

A POSTSCRIPT TO THE MCGILLITE STORY

JOHN S. STEVENSON

Department of Geological Sciences, McGill University, Montreal, Quebec H3A 2A7

LOUISE S. STEVENSON

Redpath Museum, McGill University, Montreal, Quebec H3A 2K6

JOSEPH D.H. DONNAY

Department of Geological Sciences, McGill University, Montreal, Quebec H3A 2A7

ABSTRACT

Since the original publication of the description of the manganous hydroxychlorosilicate *mcGillite* in 1980, previously unpublished information has been obtained concerning the discovery of the mineral and its geological setting in the Sullivan mine, Kimberley, British Columbia. Between 1945 and 1951, chemical, optical and X-ray studies were made by A.C. Freeze and R.M. Thompson of the mineral they tentatively identified as friedelite. These mineralogists believed that the mineral somehow differed from friedelite, but they lacked the crystallographic evidence to establish it as a new mineral. Nevertheless they made an important contribution in appreciating the value of the material and recommending its careful preservation for future workers.

Keywords: *mcGillite*, manganous hydroxychlorosilicate, friedelite, Sullivan mine, Kimberley, British Columbia.

SOMMAIRE

Depuis la publication, en 1980, de la description de l'hydrochlorosilicate manganoux naturel *mcGillite*, des renseignements jusqu'ici inédits ont été recueillis sur la découverte de ce minéral et la géologie de son gîte, la mine Sullivan, située à Kimberley, en Colombie-britannique. De 1945 à 1951, A. C. Freeze et R. M. Thompson firent l'étude chimique et roentgenographique du minéral qu'ils déterminèrent comme friedelite. Ces minéralogistes émirent l'avis que le minéral diffère de la friedelite sur certains points, mais ils ne pouvaient, faute d'observations cristallographiques, étayer son caractère de nouvelle espèce. Leur contribution fut néanmoins importante, du fait qu'ils reconurent l'intérêt que présentaient les échantillons et recommandèrent leur préservation pour les chercheurs à venir.

Mots-clés: *mcGillite*, hydroxychlorosilicate manganoux, friedelite, mine Sullivan, Kimberley, Colombie-britannique.

I. DISCOVERY, GEOLOGICAL SETTING AND EARLY STUDIES (J.S.S.-L.S.S.)

Correspondence has recently come to light in the

files of Cominco Limited concerning work done on the manganous hydroxychlorosilicate now known as *mcGillite* (Donnay *et al.* 1980), from the Sullivan mine, Kimberley, British Columbia. This led to further, previously unpublished information concerning the original discovery of the mineral, its mode of origin and the early studies of its mineralogy.

In December of 1951, Professor R.M. Thompson of the University of British Columbia wrote to Dr. A.C. Freeze, then District Geologist of the Sullivan mine, telling of X-ray work he had done on "a small specimen of a pink manganese silicate from the Sullivan mine", given to Thompson by Arthur Morris, a former student who had worked at the mine. Thompson had heard that Freeze had done optical work on the mineral, requested further information and suggested the possibility of a joint publication later. Apparently because of the pressure of work for both men and Thompson's long illness and untimely death, this collaboration was never carried out.

However, recently Freeze has been able to supply many important details which had never been published. Although Freeze left Kimberley in 1966, he recalled very clearly the discovery of the material now known as *mcGillite* and the studies he made between 1945 and 1951 (A.C. Freeze, priv. comm. Jan. 25, 1981.)

In 1945 Frank Shannon, a young miner who had been trained by the staff as a geological technician, noted a vein containing an unusual rose pink mineral while mapping a development raise into high-grade ore along the southern margin of the deposit. Freeze and Shannon mapped the occurrence in more detail and collected what Freeze described as "all the material we reasonably could, which perhaps amounted to about ten to fifteen pounds".

