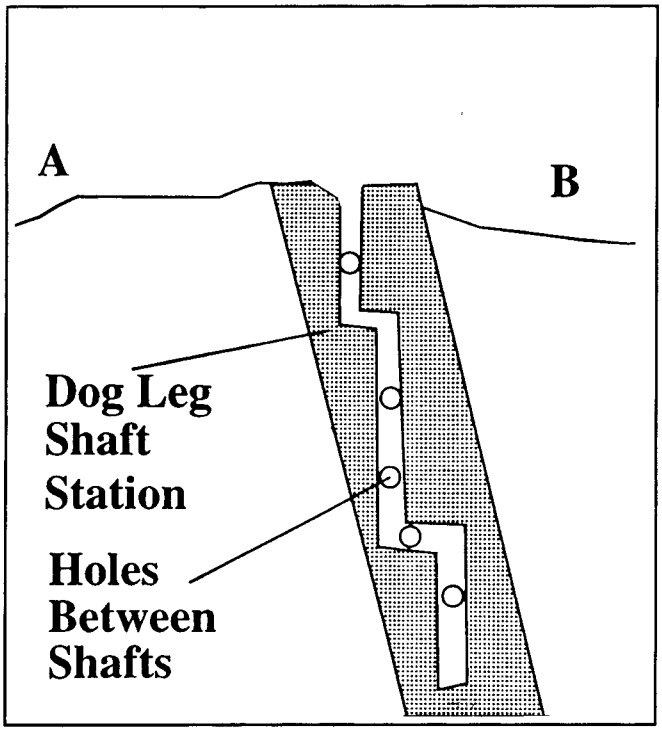


Fig. 1 (top). Schematic map view along a quartz vein.
Fig. 2 (above). Cross-section showing dog-legs in shafts.

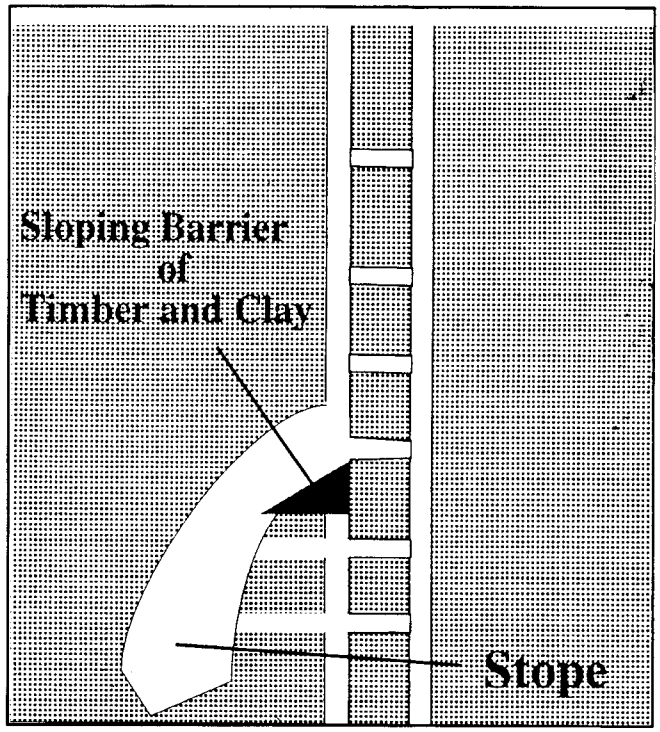


Fig. 3 (top). Cross-section showing holes in the dual shaft systems.
Fig. 4 (above). Development of a stope.

passage is sealed with clay and rubble and then once again fire setting proceeds.

At a depth where a "dog leg" is needed, small parallel stopes are excavated in the side of each shaft. Then a larger passage is made between them sufficient to be able to feed the fire from the dogleg of the downcast shaft. During firing, the hole is temporarily closed by reed matting and clay kept wet to prevent it from burning. When more fuel is needed, brush wood is pushed with a two-metre bamboo pole into the firing area. The fire creates a furnace driven ventilation system in which the draught literally howled through the cross hole to the firing zone. The late Nick Laffoley and one of us went down on one firing and you begin to realize how effective a furnace driven ventilation system was in the early coal mining days. The downcast shaft was cool and we felt we were drowning in the flow of hundreds of cubic feet of air per minute, something you experience only in a fan drift.

When maximum depth as determined by the level of the local water table is reached, a stope can be initiated by excavating an opening in the side of one of the dual shafts as in starting a dog leg. Then a way is opened from the downcast shaft through the upcast shaft and into the stope. Next the lower portion of the downcast shaft is blocked off with timber and this is well covered with clay where it leads into the upper part of the stope. Wood can be thrown down over the ramp into the stope or if very narrow fed through the draught hole directly into the stope. Water thrown down the upcast shaft runs over the baked clay surface directly into the stope without entering the bottom part

of the shaft. In effect there is still a two shaft system where the stope now becomes the upcast shaft. The lower portion of the old upcast shaft is capped off and is redundant. The connection from the downcast through the old upcast and into the stope is still accessible for firing and air flow. This arrangement allows the development of a moderate-size down-sloping stope. There were probably other variations on this theme but none were witnessed.

The method is cheap, relatively safe and compared with hand drilling holes for explosives relatively fast. The biggest, if hidden, advantage is that the quartz is not only broken but is microcracked and subsequent hand crushing and grinding is much easier, allowing better and more complete liberation of the gold. Fine gold can then be recovered from along the grain boundaries in the quartz where maximum thermal stress and cracking occur. According to the miners the method works well in quartz, reasonably well in granite but poorly in the slate-like phyllites which have a tough nature with little quartz to be thermally stressed. The recognition of twinned pairs of shafts is becoming a useful exploration tool indicating the presence of quartz veins rather than alluvial gold under deep lateritic cover.

Since the big mine started and the Galamsays were closed out, fire setting has not been observed anywhere else in Ghana, so perhaps this was the last example of a 'lost art' in use. It would be interesting to know if similiar old workings have been observed in Mali as gold mining is said to have migrated from there to the Ghana rain forests. The question being, did the technique have Moorish, Carthaginian or Egyptian sources or was it developed here independently.

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