THE MINERAL POTENTIAL OF PARAGNEISS IN THE GRENVILLE PROVINCE IN EASTERN LABRADOR

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Abstract

Recent reconnaissance geological mapping, and follow-up of regional geochemical lake sediment sampling have resulted in the discovery of several U, Mo and Cu mineral occurrences in the Grenville Province of eastern Labrador. Mapping has demonstrated that these and previously documented occurrences are mainly associated with belts of pyritic paragneiss, especially in the Lake Melville terrane. This observation, combined with available reconnaissance geochemical and geophysical data, should contribute to a more focused approach to mineral exploration in the region.

Introduction

The Grenville Province in Labrador traditionally has been considered unattractive for mineral exploration. The reasons for this appear straightforward: (i) difficulty of access, (ii) poor exposure, (iii) inadequate geological, geophysical, geochemical and mineral occurrence data, and (iv) the lack of well defined targets or metallogenic models providing a focus for mineral exploration programs.

The purpose of this communication is to outline details of mineral occurrences in the Grenville Province in eastern Labrador, many of which were found during recent 1:100,000 scale mapping by the Newfoundland Department of Mines and Energy. We examine how the mineral occurrences are related to available geophysical and regional geochemical data, and demonstrate correlations between mineral occurrences and rock type.

Regional Setting

The region includes parts of four major lithotectonic terranes (Figure 1). These are from north to south (i) the Trans-Labrador batholith, (ii) the Groswater Bay terrane, (iii) the Lake Melville terrane, and (iv) the Mealy Mountains Intrusive Suite. The geological characteristics of the terranes have been outlined elsewhere (Gower, 1984; Gower and Owen, *in preparation).* As mineral occurrences are largely confined to the Groswater Bay and Lake Melville terranes, the geology of these two regions is briefly summarized below.

The Groswater Bay terrane comprises tonalite/granodiorite orthogneiss, pelitic/psammitic paragneiss, K-feldspar megacrystic granodiorite, diorite, pyroxene-bearing granitoid intrusive rocks, and mafic rocks of various ages. The Lake Melville terrane contains similar rock types, in different proportions. Paragneiss is more extensive in the Lake Melville terrane, and includes minor quartzite, marble and calc-silicate layers. Mafic rocks are less common, except near the northern flank of the Lake Melville terrane. North-northeast structural trends in the Groswater Bay terrane reflect a pre-Grenvillian fabric modified in part by east-northeast Grenvillian fabrics. Metamorphic grade increases southeastward across the Groswater Bay terrane from greenschist to middle amphibolite facies. The northern margin of the Lake Melville terrane is characterized by granulite facies assemblages which grade southward into middle amphibolite facies rocks. The oldest rocks of both terranes appear to be older than approximately 1700 Ma. The terranes have undergone several periods of deformation, metamorphism and intrusion, and were juxtaposed in their present configuration by ductile thrust faulting of probable Grenvillian age.

After the Grenvillian Orogeny, the area was affected by normal faulting, with the development of graben and half-graben in which arkose, shale and conglomerate of the Double Mer Formation were deposited.

Contribution to the Canada-Newfoundland co-operative minerals program 1982-84. Project funded by the Newfoundland Department of Mines and Energy and the Geological Survey of Canada.

