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TUNGSTEN–MOLYBDENUM IN THE GRANITE LAKE–MEELPAEG LAKE AREA, NEWFOUNDLAND

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ABSTRACT

Wolframite and molybdenite (± bismuthinite) are found in sheeted quartz, quartz-greisen and quartz-pegmatite veins over an area of 25 km² between Granite Lake and Meelpaeg Lake in central Newfoundland (NTS 12A/2, 12A/7). This mineralization occurs both within, and externally to, a massive, pink to red, biotite–muscovite granite of probable Early Devonian age, and appears to be related to late north-northwest-trending and northeast-trending fracture zones. Minor K-feldspar alteration is present in the major north-northwest-trending fracture zone, and kaolinite alteration occurs locally. Evaluation of previous work indicates that there is major potential for large-tonnage–low-grade 'stockwork' deposits, and for high-grade vein deposits in the area.

INTRODUCTION

The Granite Lake–Meelpaeg Lake area (Figure 1; NTS 12A/2, 12A/7) was the focus of interest of the mineral exploration community during the fall of 1978. This interest resulted from the release of regional lake sediment geochemical data (Butler and Davenport, 1978), which showed anomalous element values (Mo, F, Cu, Zn, Pb, Ag, U) located to the northeast of Granite Lake. The anomalous values occur over approximately 50 km², and include some of the highest Mo and F values recorded from lake sediments in Newfoundland (Davenport, 1982, personal communication, 1986). Five exploration companies (Figure 2) were subsequently involved in exploration for Mo, W, and U during the period 1979 to 1983, and numerous occurrences of tungsten and molybdenum mineralization were located.

A gravel road from Millertown to the Granite Lake and Meelpaeg Lake reservoirs provides access to the mineralized area. Rock exposure is scarce, and consists mostly of outcrops that were created by stripping during exploration and during construction of a 'hydro ditch' (aqueduct) from Granite Lake to Meelpaeg Lake (Plate 1).

The current project involved compilation of soil geochemistry and geological data from assessment files, detailed mapping, and sampling available outcrop, with emphasis on mineralized and altered zones. Approximately 200 samples were collected and will be analyzed for a large suite of elements, including gold and silver. A compilation map at a scale of 1:15,000, showing the location of outcrops, mineral occurrences, and mineralized float in the Granite Lake–Meelpaeg Lake area, has been placed on open file (Tuach and Delaney, 1986).

Previous Work

Reconnaisance-scale geological work was performed by Phendler (1950), Riley (1957), and Williams (1970). Dickson (1982) mapped the area at a scale of 1:50,000, and presented some geochemical analyses of the granitoid rocks. In addition, Dickson (1982) documented the presence of molybdenite, wolframite, and scheelite mineralization associated with biotite–muscovite granite in the Granite Lake area. Pyrite, fluorite, and minor chalcopyrite, sphalerite, galena, and

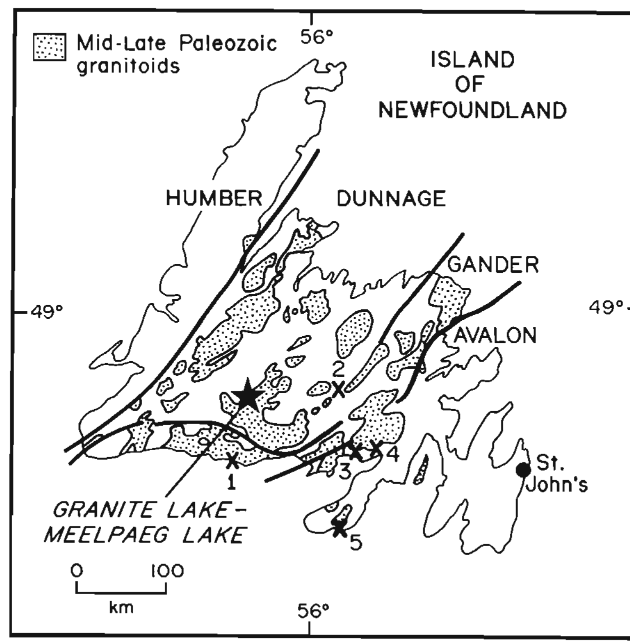
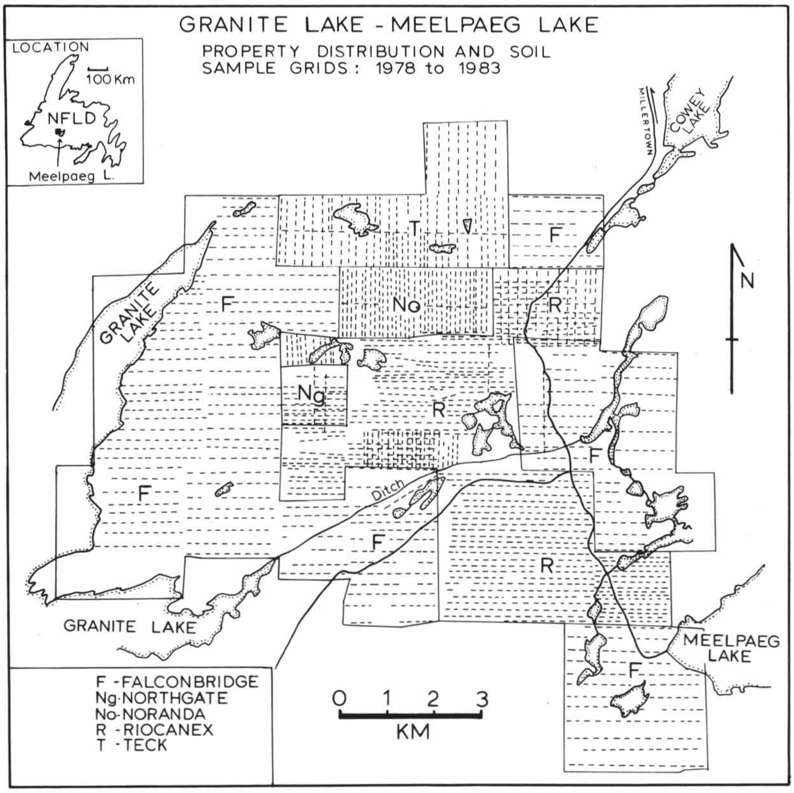


Figure 1: *Location of the Granite Lake–Meelpaeg Lake area in Newfoundland. Map shows generalized distribution of Silurian to Carboniferous granitoid rocks and location of the main granite-related mineral deposits. 1, Grey River (wolframite); 2, Great Gull (scheelite); 3, Rencontre Lake (molybdenite); 4, Sage Pond (cassiterite); 5, St. Lawrence (fluorite).*

This project is a contribution to the Canada–Newfoundland Mineral Development Agreement, 1984–1989



