15.

A TENNANTITE DEPOSIT IN THE M'CLINTOCK INLET AREA, NORTHERN ELLESMERE ISLAND, DISTRICT OF FRANKLIN

Project 730051

H.P. Trettin
Institute of Sedimentary and Petroleum Geology, Calgary

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Abstract

A replacement deposit of zincian tennantite east of M'Clintock Inlet is the first reported metallic mineral deposit in the eugeosynclinal terrane of the Innuitian Orogen. It is too small to be of economic value but could serve as a guide for exploration. Significant features appear to be (1) occurrence in an Upper Ordovician shelf dolostone, deposited fairly close to the northwestern margin of the Hazen Trough, and (2) proximity to a repeatedly active fault zone that locally contains ophiolite slices.

Introduction

A small tennantite deposit found 30 km due east of an unnamed bay on upper M'Clintock Inlet (Fig. 15.1, 15.5) at 73°20' West, 82°37.3' North (NTS 340 E; UTM zone 18X, 9174400 N, 524000 E) is the first reported occurrence of that mineral in the Arctic Islands and the first reported metallic mineral deposit in the eugeosynclinal belt of the Innuitian Orogen. The discovery was made on the afternoon of the last day of field work of the 1980 season, a season intended to complete the geological reconnaissance of northern Ellesmere Island, and only four hours could be spent in the vicinity of the deposit. More detailed work is desirable to check the local geology and search for other deposits but was not feasible at the time.

I am indebted to pilot B. Russel of Okanagan Helicopters; to B.S. Norford for the fossil identifications; to A.G. Heinrich (Calgary) and A.G. Plant (Ottawa) for mineral analyses; and to A.V. Okulitch for critical reading of the manuscript.

Areal Geology

The geology shown in Figure 15.2 is based on three short traverses (dotted lines a, b, c), airphoto interpretation, and widely spaced foot traverses and helicopter landings in adjacent areas.

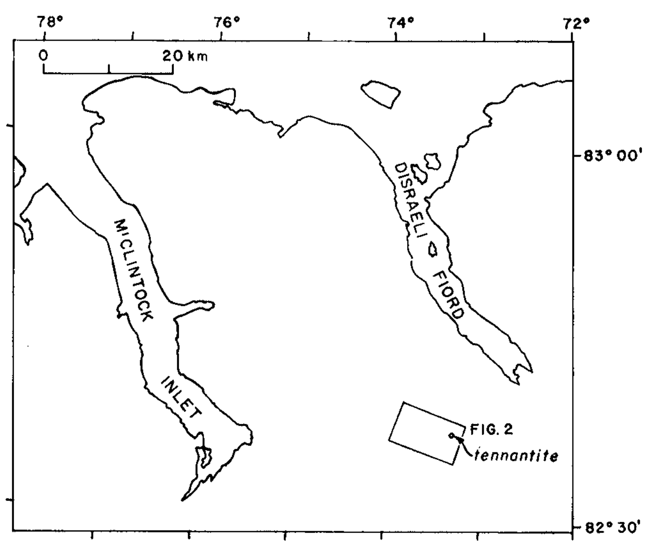


Figure 15.1. Index map.