The ore that partially hosted the vein is relatively high in zinc compared to lead, a characteristic of the margins of the orebody, and also remarkably high in manganese. Freeze reported that much of the manganese is contained in the pale brown sphalerite, but some occurs in thin films of black manganese

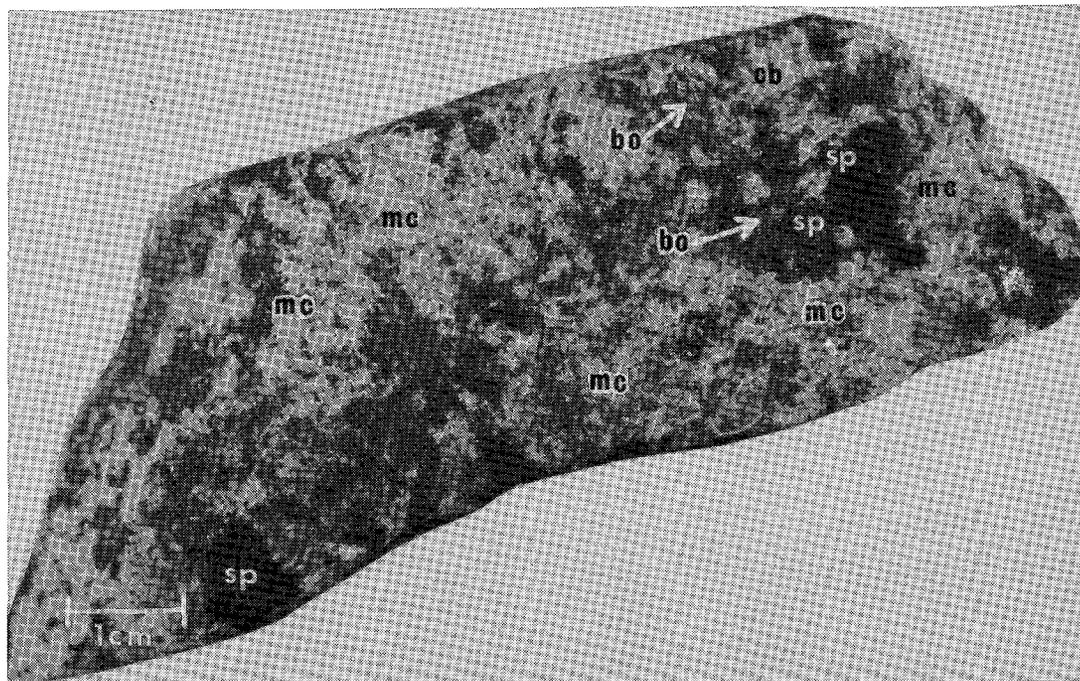


FIG. 1. McGillite from the type locality, the Sullivan mine, Kimberley, British Columbia; Redpath Museum no. NS3100, showing light grey mcGillite (mc), white carbonate (cb), black sphalerite (sp) and dark grey feathery boulangerite (bo).

oxide associated with thin veinlets of Ca-Mg carbonate.

The principal mcGillite-bearing vein was a rather small one, which Freeze remembers as "about 10 feet high, 15 feet long and less than 6 inches wide." The greatest concentration of mcGillite occurred in the widest part of the vein, where it transected the sulfide lens. Here it consisted of interlocking coarse aggregates of pink mcGillite (20-35 %) and black sphalerite, with lesser boulangerite, quartz and some carbonate (Fig. 1).

Small drusy cavities were also present, and these contained well-developed crystals of mcGillite and needle-like crystals of boulangerite. Numerous small veinlets containing quartz and mcGillite were noted in the rock.

A small quantity of mcGillite was found in another locality in the mine in 1945 by A.K. Christensen, a summer student from the University of British Columbia. Christensen collected a few specimens of the mineral in a raise into the "high-zinc zone" in the east-central part of the mine, between the 3600 and 3800 levels.

Since these early discoveries, no other occurrences of mcGillite have been observed at Sullivan mine.

EARLY CHEMICAL AND OPTICAL STUDIES

When first encountered underground, the pink mineral was thought to be either rhodochrosite or rhodonite. However, on the basis of his optical studies, Freeze tentatively identified it as friedelite. In 1946 Freeze sent a carefully selected sample to the Sullivan assay office for wet-chemical analysis. E. King White reported that the mineral is indeed a manganese silicate. He also noted that the mineral contains appreciable H₂O (expelled by heating powder in a closed tube) and a significant amount of chlorine. This chemical information is in agreement with that of Donnay *et al.* (1980). Thus, from the results of both chemical and optical work, Freeze concluded that the mineral is friedelite.