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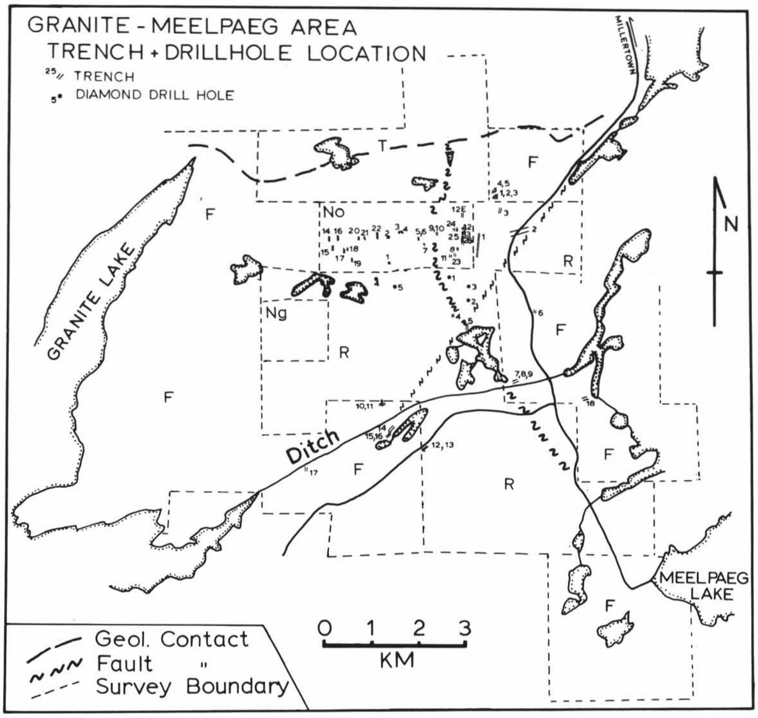


B

Figure 2. *Summary of exploration work carried out between 1979 and 1983 in the Granite Lake–Meelpaeg Lake area. A–Property distribution and grid locations; B–Location of drillholes and trenches.*

Plate 1: *Granite Lake–Meelpaeg Lake hydro ditch, showing locations of quartz vein (white) in the Meelpaeg fault zone. Looking east; rocks in background are Unit 2, rocks in foreground are Unit 4.*

beryl were also reported. Delaney (1984) performed a fluid-inclusion and lithogeochemical study on rocks in the 'hydro ditch' that contain minor mineralization.

Exploration work (Figure 2) was conducted by Falconbridge (Saunders, 1980a, b, 1982), Noranda (Dimmell, 1979, 1981, 1982), Northgate (Parker, 1979; Snow, 1980), Rio Algom (Ford, 1979; McKenzie, 1980; Harris, 1981; Bucknell, 1981, 1984), and Teck (Neelands, 1980; Godfrey and Lane, 1981). All of these companies undertook prospecting, geological, and soil geochemical programs (Figure 2). Noranda and Rio Algom conducted Induced Polarization (IP) surveys. Areas having soil geochemical anomalies were trenched by Noranda, Rio Algom, and Falconbridge (Figure 2-B), and five holes were drilled on IP anomalies by Rio Algom. Collectively, this work resulted in the discovery of abundant mineralized boulders, numerous mineralized outcrops, extensive soil geochemical anomalies, and minor mineralization in all five drill cores (Table 1). The most significant discoveries were described as the Hill, 500E, 0E, Road, Rio and Ditch prospects (Figure 3; Table 2).

Regional Geology

Dickson (1982) separated the rocks in the Granite Lake area into two major subdivisions consisting of migmatite and granitoid intrusions. The protolith to the migmatite, gneiss and schist is of sedimentary origin, and is considered to be Ordovician (equivalent to the Spruce Brook Formation; cf. Colman-Sadd, 1986). These metamorphic rocks are intruded by foliated tonalite and granodiorite, and by posttectonic, massive, biotite and biotite–muscovite granites that are considered to be Early Devonian. The migmatite forms part of a much larger area of gneiss and metasedimentary rocks in central Newfoundland, and is considered to have developed during the Middle to Late Silurian (Colman-Sadd, 1986). The granitoid rocks form part of the northwestern boundary of the North Bay Granite. Dickson (in preparation) proposes the name Wolf Mountain granite for the massive, posttectonic, biotite and biotite–muscovite granites of the North Bay Granite (equivalent to Unit 7 of Dickson, 1982).

Radiometric ages are not available from the Granite Lake area. However, U–Pb zircon dates of 396 Ma were reported from a massive, coarse grained, K-feldspar-porphyritic, biotite-granite phase of the North Bay Granite at Dolland Brook (O'Brien *et al.*, 1986). The granite at Dolland Brook forms part of the Wolf Mountain granite (L. Dickson, personal communication, 1986), and therefore, 396 Ma may be a reasonable age for crystallization of the massive, biotite–muscovite granites that are associated with mineralization at Granite Lake. Foliated granodioritic and tonalitic rocks in the Granite Lake area are older.

GEOLOGY IN THE GRANITE LAKE–MEELPAEG LAKE AREA

Four main geological units were identified in the Granite Lake area by Dickson (1982), and their distribution is outlined in Figure 3. Foliated granodiorite and tonalite in the east, and massive biotite–muscovite granite in the west, are the dominant rock types hosting mineralization. Migmatite outcrops along the northern edge of the area of economic interest, and a small area of buff, medium grained granite that was identified as a separate pluton by Dickson *(ibid.)*, is present in the southeast corner of the detailed study area. In addition, minor rhyolite was described from an area immediately to the southeast of the current map area.

Migmatite (Unit 1)

Unit 1 consists of gray to buff, banded, biotite–muscovite gneiss and schist (Plate 2), which locally contain abundant layers and pods of pink, medium grained, foliated, biotite and muscovite–biotite granite. Dickson (1982) reported the presence of sillimanite and garnet in the gneiss, and hornblende in isolated blocks of amphibolite occuring within the gneiss. The gneiss is intruded by foliated granodiorite dikes of Unit 2, and by granite, aplite, and pegmatite veins of Unit 4.

