JOHN S. MASON - PREVENTION OF ENVIRONMENTAL DISASTER AT CWMRHEIDOL MINE, CENTRAL WALES, EARLY 1990s

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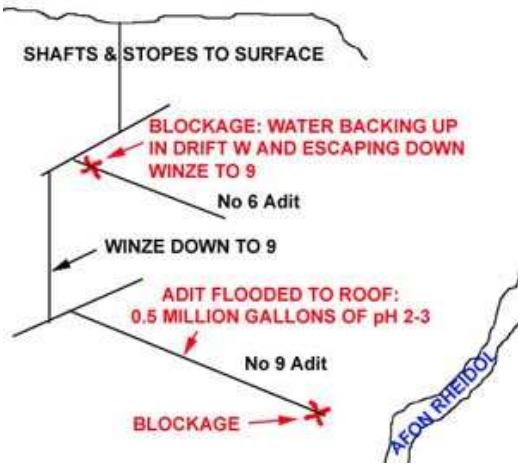
PART 1 - The problem:

Cwmrheidol mine accessed a lead-zinc bearing mineral lode but there was also a great deal of the iron sulphide marcasite present. In time this decayed into sulphuric acid which then attacked other minerals, resulting in a mine drainage that was highly acidic and laden with an unpleasant cocktail of polluting metals including zinc, cadmium and aluminium.

Here is an image of the entrance to the No 9 Adit which was taken in the summer of 1992. Dried-up, cracked ochre (hydrated iron hydroxide) covers the foreground. The timber lagging of the adit where it passes through shaly scree can clearly be seen. The discharge flows into Afon Rheidol via a settling tank put in by the C.E.G.B. in the 1970s. Filled with limestone chips, this worked initially but is now less effective because the reaction in time coats the limestone with insoluble gypsum.

The mines in this immediate area all worked mineralised fractures associated with the Castell Lode, a major ENE-striking tensional fault system. Immediately to the west of Cwmrheidol the lode could in the early 1990s be seen at the neighbouring small Tynyfron mine, where over 1m of shattered marcasite is exposed in pillars along the small stopes (above). This gives an indication of the mineralisation cut by Cwmrheidol, and why there is such a pollution problem there.



This is a simplified diagram of the mine. The oldest part is up on the hilltop at Ystumtuen. Here, workings go back into the 1700s. Lewis Morris described the marcasite at Ystumtuen thus, in the mid 18th Century:

***"There is a vast quantity of Marcasite in this work, and it shoots into Chrystals of Copperas by the very heat of ye Sun, but it is of very little value here being so far from the Sea. The waste of this mine is worked over and over to profit Every eight or ten years, the Marcasite being dissolved by the Rains and Heat of the Sun Suffers the Ore to be disengaged"* - an early example there of heap-leaching!**

The No 6 and No 9 levels at Cwmrheidol were driven more recently to make dewatering the mine easier. No 6 was started in 1824 while No 9 was a later 19th Century venture. The main mine drainage exits from No 6 as a moderate stream. This tunnel drains a lot of the Ystumtuen area and in heavy rain the water roars out. However, in the early 1990s water was backed up due to a fall of ground, which allowed it to escape down a winze into No 9 Adit.

In 1992, site investigations were commissioned with a view to solving the pollution problems. I was working with mining engineer, historian and archivist Simon Hughes of Talybont back then. Examination of the No 9 adit entrance identified an immediate cause for concern, with a shale dam that had formed

where the tunnel's wooden lagging had failed, allowing the loose scree to run in. A local reported seeing water squirting out upwards after prolonged rain.

What if this dam should have failed? The result would have been a sudden influx of over 500,000 gallons of ochreous acidic water into Afon Rheidol. This actually happened in the late 1960s, when the blocked adit was disturbed by a JCB and burst open. Thousands of fish were killed and the sea off Aberystwyth Harbour turned orange! So, in this case what did we do??

Next: No 9 Adit - The solution to the problem

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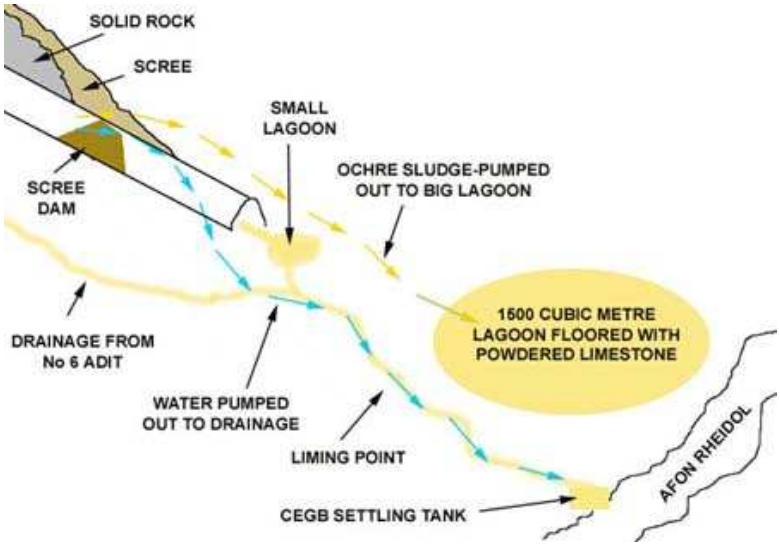
PART 2 - The solution - No 9 Adit:



The National Rivers Authority (now the Environment Agency) commissioned Simon Hughes and I to tackle the problem. This we did in 5 stages:

1. Create large lagoon to catch any sudden surges during works. The lagoon was floored with hundreds of tons of powdered limestone.

