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FROHBERGITE, MONTBRAYITE, AND A NEW Pb–Bi TELLURIDE

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ABSTRACT

The composition of frohbergite, $FeTe_2$, has been confirmed from the original locality at Robb Montbray, Quebec, and electron probe studies have revealed new associations with chalcopyrite and melonite. Frohbergite has also been found in material from Noranda, Quebec, and Lindquist Lake, B.C. Montbrayite has been analysed, and found to contain small but probably essential amounts of Bi and Pb.

This note describes new data, acquired with the electron probe, on some rare telluride minerals from three Canadian localities.

Samples have been taken from the Peacock collection at the University of Toronto and for the most part have been studied previously. Often *x*-ray identifications have been performed by earlier investigators, and in this study only information accessible through the electron probe and ore microscope has been collected. An ARL, model EMX, probe has been used, and the data processed by computer by a programme written for the purpose at Toronto (Rucklidge, 1967). Standards for the most part have of

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necessity been pure elements, though Dr. L. J. Cabri, Mines Branch, Ottawa, was kind enough to provide synthetic phases in the Au-Ag-Te system, and these have been invaluable in improving the accuracy of the analyses.

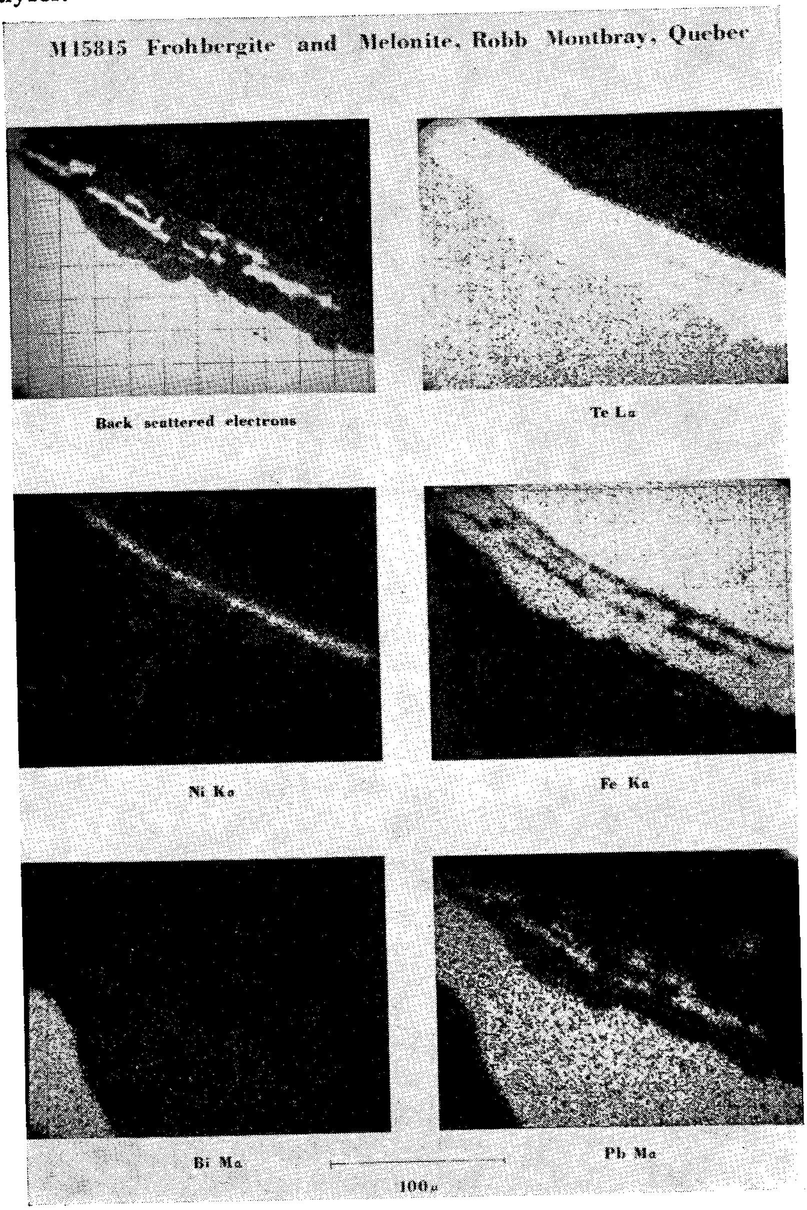

FIG. 1. Frohbergite and melonite, Robb Montbray, Quebec.