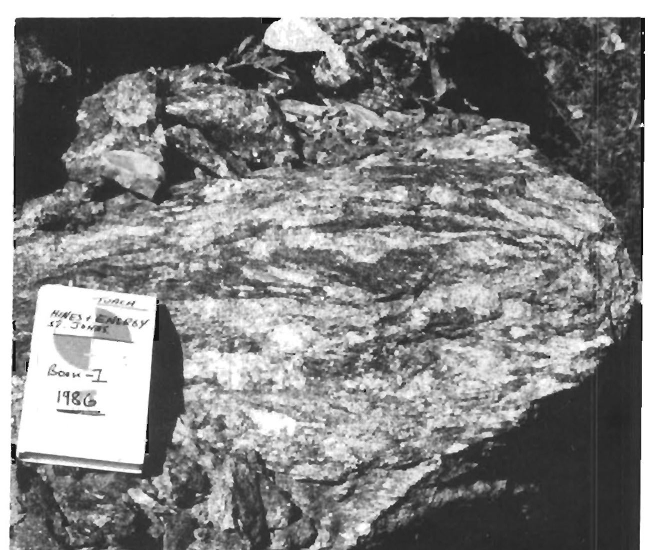


Plate 2: *Migmatite (Unit 2).*

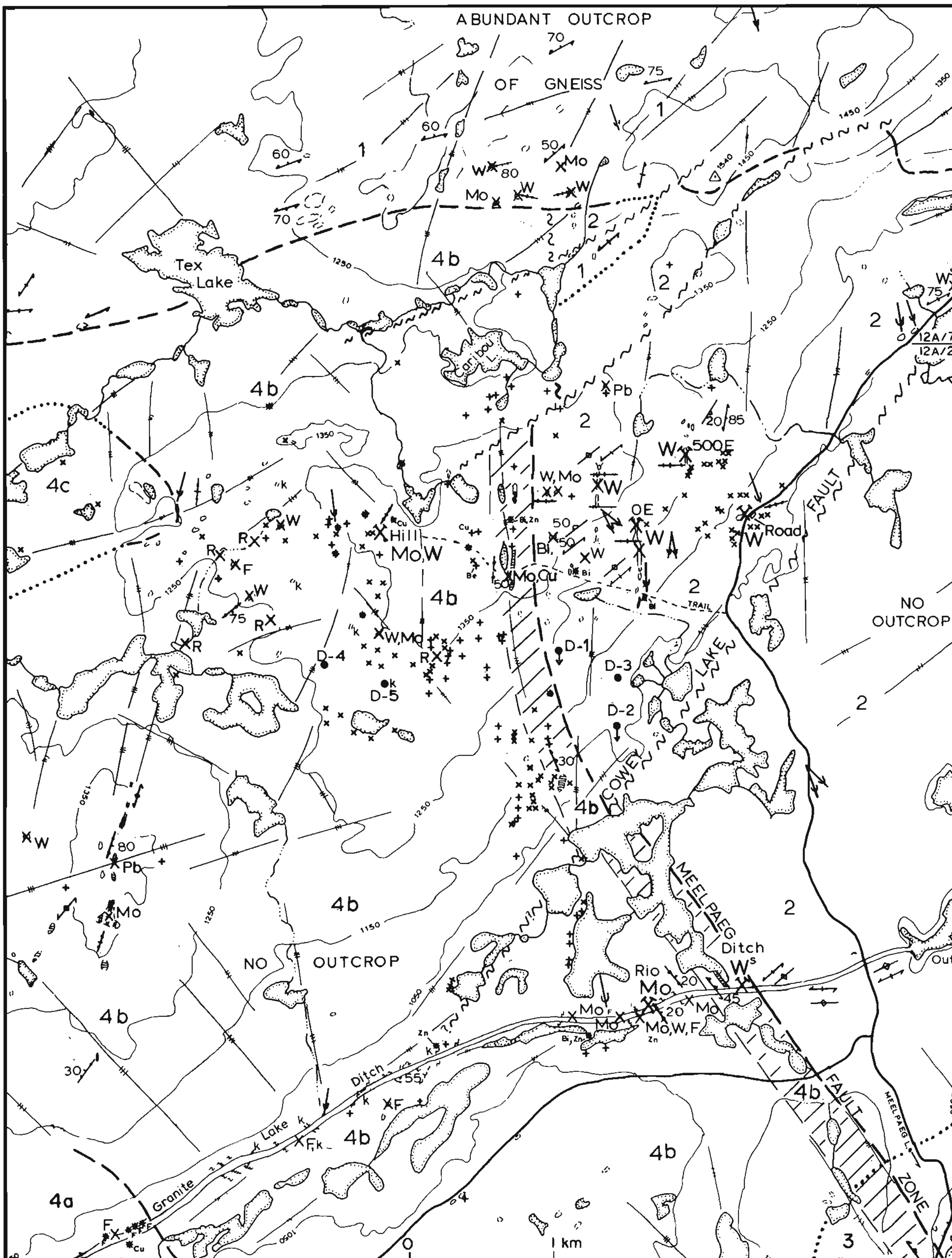


Figure 3: *Geological and mineral-occurrence compilation for the Granite Lake–Meelpaeg Lake area. Map also shows distribution of mineralized float and airphoto lineaments.*

LEGEND

DEVONIAN(?)

4 Wolf Mountain granite: *medium to coarse grained, equigranular to feldspar porphyritic, pink to red, biotite–muscovite granite;* 4a, *buff to pink, medium to coarse grained, equigranular to porphyritic granite;* 4b, *red to pink, medium to coarse grained, equigranular to porphyritic granite;* 4c, *red to pink, fine grained, porphyritic granite*

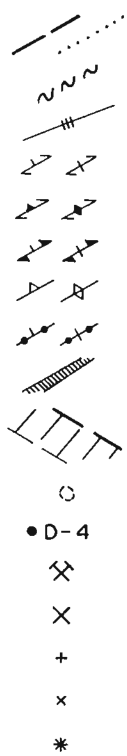
3 *Medium grained, equigranular, white to buff, biotite–muscovite granite*

ORDOVICIAN–SILURIAN(?)

2 *Foliated, banded, medium grained, pink to gray, granodiorite and tonalite;* 2a, *gray, banded, melanocratic granodiorite;* 2b, *buff to slightly pink granodiorite;* 2c, *pink to red granodiorite*

1 *Migmatite and schist*

SYMBOLS



Geological contact (approximate, assumed)
Fault or fracture (assumed)
Airphoto lineament
Foliation (inclined, vertical)
Fracture cleavage (inclined, vertical)
Gneissic foliation (inclined, vertical)
Igneous layering (inclined, vertical)
Vein or sheet veins (inclined, vertical)
Massive quartz
Area of extensive metasomatism, brecciation and quartz veining; locally mylonitized
Outcrop
Drillhole
Prospect (Mods Cards)
Bedrock mineral occurrence
Float: molybdenite bearing
Float: wolframite bearing
Float: molybdenite and wolframite bearing

Be......... Beryl
Bi.......... Bismuthinite
Cu......... Chalcopyrite (possible bornite locally)
F............ Fluorite
K........... Kaolinite
Mo........ Molybdenite
R........... Anomalous radioactivity (>5 x background)
S............ Scheelite
W.......... Wolframite (subscripts refer to scheelite)
Zn.......... Sphalerite

Table 1. Selected analyses from drill core from the Granite Lake–Meelpaeg Lake area showing metal associations (taken from assessment reports)

Drillhole	From–To (m)	Length (m)	Mo (g/t)	WO_3 (g/t)	Bi (g/t)	Cu (g/t)	Zn (g/t)	Pb (g/t)
DDH-M-1	13.50– 14.25	0.75	1300	Nil	-	200	100	100
	53.70– 53.85	0.15	Tr	1200	-	100	100	100
	114.17–114.38	0.21	1100	200	400	200	200	200
DDH-M-2	61.80– 62.10	0.30	Nil	900	-	100	300	Tr
	67.50– 67.95	0.45	500	-	-	200	100	400
	142.29–142.43	0.14	500	Tr	-	300	100	600
DDH-M-3	22.88– 23.79	0.91	Nil	400	-	100	1100	100
	33.86– 34.47	0.61	100	1400	-	100	100	Nil
	38.74– 39.35	0.61	Nil	1600	-	100	Tr	100
	40.57– 41.18	0.61	100	2400	-	200	500	100
	43.01– 43.31	0.30	200	100	-	200	4500	Tr
DDH-M-4	25.50– 26.70	1.20	Tr	1000	-	Tr	200	Tr
	29.70– 31.20	1.50	Tr	6100	-	100	1300	100
	46.20– 47.70	1.50	Tr	1500	-	100	500	Tr
	53.70– 55.20	1.50	Tr	1400	-	100	200	Tr
	76.20– 77.70	1.50	100	1800	-	100	400	Tr
	77.70– 79.20	1.50	Tr	6700	-	100	1000	100
DDH-M-5	92.00– 94.00	2.00	400	Tr	-	400	200	Tr
	110.00–112.00	2.00	Tr	1500	-	100	500	200

Note: Where values are not reported they were below detection limit or in most cases were not reported in the assay suite.