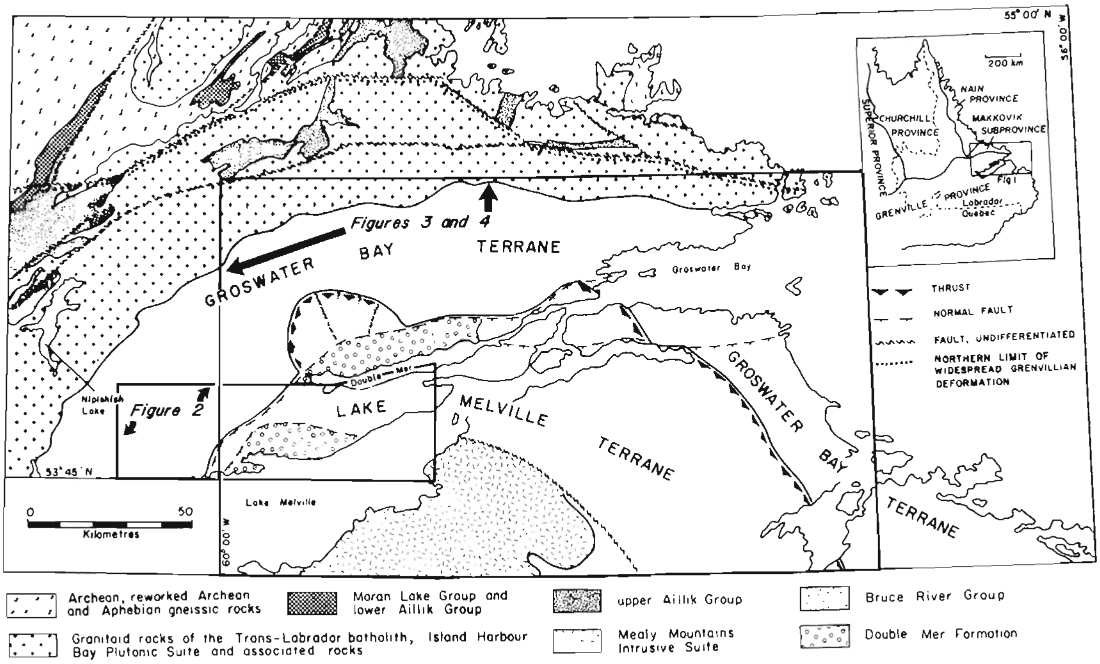

Figure 1: *General geology of the northeastern part of the Grenville Province in Labrador, adapted from Gower and Owen (in preparation). The areas covered by Figures 2, 3 and 4 are outlined.*

Relationships Between Mineral Occurrences, Lake Sediment Anomalies and Bedrock

Uranium and Molybdenum

(i) Mineral Occurrences

The best documented uranium mineralization is situated between Lake Melville and the southeast extremity of Double Mer, and was discovered by a Newfoundland Department of Mines and Energy field party led by J.W. McConnell in 1978. The party conducted lake sediment, lake water and airborne radiometric follow-up surveys (McConnell, 1978, 1979, 1982; Kerswill and McConnell, 1979, 1982) of lake sediment anomalies delineated by the 1977 Uranium Reconnaissance Program (U.R.P.) (Geological Survey of Canada/Newfoundland Department of Mines, 1978). Northgate Exploration Ltd. subsequently carried out sampling, trenching and geochemical surveys at the uranium showings in 1979, and proceeded with geophysical surveys and approximately 200 m of drilling in 1980 (Snow, 1980, and other unpublished assessment reports filed with the Newfoundland Department of Mines and Energy). The results of a radioactivity ground survey carried out during regional mapping in the region are shown in Figure 2.

The area received attention because, although absolute U values in lake sediment are modest compared to those found in mineralized areas elsewhere in Canada, the values are clearly anomalous with respect to much of the surrounding Grenville Province (Kerswill and McConnell, 1979).

The primary uranium-bearing mineral, uraninite, occurs within white weathering, pegmatitic leucogranite (diatexite) that is closely associated with psammitic and pelitic (sillimanite-bearing) paragneiss. The diatexite is locally tourmaline-bearing. Yellow secondary uranium staining (uranophane) is present in places. Kerswill and McConnell (1979) reported that the abundance of uraninite is directly proportional to the percentage of mafic minerals (biotite, chlorite and garnet) in the rock.

Molybdenite occurs as specks less than 0.5 cm across associated with uraninite and pyrite in the same area. A sample that gave a U analysis of 2932 g/t had a corresponding value of 464 g/t Mo (McConnell, 1978).

The locations of U and Mo mineral occurrences are shown on Figure 3. All occurrences except one Mo showing are

