

The Iodine Puzzle at Broken Hill

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Almost from the time of discovery of the Broken Hill lode, the richness of iodine in the Broken Hill oxidized zone became apparent. Not only were large masses of silver iodide found, but a strong iodine smell was also reported when mining operations broke into cavities rich in the iodine minerals.

The main iodine-bearing mineral is the hexagonal polymorph of silver iodide, iodargyrite. It was found in rich patches in the upper levels of the oxidized zone, especially in the Proprietary Mine, and also in the Australian Broken Hill Consols Lode, a few hundred metres to the east (Birch, 1999). In the main lode, iodargyrite occurred in two main environments. In the outcropping portion, or gossan, iodargyrite was found with other minerals such as chlorargyrite, cerussite and smithsonite, in cavities in secondary manganese and iron oxyhydroxides. In the complex oxidized zone below the gossan, iodargyrite was concentrated in masses of kaolinite containing other silver and mercury minerals.

Minor to rare amounts of other iodine-bearing species have been found at Broken Hill, most notably in the series marshite-miersite (cubic CuI-AgI), whose crystals are small and rare. Small amounts of iodine are present in minerals of the chlorargyrite-bromargyrite series, and in the complex mercury silver sulfide halide species such as perrouditite and capgaronnite.

Despite the abundance of iodine in the secondary zone, and the existence of several synthetic polymorphs of silver iodide, only iodargyrite and its cubic polymorph miersite have been recorded. Also, despite the aridity of the region, no minerals con-

taining iodine in a higher oxidation state (iodates) have been found. The structural, geochemical and temporal complexity of the Broken Hill oxidized zone makes it impossible to model the distribution of iodargyrite and groundwater. It appears that the concentrations of iodide ions in groundwaters were anomalously high, but there are no data on these concentrations.

It is postulated that AgI precipitated in the oxidized zone from solutions containing excess iodine. These solutions became concentrated by evaporation accompanying capillary action with a fluctuating water table. The richness of iodargyrite in kaolinite masses suggests the clay mineral had properties which effectively lowered the solubility of AgI . It is likely that there has been episodic precipitation of silver iodide in the oxidized zone during climatic fluctuations over the past few hundred thousand years or more, although the exact timing is unknown. There are two main sources possible for the iodine. The first is the sulfide ore itself, which is known to contain trace amounts of the element, probably in either the galena or in silver-bearing tetrahedrite. It is not known whether the iodine is incorporated in the sulfide lattice or is present in fluid inclusions. The other possible source is from seawater which originally filled the so-called 'Murray Sea' (now the Murray Basin). Windblown spray, or possibly seaweed built up around ancient shorelines, may have provided a source of iodine for groundwaters to concentrate.

There are other occurrences of iodargyrite in or adjacent to the Murray Basin region. At the Iodide mine at Mineral Hill, north of Condobolin in New South Wales, iodargyrite occurred in the oxidized

zone above primary silver-lead-zinc sulfides. At Lake Boga, near Swan Hill in Victoria, a few small crystals of iodargyrite have been found on supergene copper sulfides in granite. Elsewhere in Australia the mineral is almost unknown, so it appears there is a regional concentration in the Murray Basin. Weathering and erosion of the Broken Hill oxidized zone may have distributed iodine widely into the regional

hydrogeological environment over millions of years.

REFERENCES

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The Mount Lyell Mines, Tasmania

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The Mt Lyell mining field is situated in the West Coast Range between Mt Owen and Mt Lyell, near Queenstown, in western Tasmania. The field comprises numerous workings, open cut and underground, on more than 20 separate orebodies, in an area of ~10 square km. The Mt Lyell Mine is one of the oldest significant mines in Australia and has been operating almost continually for nearly 120 years. The mines have produced about 1.5 Mt of copper, 50 t of gold and 850 t of silver from some 130 Mt of ore in their lifetime and, despite a chequered history, the present owners talk of the mine continuing for another fifty years or more (a vast age compared to most modern mines). The mine is mineralogically most important as the co-type locality for the rare copper-iron-tin sulfide mawsonite, named after Sir Douglas Mawson, the Antarctic explorer and geologist. However, many other rare minerals are also recorded from these mines, including betechtinite, florenceite, svanbergite-woodhousite, stannoidite, hessite, jalpaite and stromeyerite. At least 85 species have been reported from the mines, many being found as attractive specimens.

The first lease in the field was on the Iron Blow, an ironstone outcrop at the head of the Linda Valley, pegged for gold in 1883. This mine struggled as a gold mine for several years, until Bowes Kelly and William Orr, both successful investors from Broken Hill, tested samples at the Broken Hill smelters and showed they were buying a copper mine. The mining engineer Robert Carl Sticht (for whom stichtite was named) was brought over from America in 1895. He developed the revolutionary pyritic smelting process which turned the economics of the mines around, and was the most important metallurgical process for sulfide ores until the development of sulfide flotation at Broken Hill.

The Mt Lyell copper-silver-gold deposits are best considered as Cambrian volcanogenic sulfides partly remobilized by Devonian hydrothermal fluids (Solomon *et al.*, 1987; Arnold and Carswell, 1990). The mineralisation is mostly hosted by schistose, highly altered rhyolitic to andesitic lavas and tuffs of the Cambrian Mt. Read Volcanics, with minor occurrences in Ordovician conglomerates and limestones, and is controlled by the inter-



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