NATIVE ZINC AT KENO HILL[1]

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Small amounts of native zinc have been recently identified in samples from the oxidized zones of the lead-zinc-silver deposits of the Keno Hill – Galena Hill area, Yukon. Most of the zinc seen came from the oxidized lodes at the Elsa mine.

The *x*-ray pattern of the natural mineral agrees with the data for the zinc standard as published by Swanson & Tatge (1953) of the National Bureau of Standards, and both *x*-ray fluorescence and spectrographic analyses show that the mineral is mainly metallic zinc with small amounts (up to 10% combined) of tin, lead, and cadmium, and traces of iron, manganese, boron, silicon, copper, silver, calcium, and barium.

The native zinc occurs mainly as small irregular greyish metallic plates and scales on oxidized siderite and in pulverulent limonite and manganese oxides. In one occurrence a few native zinc scales accompanied native silver in an ice lens in the Elsa mine. Some of the plates exhibit striations, often in more than one direction, resembling a cross-hatching. This feature, according to some authors, represents incipient crystal formation. Other plates have a lumpy or micro-botryoidal development on their surfaces. The closest mineral associate is native silver which occurs as splendent leaf, small spangles, and tangled wires. The nature and origin of this silver has been discussed previously, Boyle (1960). Other closely associated minerals are limonite, various manganese oxides, cerussite, anglesite, sulphur, and highly oxidized sphalerite, freibergite, and galena.

Native zinc has been reported in the literature since 1857. In that year Becker (1857) mentions a lump of native zinc the size of a fist that apparently came from a placer on the Mittamitta River, northeast of Melbourne, Australia.

Phipson (1862) discovered native zinc in a sample of basalt from Brunswick, near Melbourne, Australia. He claimed priority for having discovered the first occurrence of the native metal.

W. D. Marks (1876) reported the finding of fragments of metallic zinc in soil along the course of a vein in limestone in northeastern Alabama. He also stated that pieces of metallic zinc had been picked up over a wide range in southern Tennessee and in northern Georgia and Alabama.

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Ulrich (1870) described two occurrences of native zinc, one, a 4½-ounce piece in a geode in basalt, near Melbourne, and the other in the gold sands of the Mittamitta River, northeast of Melbourne. The latter occurrence appears to be the one referred to by Becker.

Dawson (1886), in a letter to the secretary of the London Mineralogical Society, mentioned that he was in possession of a sample of metallic zinc. It is not clear where the sample originated, but judging by other information in his letter, it was probably found in one of the placer workings in South Africa.

Park (1891) described a nugget of native zinc from stratified clays, sands, and gravels in an old stream bottom at Hape Creek, Thames, New Zealand.

J. D. Dana (1906) reported an occurrence of native zinc with sphalerite in Shasta County, California.

Betekhtin (1950) mentions the occurrence of native zinc in the native platinum concentrates of the Aurora deposit in the Urals, U.S.S.R.

More recently, Goncharova (1959) found metallic films coating fibrous volcanic glass (Pele's hair) from the region of Elbrus mountain in the Caucasus. Spectroscopic and *x*-ray analyses proved that the films were native zinc, containing some Pb, Sn, Ag, Fe, Cu, Cd, and Sr. Goncharova thought that the zinc represented a volcanic sublimate.

R. J. Traill (personal communication) has recently found a small nugget of native zinc in a sample of black sand obtained by H. S. Bostock from Ferguson Creek, Yukon.

Most of these occurrences suggest that native zinc is formed in the zone of oxidation. At Keno Hill the mineral is obviously derived from sphalerite by oxidation of this sulphide, but the chemistry leading to its formation is not entirely clear.

Because of the relatively high position of zinc in the electrochemical series ($Zn = Zn^{2+} + 2e^-$, $E^0 = 0.763$), it seems unlikely that any of the metals or ions, normally present in the oxidizing environment at Keno Hill (*viz.* Ag, Fe^{2+}, Fe^{3+}, Mn^{2+}, Mn^{4+}; all lower in the series), would effect the reduction of zinc from sphalerite or its soluble salts. Both carbon and methane will reduce zinc from its compounds at high temperatures, but such a mechanism is hardly applicable to the situation in the veins at Keno Hill. However, the reducing power of various organic compounds is well known, and these may be responsible for the reduction of the zinc salts both in veins and placers.

Alternatively, one can imagine an auto-oxidation process for sphalerite whereby the sulphide (ion) is oxidized directly to sulphur in a neutral or slightly alkaline environment ($S^{2-} = S + 2e^-$) and the zinc is reduced to the metal ($Zn^{2+} + 2e^- = Zn$). While such a direct mechanism seems unsatisfactory on purely energetic grounds it does, however, represent the overall reactions that have taken place. Moreover, it seems to fit the facts best at Keno Hill, mainly because native sulphur is common in the oxidized zones, especially near residual nodules of sphalerite, and the present oxidizing solutions are neutral or slightly alkaline, a condition that favours the formation and preservation of the native zinc.

I wish to thank Mrs. Joan Climo for her work on the x-ray powder patterns and Messrs. G. R. Lachance and W. F. White for their x-ray fluorescence and spectrographic determinations.

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COEFFICIENT OF ACCUMULATION. A MEASURE OF THE TOTAL TRACE ELEMENT CONTENT OF A MINERAL OR A ROCK

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ABSTRACT

The coefficient of trace element accumulation R is a measure of the overall concentration of trace elements in geological materials. If the concentration of element i is k_i and its crustal abundance is K_i, then

$$R = \frac{1}{n} \sum_{i=1}^{n} k_i/K_i$$

for the n trace elements determined. Structurally necessary major elements are excluded. Some applications of the coefficient are discussed.