MERCURY IN NATIVE SILVER

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The presence of silver amalgam in a number of mining districts has been known for many years.[1] In the amalgam the mercury content varies considerably reaching at times about 73%.

That mercury in small amounts is present also in native silver of a considerable number of the localities which produce this metal has apparently not been recognized. In specimens of native silver examined by the writer mercury was found to be present in a majority of the districts.[2]

New information on such occurrences when considered together with published data, suggest relationships in metals and types of mineral deposits which seem worthy of mention.

A striking feature in the occurrence of silver amalgam, comparatively rich in mercury, is the common association with cobalt or cobalt and nickel arsenides, or as a constituent of mercury deposits such as cinnabar. The latter are represented by its presence in the deposits of Almaden, Spain[3]; in the Ober-Moschel, Bavarian Pfalz mines in Salzburg, Rosenau, Hungary; at Brezina, Bohemia; and from the Bergmannswohlfahrt mine, Clausthal, at which place it is found with galena, cinnabar and quicksilver.[4] Silver amalgam is reported also from Moschellandsberg, Palatinate, where veins of mercury and silver intersect. It likewise occurs in the veins at Nagolnij Krjasch, Donetz basin, Russia.[5] Here it is found in the oxidized zone. The veins carry galena, sphalerite, some cinnabar, but no nickel or cobalt. It is found with cobalt, or cobalt and nickel arsenides, or arsenates, in the provinces of Atacama and Coquimbo, northern Chile; formerly an important silver producing region. Several of the mines contained silver amalgam which was very rich

[1] Stelzner, Bergeat, Die Erzlagerstätten, pp. 694, 624–34, **1905–1906.**
Dana, E. S., System of Mineralogy, pp. 23–24.
Hintze, C., Handbuch der Mineralogie, vol. 1. pt. 1. pp. 322–326, **1904.**
Doelter, C., Handbuch der Mineralchemie, vol. 3. pt. 2. pp. 364–373, **1926.**

[2] Mercury was tested for by heating one-half gram to one gram of the native silver in a small closed glass tube. Small globules of mercury collect on the walls of the tube, and may be readily identified under a binocular microscope. Several confirmatory microchemical tests were made by converting the mercury into HgI_2.
Chamot and Mason, Handbook of Chemical Microscopy, vol. 2, pp. 142–3, **1931.**

[3] Hintze, pp. 323–24.

[4] Dana, p. 24.

[5] Samojloff, J., *N. Jahrb. Min.*, pp. 191–198, **1907.**

in mercury.[6] The associated mineralization contains both cobalt and nickel. Similar relationships in regard to cobalt and nickel minerals are to be found at Allamont, Frankreich.[7] The silver at Cobalt, Ontario, contains mercury[8] in amounts reaching at times several per cent. The natural silver-antimony alloy appears to contain higher percentages of mercury than does the more pure silver. Cobalt predominates over nickel in ores from this district.[9] Similarly at South Lorraine, Ont., where cobalt again appears to predominate[10] over nickel, mercury was found by the writer in a heavy plate of silver-dyscrasite from the Frontier Mine. The native silver from the Keeley mine was known also to contain mercury.[11] A heavy plate of native silver from Gowganda was found by the writer to give a mercury test. Ores from the Silver Islet Mine on the north shore of Lake Superior likewise contain mercury according to Miller.[12] The writer found mercury in the native silver from this mine. Nickel and cobalt minerals are both present. Silver associated with cobalt arsenides[13] from Great Bear Lake, N.W.T., contains mercury, while very thin plate-like veins of native silver in the highly oxidized wall rock from the same region contained none. At Sala, Sweden, silver amalgam rich in mercury is found in veins carrying a silver-zinc-lead mineralization.[14] Some niccolite is also present.[15] Vogt[16] mentions the presence of cobalt in the veins at Kongsberg, Norway, which are noted for their production of silver amalgam.

At the Friedrichssegen Mine, Ems,[17] the silver amalgam is a

[6] Domeyko, Sur les mines d'amalgame natif d'argent d'Arqueros, au Chile: *Ann. des Mines*, 3, **XX,** pp. 255–278, **1841.**

See also Stelzner and Hintze.

[7] Hintze, p. 324.

[8] Clevenger, G. H., *Econ. Geol.*, vol. **X,** pp. 770–773, 1915.

[9] Miller, W. G., Ontario Bureau of Mines, vol. 19, pt. 2, pp. 32–35, **1913.**

Knight, C. W., *31st Annual Report Ont. Dept. Mines*, vol. 31, pt. 2, p. 330, **1922.**

[10] Knight, *loc. cit.*, p. 191.

[11] Knight, *loc. cit.*, p. 210.

[12] *Loc. cit.* p. 205.

[13] A specimen with cobalt arsenides was kindly furnished by H. S. Spence.

[14] Beyschlag, Vogt and Krusch, Ore deposits, Truscatt Translation, vol. 2, pp. 771–773, **1916.**

[15] Schneiderhöhn-Ramdohr, Lehrbuch der Erzmikroskopie, vol. 2, p. 153, **1931.**

[16] Vogt, J. H. L., *Zeit. für Prapt. Geol.*, p. 118, **1899.**

[17] Doelter, p. 366.

minor constituent, as are also millerite and linnaeite, in veins consisting predominantly of galena, sphalerite, siderite, and chalcopyrite. Silver from the Lake Superior copper desposits was found to contain mercury. Also heavy wires and plates of native silver from Helena, Montana, which are partly enclosed in a one inch scalenohedron of calcite, contain mercury.