2. Remove scree above and behind the dam in order to expose it properly.

3. Pump out clear water sitting on top of ca. 0.5m of ochre, liming the discharge every 15 minutes thus raising the pH from 2.5 to 5.5. This stage went on on a 24-7 basis.

4. Pump out ochre into the large lagoon and bury with powdered limestone.

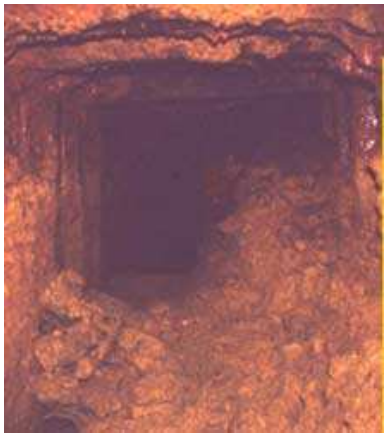
5. Remove dam and repair broken lagging.

Some aspects of this utterly messy but ultimately successful job are illustrated below.

Opening up the adit mouth and setting up pumps. A considerable amount of scree had to be cleared off the back of the adit. The excavator dug well back to allow for further landslides, this permitting access to a "porthole" into the water at the back of the dam. A submersible pump was lowered just under the surface of the water, to avoid stirring up the ochre below. A digital pH meter was installed in the mine discharge, a large stash of agricultural lime was placed just upstream and we were ready to go.

A view up the adit during pumping. The dam lies ahead in the darkness. While pumping was ongoing the adit floor up to the dam was cleared of debris.

Once the water and ochre had been pumped well down, work commenced on tackling the dam, a mixture of fine shale, soil and soft ochre. In this image the dam is half-removed. The burst lagging where the shale came in is above and to the left of the dam.



Beyond the dam lay the inky depths of the mine which was explored for a short distance. However, dangerous roof conditions and bad air made a full inspection of the mine impossible. This image is taken a short way in. Note the square timbering and copious amounts of ochre in places - it covered the floor, walls and roof. Ochre itself is however less toxic than the mine water with its loading of heavy metals - a classic case of the highly visible pollution being aesthetically displeasing while the apparently "clear" water is in fact the real rogue!

The lagging on the level portal was replaced. Note that this was a temporary job designed to tackle an environmental emergency: we made it clear at the time that a longer-term solution must be found and implemented. However, the adit should not let in any more scree for a few tens of years.

Here, one of the NRA excavators is spreading lorryloads of powdered limestone over the ochre pumped from the mine into the big lagoon. The ochre in turn was pumped onto a powdered limestone bed. This image also shows the rusty mine-tips.

Here the No 9 job is nearing completion. The words "Keep Out - bad air" were added to the mine door after this photo was taken. In front of the door are the remains of a mine-wagon which was found buried in shale and winched out of the way. The water was set to discharge via a pipe from this small settling lagoon.

Although we went home happy after completing this work, Nature was to have a nasty surprise for us, some distance away, which 6 months after this photo was taken was to transform the site's appearance once again.

NEXT: The Surge!

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PART 3 - The Surge!

March 1993.....

November 1993!

What had happened? Clearly an overwhelming flood: after all there had been heavy rain on and off through the autumn. But this surge had come from above. It had come down the drainage gully that takes the discharge from the No 6 adit. Higher up it had scoured to bedrock and washed away several trees. The next step was to try to find out why so much water had suddenly entered the workings to exit from No 6. It didn't take long...

Here it is - the stream known as Nant Bwlchgwyn to the east of Ystumtuen. The course of the stream follows in part the outcrop of the lode. Subsidence has occurred and the entire stream has entered old workings. Since all of these workings - Ystumtuen, Penrhiw and Bwlchgwyn - are drained by No 6 adit at Cwmrheidol, here we have the culprit.

In the Spring of 1994 we therefore set out to repair Nant Bwlchgwyn, by culverting it straight over the subsidence. Here we are digging the culvert into place and have just turned the water-flow back on its correct course...

And here is the nearly-completed job. However, caution is advised, as there are other workings in this area and the potential for further subsidence needs to be assessed and dealt with, if Cwmrheidol is to avoid further surges like that of late 1993!

Attention then turned to the No 6 Adit at Cwmrheidol, where a shaly dam had developed in an area where the roof was steadily crumbling close to the adit's intersection with the lode. This image depicts the general scene at this point, way in underground.

The dam was gradually lowered bit by bit to avoid any sudden water surges. Beyond lay tunnels left and right driven along the lode. The left-hand one was walled-up but archival work by Simon Hughes had already determined that it connected down to No 9 by a winze. Such tunnels are driven with a slight gradient "outbye" - that is, towards the adit, to allow water to flow outwards. But, because the water level was so high, it had overcome the gradient, so that it was able to escape down the winze into No 9. The removal of the dam allowed the correct direction of flow to be re-established.

After removing the dam, action was taken to ensure that water flow and human access would be possible in the event of further falls of ground. Strong twin-wall pipes were deployed: two at ground level to take the water, which were then buried, and a third bigger-gauge one, here being put into place. This too was buried. The pipes extend well out into the tunnels beyond, to avoid roof-falls blocking them.

That concluded the works at Cwmrheidol back then. The aim was to maintain the *status quo* with respect to underground drainage. The longer-term treatment of this drainage is a problem of much greater magnitude which, it is hoped, will be tackled eventually. The risks of potential subsidence and more sudden water surges, due to the juxtaposition of old stopes and rivers in the Ystumtuen area, is a problem that will not go away until it is fully assessed and dealt with in an appropriate manner.

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