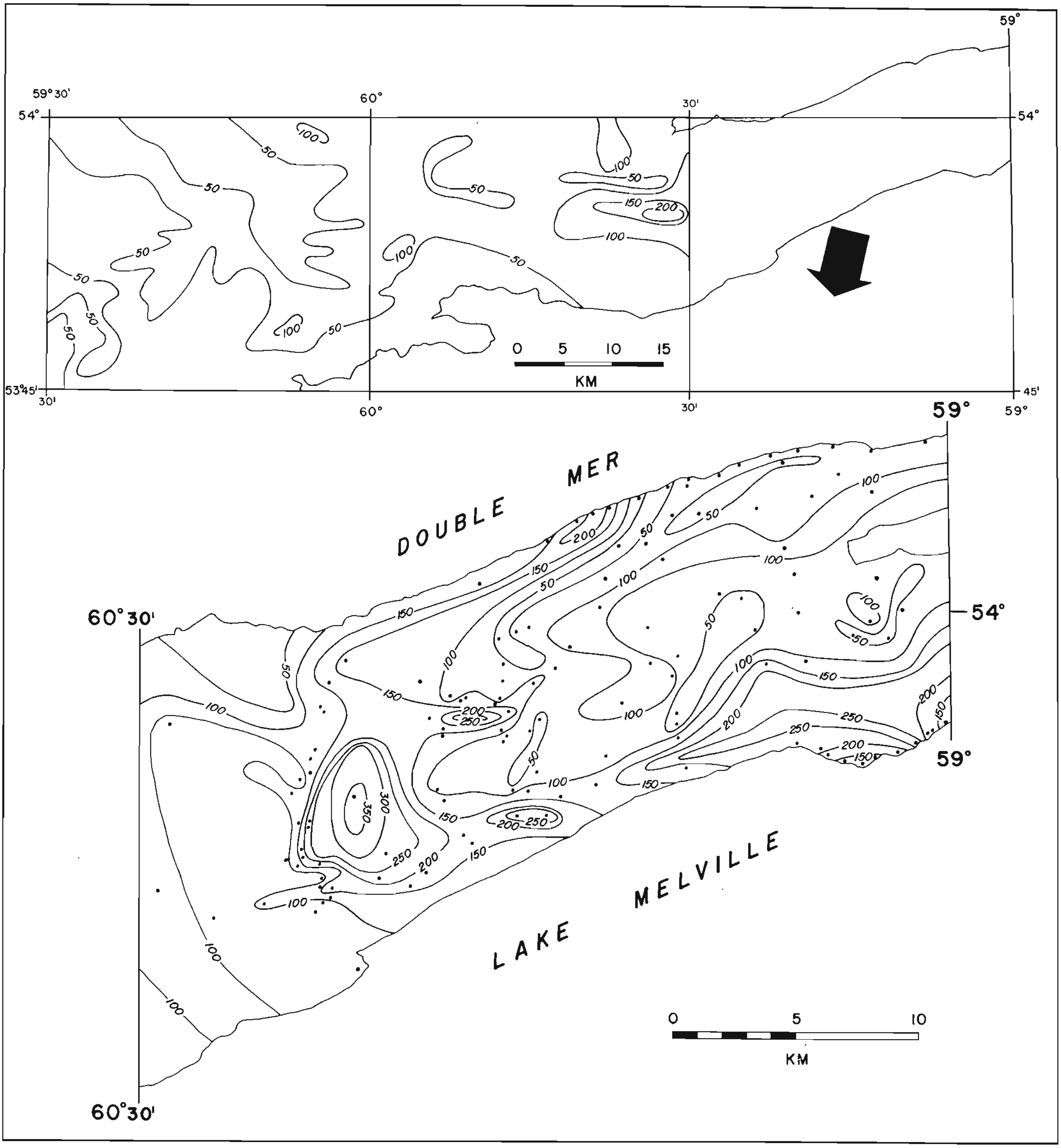

Figure 2: *Results of a ground radioactivity survey (total counts per second on Scintrex G15-4 scintillometer) in the region between Lake Melville and Double Mer. All known U showings coincide with positive regional radiometric anomalies, which suggests that mineralization is associated with all anomalies. Dots: data stations. Modified from Erdmer (1983).*

located within the Lake Melville terrane. On the north side of Lake Melville, two U and two Mo occurrences were discovered in 1980, as was the most easterly U mineral occurrence shown on Figure 3 (Gower et al., 1981; Gower et al., 1983). All three U occurrences are located in white weathering, pegmatitic diatexite associated with sillimanite-bearing paragneiss. The mineralization was recognized by yellow or greenish yellow secondary uraniferous surface coatings which give total count scintillometer (Scintrex GIS-4) readings between 15 and 45 times background.

The two molybdenite localities immediately north of Lake Melville are minor, and associated with quartz veins in paragneiss. They do not have concomitant uranium mineralization.