Stratigraphy

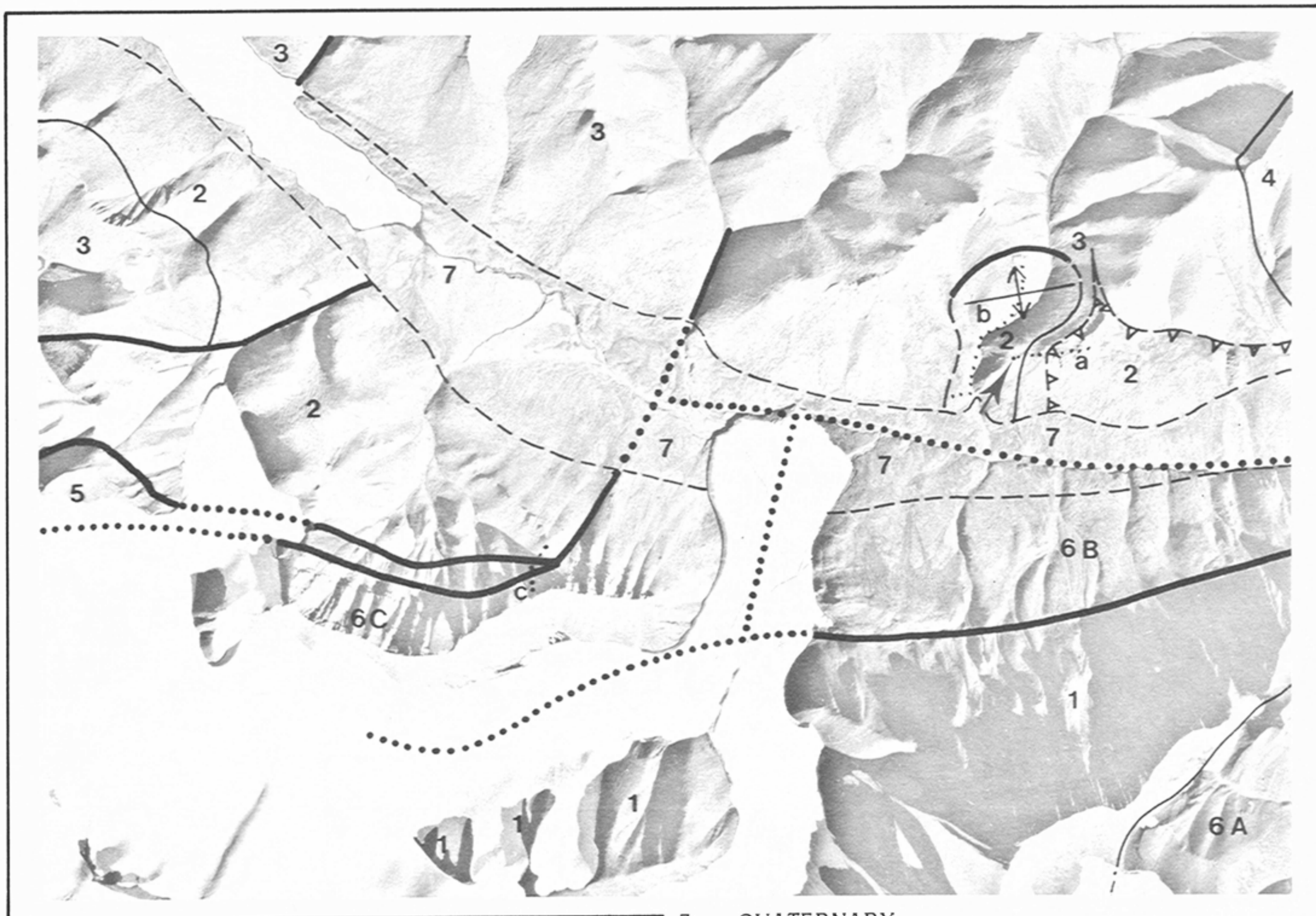
Six major units are distinguished in Figure 15.2. Although several are identical with established formations they are here referred to as numbered map-units. Comprehensive reports on the very complex lower and upper Paleozoic stratigraphy of the region are presently being prepared by the writer and U. Mayr, respectively.

Map unit 1 is composed of compositionally immature sandstone, mudrock[1] and lesser amounts of granule to boulder conglomerate and carbonate rocks. The clastic sediments are red, green and grey. Fossil collections from other parts of the M'Clintock Inlet area indicate a Late Ordovician (Ashgillian) age. The unit probably is identical with the Taconite River Formation established west of M'Clintock Inlet (Trettin, 1969). At the head of M'Clintock Inlet it overlies Proterozoic metamorphic rocks with angular unconformity but farther north it lies on the Ordovician M'Clintock and Ayles formations. Its thickness varies from less than 10 m at the head of M'Clintock Inlet to probably thousands of metres in the present area but could not be established here because of structural complexities. The unit appears to be mainly shallow marine in origin with some nonmarine sediments.