Table 2. Selected analyses from trenches and bedrock in the Granite Lake–Meelpaeg Lake area showing metal associations (taken from assessment reports)

Location	Length (m)	WO_3 %	MoS_2 %	Bi %	Pb %	Cu %	Ag g/t
Road (Rio)	0.8	1.45	-	-	-	-	-
Road (Rio)	1.15	0.68	-	-	-	-	-
500E (Rio)	3.1	0.23	-	-	-	-	-
0E (Rio)	0.5	1.70	-	-	-	-	-
0E (Rio)	1.45	0.28	-	-	-	-	-
0E (Rio)	0.50	0.80	-	-	-	-	-
Hill (Nor)	6.7	-	-	-	-	-	23
Trench 1 (Nor)	13.0	-	-	-	-	-	4
2 (Nor)	Grab	1.25	-	-	-	-	4
3 (Nor)	Grab	-	0.27	0.03	-	-	3
4 (Nor)	Grab	-	-	-	-	0.17	2
5 (Nor)	Grab	-	0.06	-	-	0.10	2
7 (Nor)	Grab	-	0.43	-	-	0.32	1.5
10 (Nor)	Grab	-	-	0.96	-	-	44
11 (Nor)	Grab	0.48	-	0.15	-	-	12
12 (Nor)	3.5	0.65	-	-	-	-	3
12 (Nor)	1.25	0.085	-	-	-	-	-
Ditch (Falc)	2.0	0.07	-	-	-	-	-
(Ngt)	Grab	-	-	-	0.01	-	11

Note: Where values are not reported they were below detection limit or in most cases were not reported in the assay suite.
Rio–Riocanex; Nor–Noranda; Falc–Falconbridge; Ngt–Northgate

Granodiorite and Tonalite (Unit 2)

Unit 2 (equivalent to Unit 4 of Dickson, 1982) consists of foliated, banded, gray to buff, medium grained, equigranular granodiorite and tonalite (Plate 3). Banding is caused by variation in abundance of biotite and hornblende between layers; the foliation is subparallel to banding, and both are steep and generally trend northeast. Unit 2 is intruded by granite, and is cut by numerous aplite, pegmatite, and sheeted quartz-greisen veins of Unit 4. Xenoliths of migmatite are locally present in the granodiorite. Dickson (1982) reported the presence of a small diabase dike in Unit 2 on the north side of the ditch near the contact with the granite.

Plate 3: *Banded and foliated granodiorite (Unit 2).*

Subunit 2a is gray granodiorite and contains up to 40 percent mafic bands averaging 5 cm in width. Subunit 2b is buff to slightly pink granodiorite and contains a relatively smaller portion (averaging 15 percent) of mafic bands compared to subunit 2a, and a lower proportion of mafic minerals. Subunit 2c is pink to red granitoid and contains abundant pink feldspar. Banding and mafic minerals are commonly absent, and the rock is locally a syenite. Subunit 2c outcrops as blocks within the Wolf Mountain granite at and near the eastern margin of the granite (Unit 4), and also immediately to the east of the Wolf Mountain granite where it is interbanded with subunits 2a and 2b. Rocks of subunit 2c are commonly developed marginal to fractures, a feature that indicates it was developed by hydrothermal modification of pre-existing granodiorite.

Muscovite–Biotite Granite (Unit 3)

Variably foliated, buff to pink, equigranular to locally feldspar-porphyritic, muscovite–biotite granite (equivalent to Unit 5 of Dickson, 1982) is present in the southeast. Dickson (1982) described the contact of Unit 3 with Unit 2 as intrusive, but noted gradational contacts locally. He suggested that the granite of Unit 3 is derived from the granodiorite and tonalite (Unit 2) by fractional crystallization.

The Wolf Mountain Granite (Unit 4)

Massive, medium to coarse grained, equigranular to feldspar-porphyritic, buff to pink and red, biotite–muscovite granite (Plate 4) underlies the central and western parts of the area. Buff granite of subunit 4a (subunit 7b of Dickson, 1982) is exposed at the western end of the ditch, whereas pink to red granite of subunit 4b occurs over much of the area (subunit 7a of Dickson, 1982). An area of fine to medium grained, massive to porphyritic, pink granite (subunits 4c) occurs in the central-west part of the map area, and locally, small areas of fine grained, muscovite-rich and biotite-rich granites are present. Fine grained, red to purple aplite dikes up to 3 m in width were noted along the ditch. Quartz and quartz-muscovite-greisen veins are common within the main exposure-area of Unit 4, and comparable veins and simple pegmatite veins (presumably related to Unit 4) occur throughout Units 1 and 2. These veins are variably mineralized with wolframite and molybdenite, the most common minerals of economic interest.

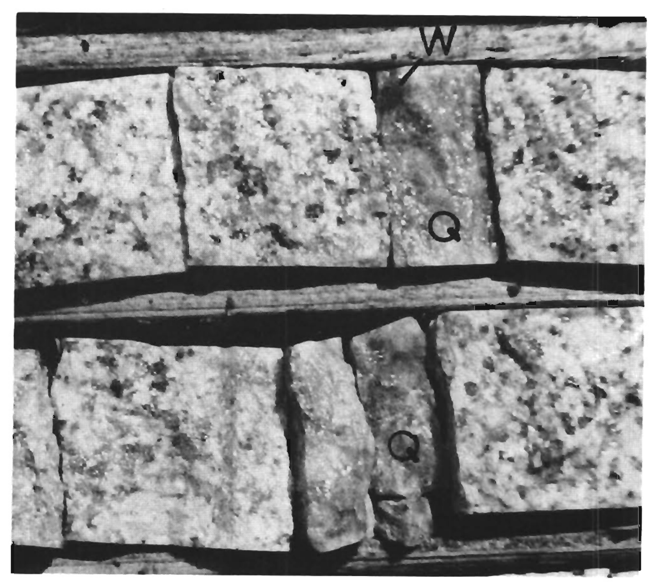


Plate 4: *Wolf Mountain granite (Unit 4) containing wolframite (W)-bearing quartz veins (Q). Quartz veins are commonly sheeted and gently dipping. Core is 2.7 cm thick.*

Intrusive contacts between subunit 4b and Unit 2 are well exposed in the ditch, and abundant large xenoliths and rafts of subunit 2c occur within Unit 4 along the contact zone (Plate 1). Granite and pegmatite dikes, and small irregular intrusions of granite occur in Unit 2 to the east of the main contact. An intrusion breccia consisting of Unit 4 granite (50 percent) and Unit 2 granodiorite occurs approximately 1 km east of the main contact over a distance of 50 m. The contact between Unit 4 and Unit 1 is not exposed in the map area, but Dickson

(1982) reported intrusive contacts on the north side of Granite Lake. Pegmatite dikes in Unit 1 are probable offshoots from Unit 4.

The contact between subunit 4a and 4b, as exposed in the ditch, is an irregular and transitional zone of color change from buff in the west to red in the east. The contact relationship of the central area of subunit 4c with subunit 4b is not exposed. However, gradational and sharp grain size variations are present in outcrop and in drill core between finer and coarser grained granites, indicating a relatively close genetic relationship between the various textural phases present. In contrast, minor red to purple aplite dikes have sharp chilled (fine grained) contacts with the host granite, and are most prevalent in areas of fracturing and hydrothermal alteration.