A specimen from the Buckeye Mine, Mohave Co., Ariz., gave a strong test for mercury. This mine was at one time noted for its masses of solid silver and beautiful specimens of wire silver.[18] The silver examined was a tooth-like mass projecting out of a calcite gangue.

Heavy plates of silver with light colored sphalerite in calcite from La Fe, Sierra Mojada, Mexico, contained mercury; also heavy platy irregular masses in calcite from Sabinal, Chihuahua. A specimen from Sombrerete, Zacatecas, Mexico, consisting of wires in calcite with galena and sphalerite, was found to contain it. Heavy wire silver from Freiberg, Saxony, contained a small amount, as did also a mass of interlacing fine wires from the Smuggler Mine, at Aspen, Colorado.

No mercury was found, however, in the specimens described below which were examined from the following localities: Minute interlacing wires resting on quartz and calcite from Boulder Co., Colorado; wire silver with quartz from Guadalajara, Mexico. (Specimen contains some limonite.) A mass composed of filaments of silver resting on euhedral galena crystals from Horcajo, Spain; Minute hair-like matted wires forming a crust on fractured quartz from the Mexico Mine, El Oro, Mexico; Thin plates of silver resting on limonitic rock from Durango, Mexico.

A recent investigation[19] of native silver by metallographic methods has led to conclusions of much interest regarding temperature conditions during silver deposition. The natural silver-antimony alloy receives new attention in this work. In any final statement of the origin and constitution of the natural silver-antimony alloy at Cobalt, Ontario, and other places, consideration should be given the fact that it frequently is a silver-antimony-mercury alloy.

Beyschlag, Vogt and Krusch, Die Erzlagerstätten, pp. 224–226, **1921.**

[18] Schrader, F. C., *U. S. Geol. Survey Bull.* **397,** pp. 83–84, 1909.

[19] Carpenter, H. C. H., and Fisher, M. S., A metallographic investigation of native silver: *Bull. Inst. Min. & Met.*, No. **330,** pp. 1–22, Mar. 1932; No. **335,** pp. 9–14, Aug. 1932.

Comparisons with the diagram of the silver-antimony system may be to some extent misleading.

Relation of Amount of Mercury to Type of Ore Deposit

The data recorded in literature and the evidence obtained in the present investigation indicate that the percentage of mercury to silver varies somewhat in a single district, or mine, or even in a single specimen. However, it is clear that the silver amalgam which is richest in mercury is, in general, found in deposits with cinnabar, or in others of a radical different mineralogical type, that is with cobalt and nickel minerals. Smaller amounts in general are found in other types of silver deposits.

It may be suggested that the mercury deposits, where cinnabar is the chief mineral, and cobalt-nickel deposits containing silver amalgam, are both derived from basic igneous rocks at different stages or along different lines of differentiation. The genetic relation of cobalt and nickel arsenides with the basic end of the rock series has received attention before.[20]

Origin of Amalgam by Hypogene Solutions

Most of the silver which contains much mercury is probably of *hypogene* origin. There can be little doubt of it in the material examined from Cobalt, South Lorraine, and Gowganda, Ontario; Kongsberg, Norway; Lake Superior Copper deposits and Silver Islet. The relations between the silver and calcite scalenohedron from Helena, Montana, appear to indicate that the silver, at least in part, preceded the deposition of the calcite. On the other hand, where the silver exhibits features indicating a supergene origin, mercury, as a rule, was not found. These occurrences included fine wires matted to form thin plates in open fractures and in open cavities, and draped over limonitic material, obviously of later age than the formation of the limonite surface.

According to Miller at Cobalt[21] "characteristically the native silver of the area is impure, chiefly from the presence of antimony and mercury. Samples of well crystallized silver and certain vein-

[20] Miller, W. G., *Ont. Bur. Mines Report*, vol. **19**, pt. 2, 1913.

[21] Miller quoted by Knight, *31st Ann. Rept. Ont. Bur. Mines*, vol. **31**, pt. 2, p. 37, 1922.

lets of the mineral that have been examined are free from these impurities. Such silver is probably of secondary origin."

These relations are only suggestive since the material examined by the writer is of uncertain origin. They may merely indicate that mercury is not carried in the solutions, or that the temperature is too low for it to enter the crystal structure, when fine wire silver is deposited. The determination of mercury is easy and quickly carried out. The suggestion inherent in the data so far known, that mercury is perhaps only found in hypogene silver, could be readily checked in mines where the geological relations are certain. It is known that silver may be carried in carbonate and bicarbonate solutions or in sulphate solutions with ferric sulphate.[22] These solutions which may be effective in the movement of silver in the oxidation processes, are not effective in the case of mercury.[23] Chloride solutions however, will readily carry mercury in the supergene zone. These solubility relations may be interpreted as lending some support to the idea that silver amalgam is largely deposited by hypogene solutions.

[22] Emmons, W. H., *Bull.* **625,** pp. 251–265, 1917.
Bastin, E. S., *U. S. Geol. Surv. Bull.* **735,** pp. 152–154, 1923.

[23] Broderick, T. M., Secondary enrichment of mercury deposits, *Econ. Geol.*, vol. 11, pp. 645–651, 1916.