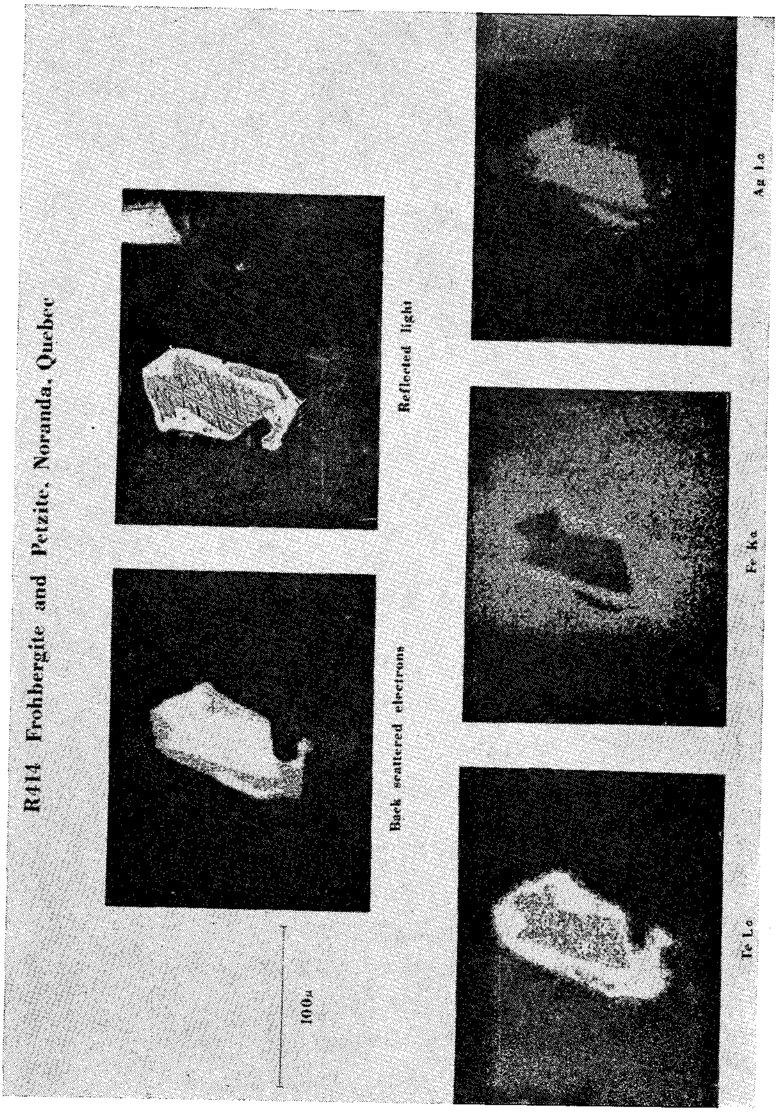

FIG. 2. Frohbergite and petzite, Noranda, Quebec.