Map unit 2 overlies map unit 1 with conformable contact, but the contact is not exposed in this area. The unit consists of variable proportions of limestone and dolostone, locally with some sandstone, mudrock, and granule to pebble conglomerate. The area containing the mineral deposit is underlain mainly by dolostone with less abundant dolomitic limestone. The limestones contain a diverse and fairly abundant benthonic fauna of Late Ordovician (Ashgillian) age. Fossils collected from talus at three localities along traverse b (Fig. 15.2) include **Catenipora** sp., **Paleophyllum** sp., ?**Austinella** sp., **Dicoelosia** sp., ?**Lepidocyclus** sp., aff. **Rhynobulus** sp., ?**Maclurites** sp., along with strophomenid, sowerbyellid and orthid brachiopods and unidentified gastropods, pelecypods, bryozoans, echinoderms, etc. The unit is identical with Members A and B of the original Zebra Cliffs Formation (Trettin, 1969), the original Member C now being regarded as a tongue of the upper Hazen Formation (Trettin and Balkwill, 1979). Lithology and fauna indicate predominantly subtidal shelf environments of deposition.

The overlying map unit 3 consists of compositionally immature sandstone and mudrock with small amounts of granule and pebble conglomerate and limestone. Most clastic rocks are conspicuously red, but green and grey strata also are common. East of the head of M'Clintock Inlet, map unit 3 overlies map unit 2 with low angular unconformity.

[1] The term mudrock is used here for all silt and clay-grade clastic sediments containing less than 50 per cent carbonate minerals. Some are fissile and most relatively fine grained rocks have a slaty cleavage.



7 QUATERNARY
unconsolidated sediments (obscuring bedrock geology)

6C PENNSYLVANIAN AND/OR PERMIAN
dolostone

6B gypsum-anhydrite, clastic sediments, carbonate rocks (?) (not examined on the ground)

6A PENNSYLVANIAN
sandstone, conglomerate; minor dolostone

5 LOWER DEVONIAN OR OLDER
stratified igneous complex, ultramafic to granitic

4 UPPER ORDOVICIAN AND/OR SILURIAN
conglomerate, sandstone; minor mudrock

3 UPPER ORDOVICIAN
sandstone, mudrock; minor conglomerate, limestone

2 dolostone, limestone; locally minor sandstone, conglomerate, mudrock

1 sandstone, mudrock; minor conglomerate, carbonate rocks

Geological boundary (located, approximate, projected through ice)

Fault (located, projected through ice or overburden)

Probable thrust fault (teeth on hanging wall)

Anticline

b Foot traverse

Figure 15.2. *Geology in the vicinity of mineral deposit; deposit is at tip of arrow. (Part of vertical air photograph A-16708-14).*

The hiatus, however, must be small because benthonic fossils in this unit also are Late Ordovician (Ashgillian) in age. In the present area the contact relationships are uncertain. The sediments appear to be mainly or entirely of shallow marine origin. Map unit 3 is overlain at some localities by map unit 4 and at others by the Upper Silurian (Ludlovian) Marvin Formation. Both contacts probably are disconformable. Southeast of the head of Disraeli Fiord, where map unit 3 is overlain by the Marvin Formation, it has a thickness of about 770 m.

Map unit 4, composed mainly of resistant granule to pebble conglomerate and compositionally immature sandstone with lesser amounts of mudrock has been examined only at a few localities. The conglomerate beds appeared to be of nonmarine (braided river?) origin. It is tentatively regarded as latest Ordovician and/or Early Silurian in age.

Map unit 5 is a tabular body of stratified igneous rocks ranging in composition from ultramafic to granitic. It dips south and lies between map units 2 and 6C. Both contacts are covered but interpreted as faults. Three sets of samples collected along traverse c (Fig. 15.2) from south to north (i.e. structurally from top to bottom) represent (1) slightly serpentinized clinopyroxenite; (2) hornblende-rich diorite with coarse phenocrysts of hornblende; and (3) fine grained, leucocratic granitic rocks that are sheared, altered, and partly metamorphosed in the greenschist facies. The compositional trend is opposite to that normally observed in layered intrusions, suggesting that the body is overturned; it also appears to be incomplete on the ultramafic (south) side. The present body lies on strike with the M'Clintock East ultramafic massif (Frisch, 1974) from which it is separated by a glacier and volcanic rocks. Petrology and structural setting suggest that both are fault slices derived from the cumulate part of an ophiolite (cf. Coleman, 1977). Both probably are related in age, origin, and structural setting to the larger M'Clintock West massif, which is unconformably overlain by middle Pennsylvanian strata and has a K/Ar (hornblende) age of 390 ± 20 Ma (Trettin, 1969; Frisch, 1974). All three igneous bodies are regarded as Early Devonian or older in age.