Southeast of the map area at Meelpaeg Lake, small areas (up to 0.5 km²) of dark-red to purple, massive rhyolite occur (Dickson, 1982). Some of these units have sharp chilled margins and may be aplite plugs or intrusions. Outcrops at the Meelpaeg Lake dam exhibit tuffisite textures and are hematite stained. They are variably veined by quartz, and are propylitized and sericitized. These rocks are similar to the red-purple aplites of Unit 4 exposed in the ditch, and are tentatively correlated with them.

Geochemical data from 11 samples analysed by Dickson (1982; see also Figure 4) indicate that the Wolf Mountain granite north of the ditch is a differentiated, high-silica (73.1 to 77.7 percent SiO_2), alkali (4.35 to 5.57 percent K_2O and 3.11 to 3.8 percent Na_2O) pluton that has a moderately high alumina content (12.9 to 15.2 percent Al_2O_3).

Structure

Banding and foliation in the gneiss and schist of Unit 1 trend east to northeast. Numerous minor isoclinal folds of the gneissic banding have fold axis that plunge to the northeast and southwest (cf. Godfrey and Lane, 1981). Foliation in the granodiorite and tonalite of Unit 2 also generally trends northeast. Detailed structural studies were not undertaken within these rock types. Both of these units are intruded by the Wolf Mountain granite (Unit 4).

The Meelpaeg fault zone refers to a north-northwest- to north-trending zone of fracturing, mylonitization, multistage quartz veining, and hydrothermal potassic-feldspar alteration that occurs at and near the eastern margin of the Wolf Mountain granite. The zone is identified as an unnamed fault on the Wolf Mountain map sheet (Dickson, 1982). Quartz veins form outcrops that range in size up to 20 by 100 m (see Plate 1), and the larger veins are shown on Figure 3. Large blocks of subunit 2c occur as xenoliths, and possibly as tectonic slivers, within the fault zone, and a fracture cleavage and local mylonitic fabric are developed in the Wolf Mountain granite. South of the area shown on Figure 3, at Meelpaeg Lake, the granites of Units 3 and 4 are also fractured and mylonitized, and veined by quartz within the Meelpaeg fault zone. This zone was not traced to the northern contact of the Wolf Mountain granite because of lack of exposure and float, and it could not be identified with any degree of confidence in Unit 1 migmatite.

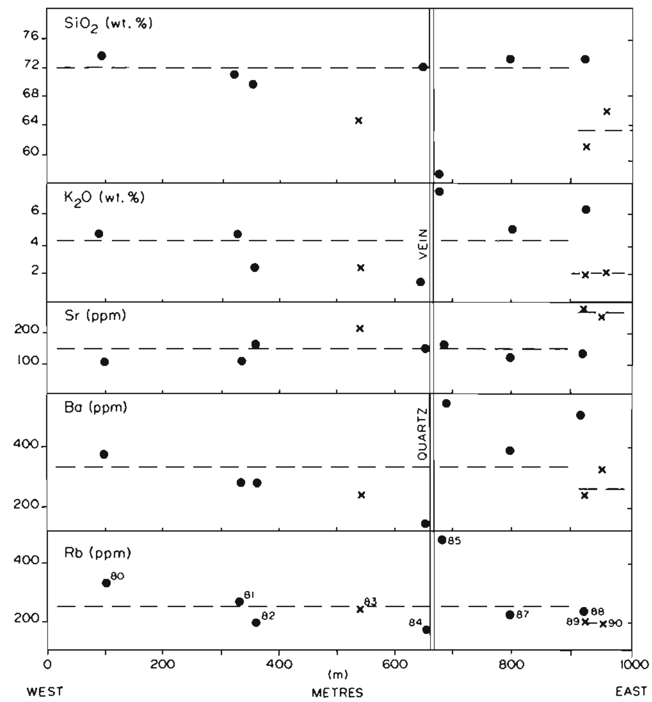


Figure 4: *Distribution of SiO_2, K_2O, Sr, Ba, and Rb in samples collected across the Meelpaeg fault zone at the ditch (from Delaney, 1984). Dots—Unit 4; x—Unit 2. Horizontal dashed lines are means of data from Unit 4 (on left; 11 samples) and Unit 2 (on right; 4 samples) from Dickson (1982).*

The more prominent airphoto lineaments in the map area are depicted on Figure 3. Those lineaments over Unit 1 may be related to penetrative structural and possibly lithological features, and to later cross-cutting fracture zones. Lineaments over Unit 2, and in the western part of the map area, may reflect glacial features; there is no outcrop, and overburden is relatively thick. Lineaments developed in the central part of the map area appear to relate to fracture zones in the Wolf Mountain granite since their projected trace in the ditch is reflected by relatively abundant fracturing and increased hydrothermal-alteration features in the granite. For example, the two north-northwest-trending lineaments north of the ditch are reflected by the dominance of north-northwest fractures in the ditch, and the northeast lineament that extends from the ditch to Cowey Lake (Figure 2) is reflected by the dominance of northeast fractures at its projection in the ditch. This lineament is named the Cowey Lake fault, and it may be significant with respect to mineralization in the area. Dickson (1982) showed a northeast-trending fault in the northern part of the map area, which is shown as a series of airphoto lineaments on the current map.

In the vicinity of the ditch, a series of lineaments trend east-northeast, parallel to the trend of the ditch. A major fracture zone is indicated by numerous fractures, areas of alteration, and aplite intrusions exposed in the ditch that also parallel this trend (Plate 5).

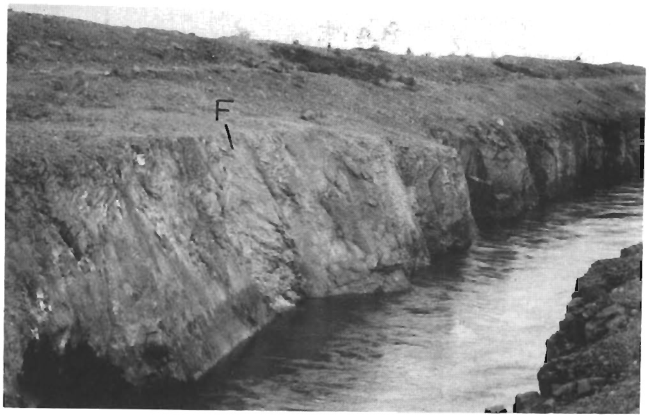


Plate 5: *Zone of fracturing (F) and alteration in ditch, which trends east-northeast.*

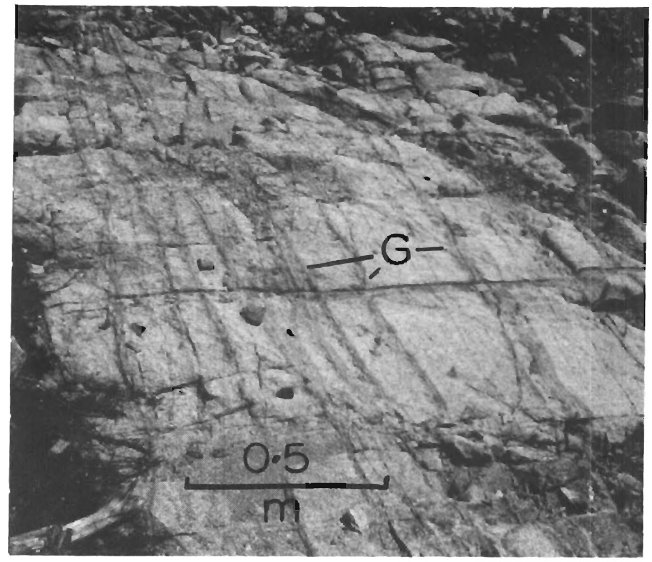


Plate 6: *Subvertical quartz-greisen vein (G) sheet (in Unit 2) trending east–west. From trench 0E.*