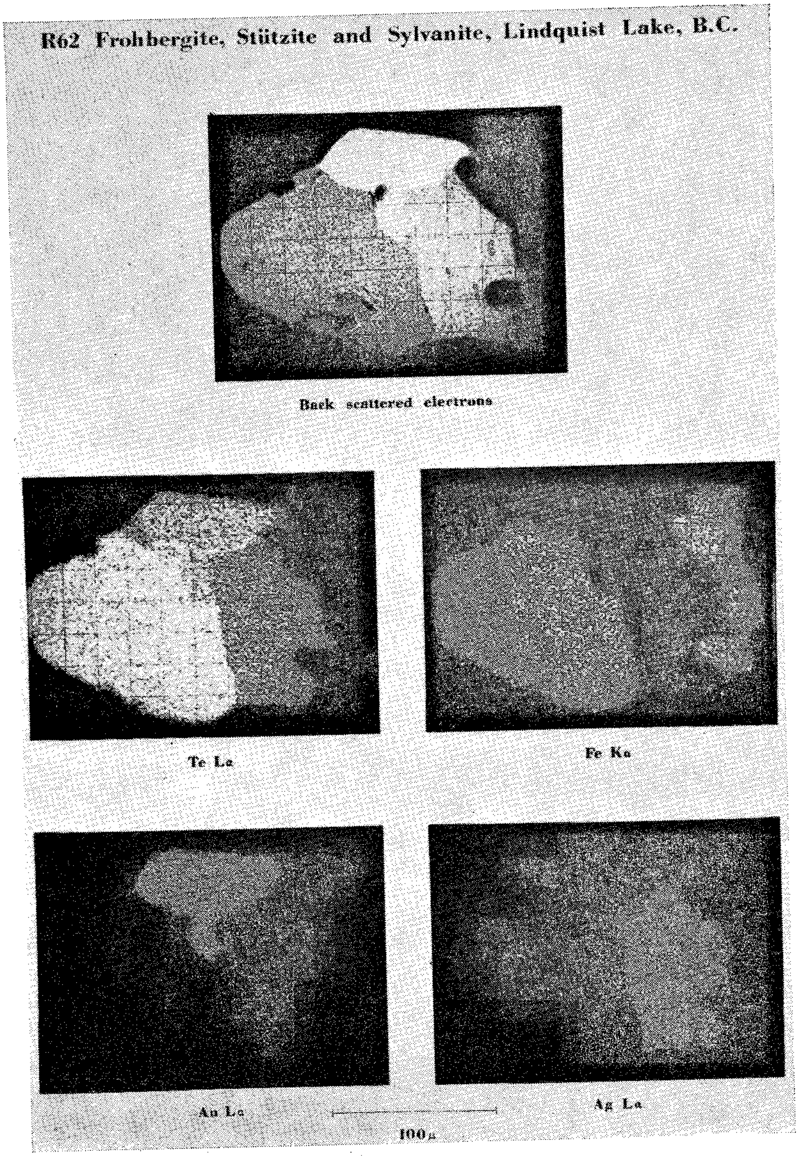

FIG. 3. Frohbergite, stutzite and sylvanite, Lindquist Lake, B.C.

The unique occurrence of tellurides at Robb Montbray, Quebec has long been the subject of investigation (Thompson, 1949). The minerals frohbergite, $FeTe_2$,and montbrayite Au_2Te_3 have only been found at this locality. Frohbergite usually occurs as a hard pinkish rim to chalcopyrite,

TABLE 1. ELECTRON MICROPROBE ANALYSES OF FROHBERGITE $FeTe_2$

	1	2	3	4
Fe	17.94	18.1±.3	17.1±.3	18.3±.5
Te	82.06	82.7±.5	80.4±.5	82.5±.5
	100.00	100.8	97.5	100.8

1. $FeTe_2$, theoretical composition.
2. Robb Montbray, Quebec.
3. Lindquist Lake, B.C.
4. Noranda, Quebec.

and this rim is rarely more than 20 microns wide. Consequently earlier investigators could not gather sufficient material for quantitative chemical analysis, though by a combination of *x*-ray powder work and synthetic studies Thompson (1947) was able to suggest the correct formula $FeTe_2$ for this phase. Probe studies have confirmed this directly and at the same time have revealed more detail in the frohbergite-chalcopyrite relationship than was hitherto observed. Figure 1 shows scanning photographs which demonstrate the existence of melonite $NiTe_2$ occurring as a thin band only 2 or 3 microns wide, between the frohbergite and chalcopyrite. This is frequently but not always present, and melonite also occurs as large independent grains elsewhere.