The most southerly U occurrence indicated on Figure 3 was detected during an airborne gamma-ray survey (McConnell, 1978). This survey covered an area of about 600 km^2 on the south side of Lake Melville. The indicated U mineral locality is one of several in the surveyed area that gave anomalous U radiation counts (McConnell, 1978). During cursory ground examination, total count scintillometer readings of more than 5 to 10 times background were detected. The bedrock consists of quartzofeldspathic gneissic rocks but has not been examined in any detail.

The most southerly Mo mineral occurrence is regionally on strike with the last mentioned U occurrence. Mineralization consists of specks of molybdenite which were detected at a helicopter data station where the bedrock is a leucocratic, white weathering biotite granite gneiss. This is the only Mo mineral occurrence in the region where the host rock protolith was not unequivocally sedimentary. However, it should be noted that the possibility of a paragneiss host has not been excluded for either this Mo locality or the U occurrence along strike.

It appears that all the U mineral occurrences and most of the Mo localities can be related to a belt of paragneiss (now

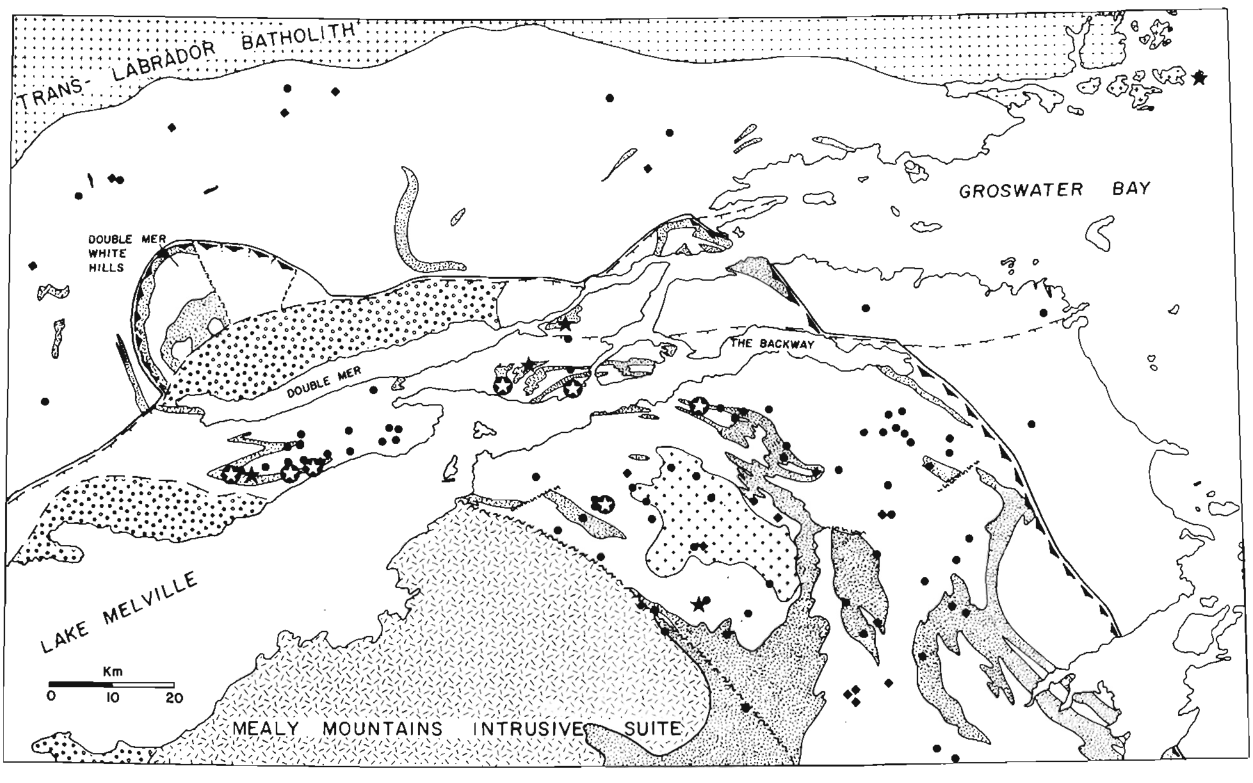

Figure 3: *Uranium and molybdenum occurrences and geochemical anomalies. Symbols: white star - uranium mineral occurrence; black str - molybdenite occurrence; black dot - lake sediment or lake water U anomaly; diamond - lake sediment Mo anomaly. Stipple pattern - paragneiss; circles - Double Mer Formation; small crosses - pyroxene quartz syenite.*

very deformed and intermixed with other rock types) that outlines an arcuate domal structure trending east-northeast near Double Mer, and southeast on the east side of the Mealy Mountains Intrusive Suite. The core of the dome is a pyroxene-bearing quartz syenite pluton (Figure 3).