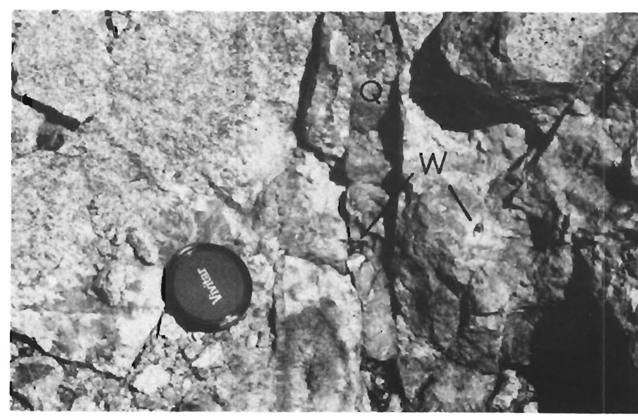


Plate 7: *Quartz vein (Q) cutting earlier pegmatite vein; both contain wolframite (W). Same outcrop as Plate 6.*

The purple aplite dikes in the ditch are predominantly located in fracture zones and in zones of clay and epidote alteration. They are generally less fractured and altered than the rocks that they intrude. Some of the purple felsites located at Meelpaeg Lake occur within fractured and mylonitized rocks of the Meelpaeg fault zone, and show evidence of extensive hydrothermal alteration (epidote, sericite, clay) and local quartz veining. However, cleavage and mylonitic textures are generally absent, although quartz veining is common. These features suggest that the felsites were intruded at a late stage in the development of the fracture system that affected the Wolf Mountain granite in the map area.

MINERALIZATION AND ALTERATION

Mineralization

North of the ditch within Unit 2, the dominant style of mineralization (exocontact mineralization) consists of east-trending, thin (1 to 5 cm), subvertical sheeted quartz veins, quartz–feldspar veins (simple pegmatite), and quartz–muscovite-greisen veins (Plates 6 and 7) containing coarse grained wolframite and locally traces of scheelite and molybdenite. At the 0E trench, wolframite-bearing quartz-greisen veins cut earlier wolframite-bearing pegmatite veins (Plate 7). Locally, quartz and quartz–feldspar veins up to 1 m thick, and containing coarse grained wolframite, occur (e.g., the Road prospect; Plate 8). The wolframite is dark brown to black and individual crystals and clumps of crystals up to 5 cm across are not uncommon; scheelite occurs as a fine coating on fracture surfaces.

Within Unit 4, narrow sheeted quartz veins containing molybdenite, and locally wolframite (Plates 9 and 10), commonly occur in zones of fractured granite. In the ditch, the molybdenite-bearing veins dip eastward at a low angle, and intersections of sheets of mineralized veins in drill core (Plate 4) also indicate that most mineralized veins dip at less than 30 degrees. The molybdenite occurs as coarse grained (up to 1 mm) selvages to the quartz veins (Plate 10), as isolated coarse grains and rosettes (up to 2 mm), and as 'paint' on fracture surfaces. Wolframite crystals and crystal aggregates up to 3 cm across are common (Plate 9).

Mineralization in the Meelpaeg fault zone consists of minor disseminated and fracture-controlled wolframite and scheelite (e.g., the Ditch showing). Thin anastomosing quartz veins (< 2 cm wide) containing molybdenite and chalcopyrite occur in fractured granite approximately 1 km west of the 0E trench (Figure 3). Traces of disseminated molybdenite, pyrite and fluorite were also noted in a small area of syenite at the ditch.

A zonal arrangement of mineralization is emphasized by mineral occurrences in bedrock and by the distribution of the mineralized boulders (locations taken from assessment

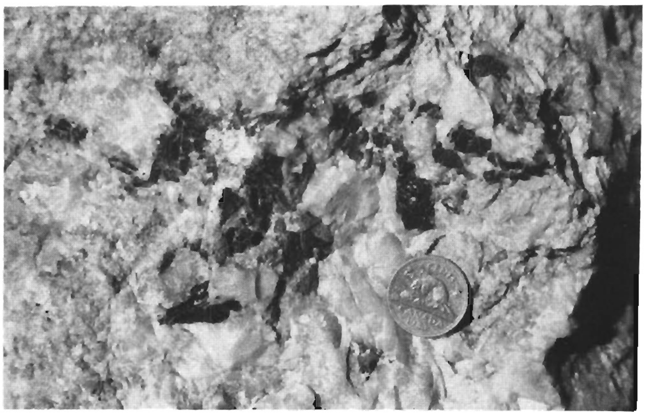


Plate 8: *Coarse grained wolframite (W) in quartz vein in Unit 2 at the Road prospect.*

Plate 9: *Wolframite (W) in a quartz vein in the Wolf Mountain granite (Unit 4). Float, near the Hill prospect.*

reports) to the north of the ditch (Figure 3). Molybdenite is most abundant within Unit 4 near the Meelpaeg fault zone. Wolframite occurrences and wolframite-bearing boulders are dominant to the east of the Meelpaeg fault in Unit 2, and wolframite- and molybdenite-bearing boulders are found to the west of the Meelpaeg fault in Unit 4. It is noted that Davenport (1982) described large-scale zonation in the lake sediment geochemical patterns in the area, which may also reflect bedrock-mineralization patterns.

Minor bismuthinite, traces of chalcopyrite, and dark-brown, translucent sphalerite are present in boulders in and near the Meelpaeg fault zone, and are locally associated with molybdenite-rich quartz veins in Unit 4. Traces of galena have been reported from two outcrops, and a crystal of beryl was reported from Noranda trench #7 (Dimmell, 1982).

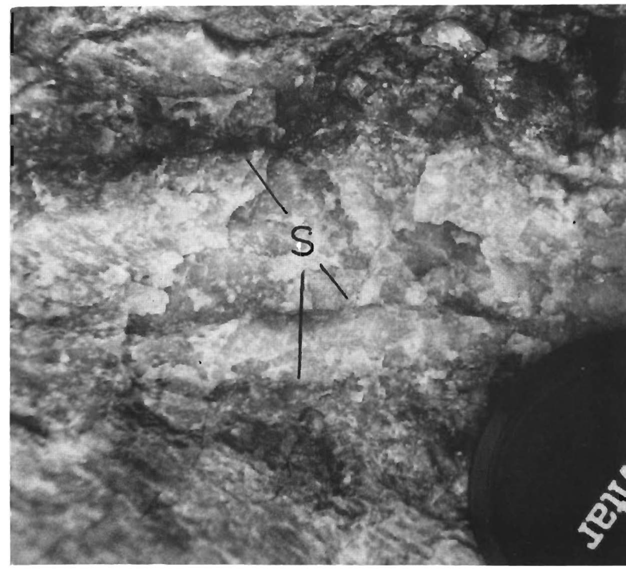


Plate 10: *Close up of quartz vein from zone of gently dipping sheeted veins in the Wolf Mountain granite, Rio prospect, showing molybdenite-rich selvages (S) and partings.*

Pyrite is rare in association with the molybdenite- and wolframite-bearing sheet veins, but quartz veins containing up to 5 percent pyrite occur locally. Disseminated pyrite (< 2 percent) is common in clay-altered zones in Unit 4, and fracture-controlled pyrite (up to 3 percent) occurs locally in mafic rocks of Unit 2 and in the intrusion-breccia zone along the ditch.