Nevertheless, Freeze still has some concern about the identification. He obtained, from the New Jersey Zinc Company, a specimen of friedelite from their mine in Franklin Furnace, New Jersey, to study for comparison, and found the two specimens to be slightly different.

X-RAY STUDIES

Freeze recalled the considerable interest shown in

the mineral by Cominco staff and, especially, by summer students returning to the university for postgraduate studies. Morris and Christensen took small amounts of "friedelite" to the University of British Columbia, and it appears to be the material to which Thompson referred in his 1951 letter.

In the summer of 1951, Thompson took his specimens to Queen's University where he and Professor L.G. Berry were working on "X-ray powder data for the ore minerals: The Peacock Atlas" (Geological Society of America Memoir 85). Berry remembered that Thompson brought specimens with him and did further powder work and some single-crystal work on cleavage fragments. Berry recalled that the only work he did himself on the mineral was in helping Thompson with the Weissenberg and precession study at that time (L.G. Berry, priv. comm. Feb. 26, 1981).

Thompson took his specimens and all his data back to the University of British Columbia when he returned. The present curator of the M.Y. Williams Geological Museum at the University, J. Nagel, has located Thompson's specimens labeled "Friedelite, Kimberley, B.C." There are two small specimens rich in mcGillite, a single-crystal mount and a small Debye-Scherrer powder rod; his data and notes are also there.

Thompson, in his 1951 letter to Freeze, showed some doubt that the mineral could be friedelite. As he said, "I did considerable X-ray work on this mineral last summer, and, if it is friedelite, the existing data are in need of revision." Thompson concluded that the substance is monoclinic, pseudo-hexagonal. He also stated that the one small chip of friedelite he obtained from the Royal Ontario Museum for comparison "looks quite unlike the Sullivan material although it gives a similar X-ray pattern". This problem was not resolved until the nineteen eighties.

Donnay *et al.* (1980) used single-crystal X-ray diffraction to establish mcGillite as a distinct species obeying the criterion of the rhombohedral lattice; they were unable to refine its crystal structure. Professor Gabrielle Donnay then sent a crystal to Dr. Iijima for examination by electron diffraction and high-resolution electron microscopy. These techniques proved mcGillite to be monoclinic $C2/m$, thus confirming Thompson's unpublished results of 1951 (Iijima 1982).

Recent studies by Ozawa and coworkers of the layer structure of mcGillite and friedelite have shown that the basic X-ray reflections that characterize the monoclinic structure, which are sharp in mcGillite, are diffuse in friedelite, which may thus be regarded as a disordered equivalent of mcGillite (Ozawa *et al.* 1983).

DISCUSSION

Despite the fact that Freeze and Thompson lacked sufficient evidence to establish mcGillite as a new mineral, these early workers made an important contribution in appreciating the value of the material and recommending its careful preservation for future workers.

II. R.M. THOMPSON'S NOTEBOOK OF 1951 ON "FRIEDELITE" (J.D.H.D.)

Thompson's folder on "friedelite" from Kimberley, British Columbia, was received from Mr. J. Nagel, University of British Columbia, in early December 1982. It contains three films of X-ray powder patterns and all the measurements made on single-crystal patterns [rotation, Weissenberg (zero and first layers), one zero-layer precession pattern, one cone-axis pattern parallel to the cleavage]. The single-crystal films themselves, however, are missing.

The first powder photograph is enclosed in an *ad hoc* envelope, carrying a printed form: "University of British Columbia, Department of Geology and Geography, X-ray Film. Date Jan. 12, '51. Substance 'Friedelite', Sullivan Mine, Kimberley, B.C. No. 559, Radiation Cu, Filter NiO." The other two powder films are dated August 11 and September 2, 1951. Thompson must have spent the intervening period with L.G. Berry, as these films are contained in envelopes of Queen's University, Department of Mineralogy. These envelopes and that of the University of British Columbia are identical to those designed at the University of Toronto by M.A. Peacock (1898-1951), whose perfectionism survived in his students, Berry and Thompson among them.