Frohbergite has also been found in samples from Noranda, Quebec and Lindquist Lake, B.C. Figure 2 illustrates former examples where it is associated with petzite which it rims in much the same way that it rims chalcopyrite at Robb Montbray. At Lindquist Lake only one grain was found and this a discrete entity rather than a rim. This is shown in Fig. 3. The association here is with sylvanite and stützite ($Ag_{5-x}Te_3$). The compositions of frohbergite from these three occurrences are shown in Table 1, and are identical within the limits of error.

Montbrayite, the other unique occurrence at Robb Montbray, has been given the formula Au_2Te_3 by Peacock and Thompson (1946). A phase of this composition has defied synthesis though most other natural phases in the system Au-Ag-Te have been produced artificially (Cabri, 1965). Electron probe studies of this mineral have shown that it contains small amounts of Bi, Pb and Sb. The content of Sb is difficult to define as it appears to vary from point to point. The analysis of the phase is given in Table 2 where it can be compared with that of Peacock and Thompson who ascribed the presence of Bi, Pb and Sb to impurities. Another gold telluride, calaverite, $AuTe_2$, has been found in intimate association with the montbrayite. This has not been recorded before even though it was found in one of the original sections examined by Peacock and Thompson,

TABLE 2. ELECTRON MICROPROBE ANALYSES OF GOLD TELLURIDES FROM ROBB MONTBRAY, QUEBEC

	1	2	3	4		5	6
Au	44.32	47.7	50.77	22.7	} 23.8	43.2	43.56
Ag	0.55	0.6		0.3		1.5	
Sb	0.90	0.3		0.2		0.1	
Pb	1.61	1.3		0.6		0.0	
Bi	2.81	2.9		1.3	} 35.8	0.0	
Te	49.80	47.0	49.23	34.5		56.0	56.44
	99.99	99.8	100.00			100.8	100.00

1. Montbrayite, Peacock & Thompson, 1946.
2. Montbrayite by electron probe.
3. Au_2Te_3, theoretical composition.
4. Anal. 2 recast to show atoms in unit cell with volume 1568 Å^3, G = 9.94.
5. Calaverite by electron probe.
6. $AuTe_2$, theoretical composition.