Minor purple to black fluorite (< 0.5 percent) was noted at numerous isolated localities throughout the area. It occurs as fracture coatings and as small (< 1 mm) disseminated crystals, and has been noted in association with all the rock types in the area. One boulder (20 cm in diameter) was found at the ditch, about 400 m west of the Meelpaeg fault zone, that showed angular, hydrothermal-breccia fragments whose matrix contains approximately 50 percent fine grained fluorite.

Fine grained tourmaline occurs locally in Unit 2 as fracture coatings (< 1 cm wide), and as a fine grained matrix to thin tuffisite veins (< 5 cm wide). It also occurs within the pegmatite veins in all units.

Alteration

The most widespread alteration feature is a red staining of the granitoid rocks, which appears to be focused on the Meelpaeg fault zone. Units 2 and 4 have been affected. The alteration is accompanied locally by the growth of pink and red feldspar adjacent to fractures in Unit 2. Figure 4 shows the distribution of SiO_2, K_2O, Sr, Ba, and Rb adjacent to the large quartz vein exposed at the ditch (from Delaney, 1984), along with the means of analyses from Units 2 and 4 (which were presented by Dickson, 1982). Considerable element mobility is indicated, and sample 86 (syenite?) is strongly enriched in K_2O suggesting that potassic metasomatism occurred in the Meelpaeg fault zone.

Numerous areas of white to gray clay (kaolinite?) alteration occur along the ditch. These are generally associated with fractures and aplite dikes in the Wolf Mountain granite, and are less than 5 m wide. Small areas of clay-altered granite and float were also reported to the north of the ditch (Dimmell, 1982). Approximately 50 percent of the core in DDH-4 consists of clay-altered granite. However, much of the altered section has a weak to intense, red-brown hematite stain. In trench 0E, a small zone (2 m wide) of pale-green clay alteration occurs in Unit 2.

Epidote, chlorite, and minor sericite are common in the fractured areas in the ditch. These minerals may be associated with clay alteration, or they may form independent alteration zones and areas of 'gouge' in fractures. Chlorite is commonly developed along fractures.

Genesis of Mineralization and Alteration

Mineralization is probably related to the high-silica, biotite–muscovite phase of the Wolf Mountain granite (Dickson, 1982, 1984). High-temperature vein-style mineralization and associated alteration occurred after solidification of the granite. However, the sheet-vein wolframite mineralization in Unit 2 may have accompanied granite emplacement and solidification. Fluids responsible for the mineralization were focused by late fracturing in the area (Plates 6 and 9). The Meelpaeg and Cowey Lake fault zones may have been important large-scale controls on the spatial distribution of mineralization. Lower temperature clay alteration continued in fault and fracture zones, and was accompanied by emplacement of minor aplite dikes. The presence of silver and bismuth (Table 1) may suggest that lower temperature veining and mineralization occurred, and may have overprinted higher temperature mineralization. It is possible that the fluids emanated from the fine grained porphyritic phase of the Wolf Mountain granite or from similar buried phases. No information is available on the detailed temporal relationship between the various styles of mineralization.

Mineral Potential

The locations of mineral occurrences and prospects in the Granite Lake–Meelpaeg Lake area are shown on Figure 3, and a list of representative analyses compiled from the assessment reports is presented in Tables 1 and 2. These clearly indicate a potential for significant granophile mineralization. Sheeted-vein tungsten mineralization similar to that in the Granite Lake area is common in association with granites of southwest England and Malaysia (Dines, 1956; Manning, 1986). In particular, striking similarites with the famous Cligga Head vein sheets (Moore and Jackson, 1977), and with the large low-grade tungsten–tin deposits at Hemerdon and Redmoor (Moore, 1977; Bull, 1982) are noted. The association of molybdenite-bearing vein sheets with high-silica alkali granites indicates a potential for Climax-type stockwork deposits (cf. White *et al.*, 1981).

Mineralized float has been reported from an area of approximately 25 km to the north of the ditch (Figure 3). Mineralization in the boulders is generally sparse, but can reach levels of 2 percent tungsten and 1 percent molybdenum. The boulder-distribution pattern is strongly influenced by the topography and by the relative boulder-prospecting effort made by the various companies. Nonetheless, it is apparent that many of the boulders and known occurrences are spatially related to the Meelpaeg fault zone, and this may have been the source of mineralization. Ice movement is generally to the south (D. Vanderveer, personal communication, 1986; Sparkes, 1982). Most boulder rock types reflect the composition of the underlying rocks, and the presence of mineral occurrences in the boulder fields indicates that the mineralized float has not travelled a great distance (probably less than 500 m).

The generalized distribution of WO_3, Mo, Cu, Ag, Pb and Zn in soils, as compiled from assessment reports, is shown in Figures 5 and 6. The soil samples were collected at 25- and 50-m spacings on grid lines established by the various exploration companies (Figure 2-A); different collection and analytical techniques, element suites, and laboratories used in the soil surveys cause problems with interpretation. Additional interpretive problems may result from variations in overburden type and thickness. Nevertheless, several interesting features are apparent. (Contour intervals shown in Figure 5 and 6 were arbitrarily selected to include the upper 10 to 15 percent of the values.)

Molybdenum values in excess of 500 ppm (maximum value in soil of 8900 ppm) occur in several large areas up 1 km in diameter. These molybdenum anomalies are generally coincident (Figure 6) with Cu anomalies (greater than 50 ppm). Weak Zn (greater than 65 ppm) and Pb (greater than 40 ppm) anomalies overlap the Mo–Cu anomalies. The main Mo–Cu anomalies are labelled A, B, and C on Figure 6. Anomaly A lies at the southern end of the Cowey Lake fault zone, anomaly B occurs at the intersection of the Meelpaeg and Cowey Lake fault zones and trends north along the Meelpaeg fault zone, and anomaly C occurs to the north along the projected extension of the Meelpaeg fault zone.

A pilot study by Rio Algom (Bucknell, 1981) defined a bismuth anomaly (greater than 50 ppm) against a background of less than 3 ppm associated with Mo and Cu at anomaly B. This was the only area from which samples were analyzed for bismuth. Highly anomalous Ag values (greater than 2 ppm) are present in the north. However, soils from the main anomalous areas (A, B, C) were not analyzed for silver. The distribution of these elements may be useful in outlining a source for the Bi–Ag-rich float in the area (Table 2), and further sampling and analyses are warranted.

Tungsten anomalies are widespread over Unit 2 in the northeast and occur in areas containing abundant sheeted wolframite-bearing quartz veins. Other, less consistent, tungsten anomalies are present. However, the tungsten contours commonly follow property boundaries, which implies that the various different surveys cannot be directly compared, as is the apparent case for Mo and Cu. Further work to define consistent tungsten anomalies is required. In addition, the eastern boundary of the tungsten anomalies may reflect increases in overburden thickness.