The results of the 1951 investigation can be quoted from Thompson's working sheets. The cell dimensions of "friedelite" (everywhere written between precautionary quotation marks) were given as follows on the sheet dated September 2 (numerical values between brackets added by J.D.H.D.):

$$a = 5.83 = \left[\frac{23.32}{4} \right], b/4 = 3.39 = \left[\frac{13.56}{4} \right],$$

$c = 7.40 \text{ \AA}$, $\beta = 105^\circ 12'$. The axial ratios and space group, however, read

$a : b : c = 1.720 : 1 : 2.183$ [= 0.546×4], $C2/m$. These ratios indicate that Thompson used the value $b/4$ instead of b or else that he multiplied a , as well as $b/4$, by 4 to get the (correct) ratio $a:b = 1.720$. The $c:b$ ratio of 2.183 implies the use of 5.83 and 3.39.

The dimensions of the monoclinic cell a' , b' and c' calculated by Iijima (1982) from the rhombohedral cell used by Donnay *et al.* (1980) are quoted here for

comparison: $a' = 23.379$, $b' = 13.498$, $c' = 7.390$ Å, $\beta = 105.3^\circ = 105^\circ 18'$. They yield the axial ratios $a' : b' : c' = 1.732 : 1 : 0.547$.

The reason for the quartering of the a and b values that confronted Thompson in 1951 is now known (Takéuchi *et al.* 1969): in all members of the pyrosmalite group, the crystal structure contains a superlattice, which is due to the Mn-brucite-type layer. McGillite and friedelite both belong to this mineral group. Thompson was obviously mystified by his observations. In view of the unavailability of his X-ray films, it is impossible to figure out why he would have recognized the quartering of b and not that of a .

In brief the numerical values of the cell edges [after the quadrupling of a] are in agreement with those given by Iijima (1982). The β angle agrees to one-tenth of one degree. The correct space-group criterion, " $(h+k)$ even, for all hkl reflections", somehow held true for the Thompson cell. Despite having failed to carry this work to completion, Thompson definitely established the monoclinic character of his "friedelite" [=mcGillite] and properly deserves the posthumous credit given to him by Iijima (1982).

ACKNOWLEDGEMENTS

We thank the geological staff of Cominco Limited for sending a copy of the late Professor Thompson's 1951 letter to Professor Gabrielle Donnay of McGill University.

We thank Professor Donnay for referring the letter to us and for helpful discussion and advice. We

also thank Dr. A.C. Freeze for his important and very useful first-hand information concerning the discoveries and early studies of mcGillite. We are grateful to the late Professor L.G. Berry of Queen's University, who recalled the work done in Kingston. We thank Mr. J. Nagel, curator of the M.Y. Williams Geological Museum at the University of British Columbia, for information concerning the location of the Thompson material and for making it available to us. R. Yates kindly assisted with the photography.

REFERENCES

- DONNAY, G., BÉTOURNAY, M. & HAMILL, G. (1980): McGillite, a new manganous hydroxychlorosilicate. *Can. Mineral.* **18**, 31-36.
- IIJIMA, S. (1982): High-resolution electron microscopy of mcGillite. I. One-layer monoclinic structure. II. Polytypism and disorder. *Acta Cryst.* **A38**, 685-694, 695-702.
- OZAWA, T., TAKÉUCHI, Y., TAKAHATA, T., DONNAY, G. & DONNAY, J.D.H. (1983): The pyrosmalite group of minerals. II. The layer structure of mcGillite and friedelite. *Can. Mineral.* **21**, 7-17.
- TAKÉUCHI, Y., KAWADA, I., IRIMAZIRI, S. & SADANAGA, R. (1969): The crystal structure and polytypism of manganpyrosmalite. *Mineral. J.* **5**, 450-467.

Received January 11, 1983, revised manuscript accepted July 19, 1983.