One other Mo occurrence appears to be within granitoid rocks of the Trans-Labrador batholith (Figure 3). Here, the mineralization occurs within a narrow septum of pyritic sillimanite-bearing paragneiss within granitic and gneissic rocks.

(ii) Lake Sediment Anomalies

Figure 3 shows a marked concentration of U and Mo lake sediment anomalies (greater than 2 σ above mean value for the region) in the Lake Melville terrane. The anomalies are also regionally associated with known mineral occurrences. In contrast to this, the only area of interest with respect to possible mineralization in the Groswater Bay terrane appears to be an arcuate, northeast trending zone north of Double Mer White Hills. This is underlain in part by muscovite-bearing gneiss, at least some of which was derived from a metasedimentary protolith.

U and Mo lake sediment anomalies in the Lake Melville terrane do not show a close spatial association either with known mineral occurrences or with paragneiss. This can be attributed to several factors: (i) glacial redistribution of anomalous material, (ii) mapping not sufficiently detailed to define all paragneiss, (iii) additional favorable source rocks, (iv) potentially favorable areas buried beneath thick glacial till, and (v) lack of lake sediment sampling close to mineralized localities.

The dominant glacial transport direction in the region is to the east-northeast (Fulton and Hodgson, 1979). This may explain why most lake sediment anomalies between Double Mer and Lake Melville lie east of known mineralization, and is a factor to be considered in the assessment of lake sediment anomalies southeast of Lake Melville.

It should be stressed that bedrock mapping is at a reconnaissance scale only, and that many paragneiss belts have forms much more complex than shown on available maps, and, in particular, may be more extensive along strike. For example, with respect to the large cluster of U anomalies south of The Backway, it is conceivable that the tongue of paragneiss immediately southeast of the anomalies on Figure 3 extends farther north than depicted on the map. Also, paragneiss along the northeast side of the Mealy Mountains Intrusive Suite may be more extensive than indicated on the map, and may underlie the Mo locality in the area.

The outline of a pyroxene-bearing quartz syenite is included on Figure 3. No whole rock U analyses of this unit are yet available, but it is abnormally enriched in other large ion lithophile (LIL) elements; hence it may also be a source for U lake sediment anomalies.

(iii) Comment on metallogenesis

The two-stage genetic model proposed by Kerswill and McConnell (1979) for uranium in the region between Lake Melville and Double Mer appears to be applicable to other U occurrences in the Lake Melville terrane. This model is based on a concentration of uranium in the metasedimentary strata (and in some of the granite plutons) during one or several pre-Grenvillian events. The resulting "regionally" enriched strata (several times the natural crustal average) were partially melted, perhaps during several events which may include the Grenvillian Orogeny, to produce uraninite-bearing diatexite. Molybdenum mineralization, which is commonly (but not invariably) associated with uraninite in the region, may have had a similar origin.

While the several favorable paragneiss horizons in the Lake Melville terrane may have protoliths of different age, the final concentration of U (and Mo) into ore grade diatexite is probably of Grenvillian age.

Copper, Lead, Zinc, Pyrite

(i) Mineral Occurrences

Chalcopyrite, bornite, pyrite and pyrrhotite associated with malachite staining is found in both the Groswater Bay and Lake Melville terranes.

The two westerly Cu occurrences (Figure 4) in the Groswater Bay terrane are minor and are associated with muscovite-bearing schist interpreted as derived from a sedimentary protolith. Similarly, the occurrence on Black Island on the north side of Groswater Bay is associated with metasedimentary rocks.

In contrast, the other three Cu occurrences in the Groswater Bay terrane are adjacent to mafic intrusions, as are the pyrite occurrences in the same region. The two Cu occurrences on the north side of Groswater Bay were discovered by BRINEX Ltd. (Kirwan, 1960). Grab samples from one locality gave Cu values of 0.25% and 0.30%, and one from the other locality has 1.4% Cu.