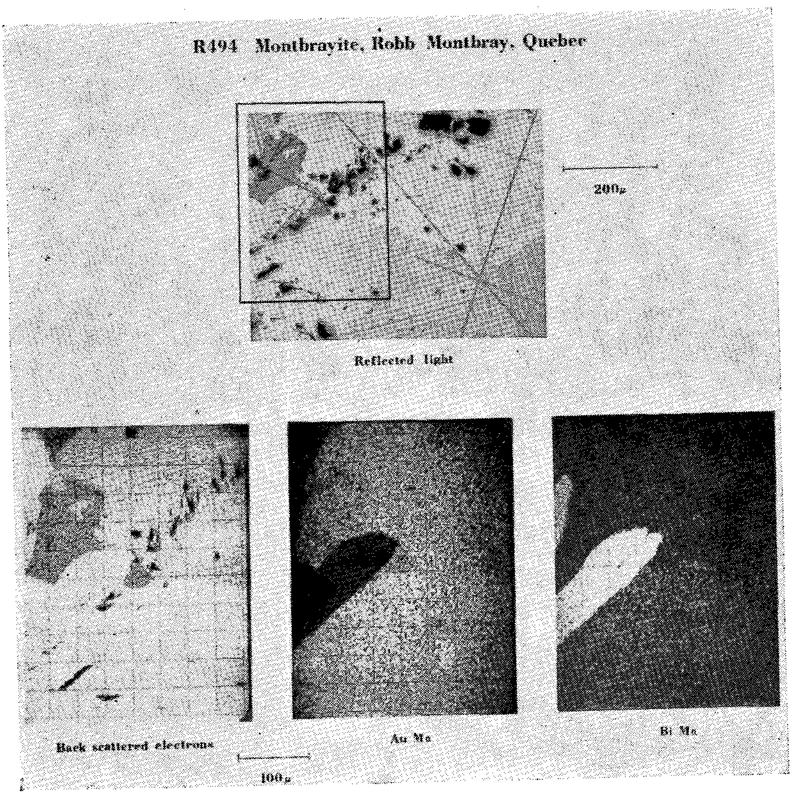

FIG. 4. Montbrayite, Robb Montbray, Quebec.

admittedly in minor amounts. The reason it was not found is that it is virtually indistinguishable optically from montbrayite. Only in the probe was the distinction established, and it is seen from the analysis that it contains no Bi or Pb, an uncertain amount of Sb, and about 1.5% Ag. In Fig. 4 the optical distinction between calaverite and montbrayite may just be detected, and the differences in Bi and Au contents are also demonstrated.

Detailed microscopic investigation of material from Robb Montbray also revealed the presence of minute white grains 30–40 microns in size completely surrounded by chalcopyrite. The reflectivity of this material is slightly lower than that of associated altaite, PbTe, and higher than that of tellurbismuth. The hardness is quite low. Microprobing revealed the presence of Pb, Bi and Te. No natural compound containing these three elements has so far been described and this phase apparently represents a new mineral. Quantitative analyses have been performed on the Toronto ARL probe as well as, through the kindness of Andrew M. Clark, on the Cameca probe in University College, London. The results obtained in these two laboratories are shown in Table 3 and are seen to be in good

TABLE 3. ELECTRON MICROPROBE ANALYSES OF A NEW Bi-Pb TELLURIDE FROM ROBB MONTBRAY, QUEBEC

	1	2
Pb	16.6±.2	15.2
Bi	37.4±.4	40.2
Te	44.6±.4	45.3
	98.6	100.7

Generalised formula $(Pb,Bi)_3Te_4$.
1. University of Toronto A.R.L. probe.
2. University College, London, Cameca probe.
By courtesy of A. M. Clark.

agreement. The generalized formula $(Pb,Bi)_3Te_4$ fits both compositions closely. Insufficient material is present for *x*-ray work at present, but optical evidence suggests cubic symmetry, with an estimated reflectivity of 63% in white light and microhardness in the range 20–50 VHN.

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A WIDE FIELD TECHNIQUE FOR VIEWING ROCK TEXTURES

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Abstract

By manipulation of its optical components the low power magnification range of the petrographic microscope may be extended. The technique described allows a five to ten times increase in the diameter of the field of view; an aid to the interpretation of small scale structures and coarse textures in petrographic thin sections.

When examining thin sections with the petrographic microscope there is often the need to extend the field of view to facilitate the observation of structures and to obtain a representative view of coarse textures. One is limited to a field of approximately 2–3 mm on most microscopes when using the lowest power objectives (2 or 3×), even in combination with wide-field eye pieces. This relatively small field of view can be conveniently extended by 5 to 10 times by employing the technique described herein. The interesting fact to keep in mind is that the area of view is a function of the square of the diameter of the field. Thus an increase in the diameter of the field by a factor of 5 gives a corresponding increase in viewing area of approximately 25 times. By observation of these large areas the interpretation of rock textures may be greatly facilitated.

The technique involves the following manipulations. The objective lens is removed from the microscope and the Amici-Bertrand lens is inserted; with this new lens system focusing is by means of the Bertrand lens focusing knob rather than the regular focusing knob. The latter is now used to control the extent of magnification. On microscopes with no provision for focusing the Bertrand lens one must bring the specimen into the plane of focus by the normal method; thus with this arrangement one cannot vary the magnification. The technique allows one to observe, within a single field, the full width of a standard thin section, or approximately one third of the area of the large (78 × 38 mm) sections.