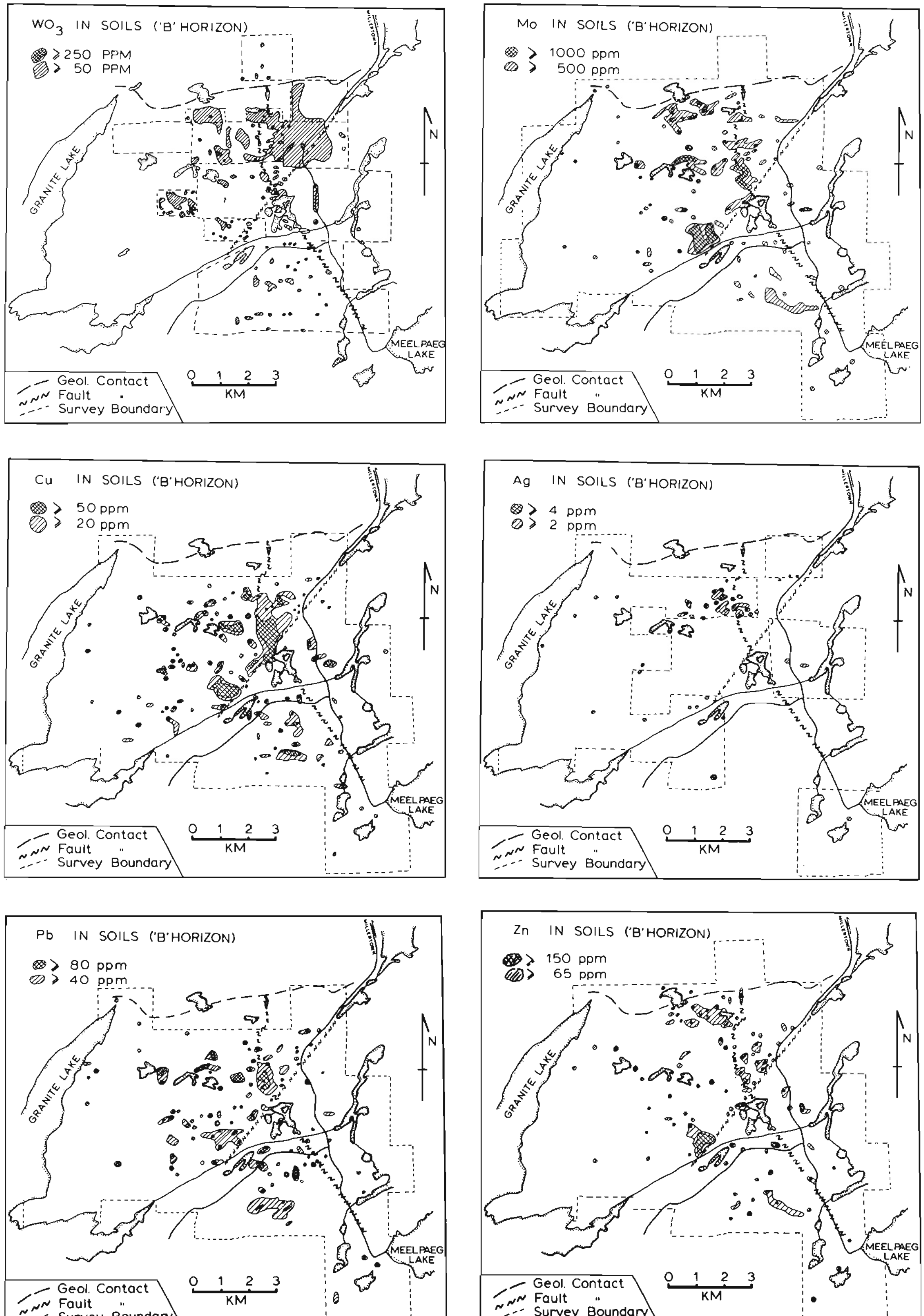


Figure 5. *Generalized distribution of WO_3, Mo, Cu, Ag, Zn, and Pb in soils; sampled grids shown in Figure 2-A.*

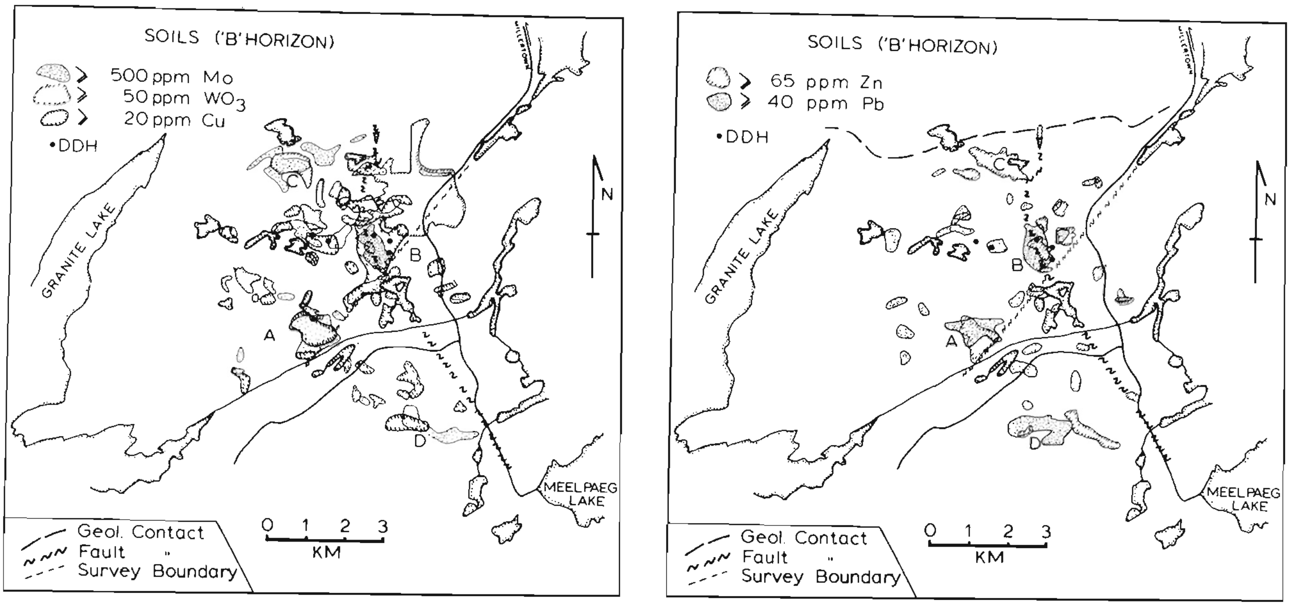


Figure 6: *Composite soil-anomaly plan for Mo, WO_3 and Cu, and for Zn and Pb; the three main anomalies are labelled A, B, and C.*

Nevertheless, a large-scale element zonation in soils that partly reflects bedrock mineralization is apparent. An east–west 'core' of tungsten is bordered to the north and south by molybdenum–copper anomalies. Element zonations are characteristic of many large mineralized systems associated with granitic rocks.

The location of the drillholes with respect to anomalies A, B, and C are shown on Figure 6, and the distribution of drillholes and trenches is shown on Figure 2-B. It is evident that the three main geochemically anomalous areas (Mo–Cu–Bi) have not been adequately tested by either trenching or drilling, and further work may be justified to investigate some of the other defined anomalies.

There is good potential for high-grade, wolframite-mineralized veins similar to those at Grey River (as noted by Dickson, 1982). However, the large, consistent, geochemical anomalies, and the style of mineralization in sheet veins imply that there is potential for major, large-tonnage low-grade, stockwork, tungsten–molybdenum–bismuth deposits in the Granite Lake–Meelpaeg Lake area. In addition, the presence of silver and bismuth may indicate a potential for lower temperature, vein-style, precious-metal mineralization.

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