In the Lake Melville terrane, Cu mineralization occurs in a belt that is roughly parallel to the Rigolet thrust zone. Three general observations can be made: (i) this belt correlates with a zone of granulite facies rocks, (ii) Cu mineralization in the Lake Melville terrane is separate from U and Mo mineral occurrences, and (iii) with two possible exceptions, Cu mineralization is associated with paragneiss.

The first two observations may be interdependent, in that granulite facies rocks are commonly depleted in LIL elements.

Within paragneiss, the Cu mineralization commonly is accompanied by broad pyritic zones. For example, the most northerly Cu mineral locality in the Lake Melville terrane is associated with a concordant pyritic layer more than 3 m wide. Pyritic zones, associated with traces of Cu mineralization, are also extensive at the south end of Sandwich Bay. The Cu locality at Eagle River was first reported by Douglas (1953), who described the mineralization as being a 70 cm wide band in a quartzitic layer about 4 m across, traceable along strike for more than 30 m. A grab sample from this locality contains 2.8% Cu (Douglas, 1953). BRINEX Ltd. carried out stream sediment and airborne magnetic and EM surveys in the area in 1965 (Sutton, 1965) and conducted follow-up drilling of the Eagle River showing in 1966. Five holes were drilled for a total length of about 80 m (Sutton, 1966). Samples were analyzed for Cu, Au and Ag but results were not encouraging. Apart from this locality, we are unaware of any Au analyses for the region.

The only Cu mineral occurrence in the Lake Melville terrane that is clearly not associated with metasedimentary rocks is located at the east end of The Backway, where the host rock is metagabbro.

A large pyrite showing without known Cu mineralization occurs in the Double Mer White Hills. Several pyritic layers are present, some exceeding 50 cm in thickness, with a strike length of more than 50 m.

Lead and zinc mineralization was found on the north side of Double Mer, 11 km west of Rigolet. Galena, sphalerite and chalcopyrite are associated with quartz and calcite in a vein 1 m across and 10 m long. One sample gave values of 0.36% Pb and 2.5% Zn (Halet, 1946).

(ii) Lake Sediment Anomalies

Most of the Cu lake sediment anomalies are in the Groswater Bay terrane. Apart from two anomalies in the western part of this terrane, which can be correlated with known Cu-mineralized muscovite-bearing schist, there is no obvious correlation with metasedimentary gneiss. Some of the lake sediment Cu anomalies in the Groswater Bay terrane are associated with high Co or Ni values in lake sediment and, hence, probably relate to material derived from mafic rocks.

A major Pb and Zn lake sediment anomaly was delineated 2 km west of Rigolet during the 1977 U.R.P. survey. Its close proximity to this settlement casts doubt on its significance (as it may have resulted from local contamination), but high Pb and Zn values exist elsewhere in the district and show a spatial association with areas underlain by quartz diorite (which is also the host rock for the known Pb-Zn mineralization). High Pb and Zn values are associated with similar quartz diorite south and east of Cartwright (mostly outside the area shown in Figure 4).

(iii) Comments on Metallogenesis

Cu mineral occurrences in the region are associated with two rock types, paragneiss and mafic intrusive rocks. Stratabound Cu mineralization in sedimentary rocks occurs in a variety of associations. However, any attempt to associate mineralization in the Grenville Province with specific sedimentary environments is unrealistic, for two principal reasons: (a) no specific study has been made of the mineralization or host rocks, (b) the mineral occurrences are in granulite facies rocks which opens to question detailed protolith identification.

Cu mineral occurrences associated with gabbro are accompanied by pyrite and pyrrhotite. Their localization at gabbro-gneiss contacts probably results from concentration of sulfides in a relatively low stress local environment during metamorphism.

Conclusion

The empirical observation that mineralization is closely associated with paragneiss, and the recent delineation of areas underlain by paragneiss in the Grenville Province of eastern Labrador, should contribute to a more focused approach to mineral exploration in this region. Identification of the mineral occurrence - host rock association, combined with the

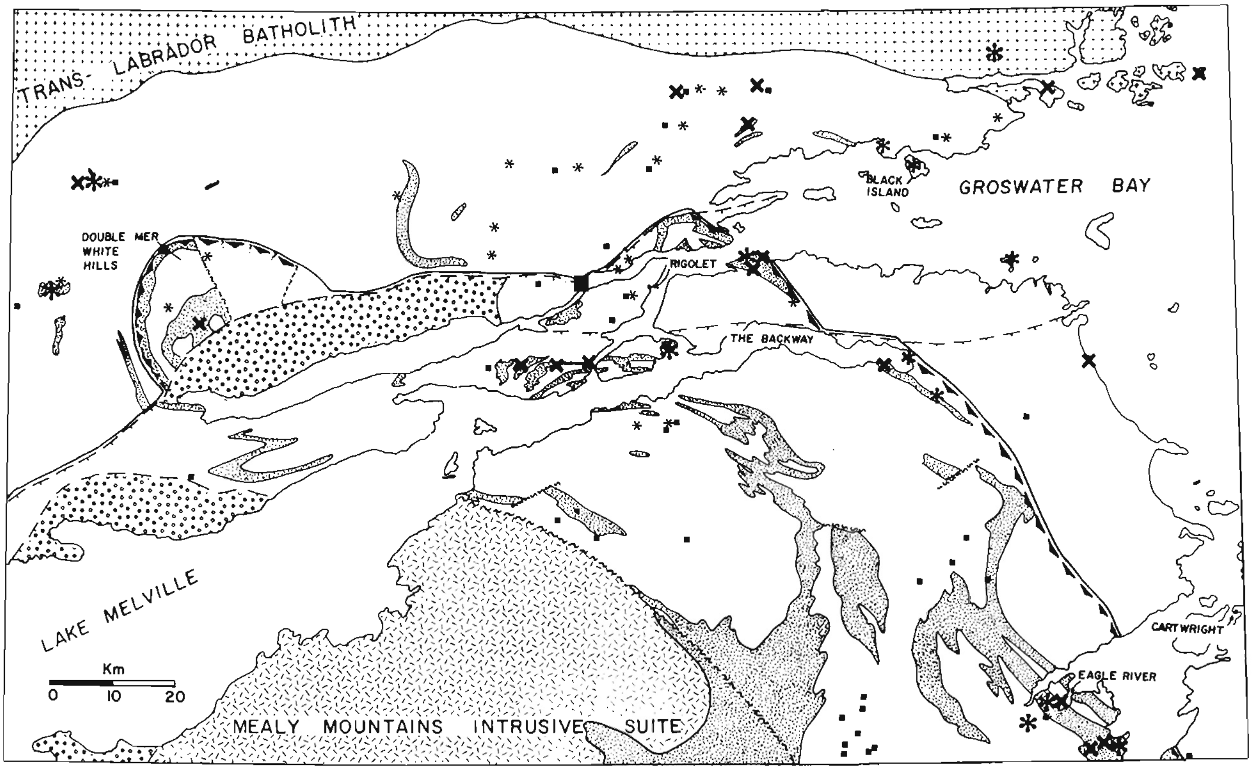

Figure 4: *Copper, pyrite, pyrrhotite and lead and zinc mineral occurrences and geochemical anomalies. Symbols: large asterisk - copper mineral occurrence; small asterisk - Cu lake sediment anomaly; cross - pyrite and/or pyrrhotite occurrence; large square - lead-zinc mineral occurrence; small square - Zn lake sediment anomaly. Other symbols as in Figure 3.*

use of available reconnaissance geochemical and geophysical data will assist in the identification of new exploration targets.

Acknowledgements

R. Wardle and P. Dean reviewed and substantially improved an earlier version of this manuscript.

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Note: Unpublished reports are followed by numbers in square brackets which refer to the Open Files of the Mineral Development Division.

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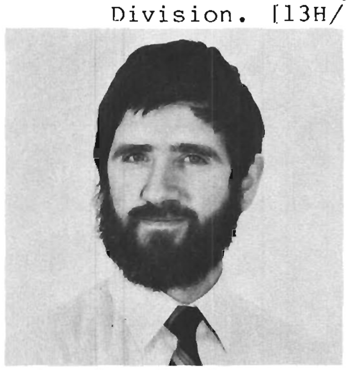

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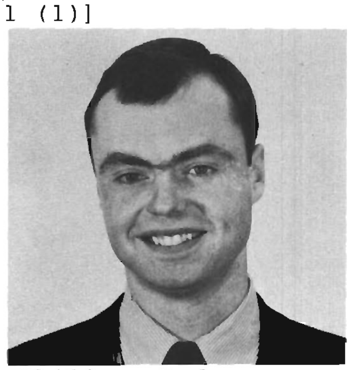

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