Three upper Paleozoic units occur as separate fault blocks in the southern part of the area. The oldest (map unit 6A), composed mainly of sandstone and conglomerate with some dolostone, overlies map unit 1 with angular unconformity and probably is early or middle Pennsylvanian in age. The age of the other two, composed of gypsum-anhydrite with clastic and (?) carbonate sediments (map unit 6B, not examined on the ground) and dolostone (map unit 6C) respectively, has not yet been determined but probably also is Pennsylvanian (U. Mayr, personal communication, 1980).

Structure

The lower Paleozoic strata are involved in complex and tight folds, which are better exposed immediately to the east than in the present area. The upper Paleozoic strata are faulted and tilted but not folded.

The most significant structural feature of the present area is the fault that separates map units 6B and 6C in the south from map units 2 and 3 in the north. It generally trends westerly, but is offset by poorly exposed, north-trending faults in the vicinity of the mineral deposit. The western branch of the fault bifurcates and encloses between its two branches the igneous rocks of map unit 5. If this ophiolite slice was tectonically emplaced in pre-Middle Pennsylvanian time (as inferred for the M'Clintock West massif) then the fault zone must have had at least two major phases of movement in pre-and post-Pennsylvanian times, respectively.

The Tennantite Deposit

The mineral deposit occurs on the southern limb of a west-trending asymmetrical anticline, in the upper part of map unit 2, close to the contact with map unit 3. The clastic strata of that unit are overlain by another set of dolomitic carbonate rocks, interpreted as a thrust slice of map unit 2.

The surface area of the deposit, perhaps 10 m to a few tens of metres in diameter, is strewn with fragments of dolostone weathered in place that contain scattered crystals, or lumps of crystals, of tennantite, surrounded by haloes of malachite and minor azurite. The tennantite content of the specimens collected varies from trace amounts to an estimated 5-10 per cent by volume. The crystals are euhedral, mostly tetrahedral in habit (Fig. 15.3), and vary in edge length from 0.7 mm to about 3 cm.

Semiquantitative X-ray fluorescence analysis by A.G. Heinrich revealed the following composition:

major elements (>2%)	minor elements (0.1 - 2%)	trace elements (<0.1%)
Sb	Ca	Ag
As	Al	Cd
Zn		
Cu		
Fe		
S		

As is considerably more abundant than Sb, and Zn is fairly common.

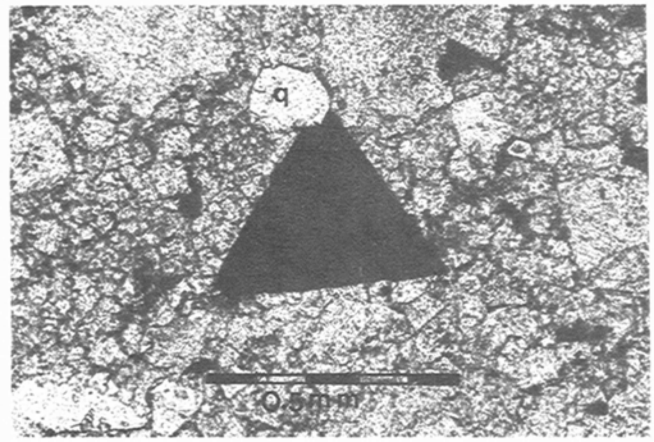


Figure 15.3. *Tennantite (dark) in matrix of dolomite and quartz (q) displays characteristic tetrahedral habit; photomicrograph, ordinary light.*

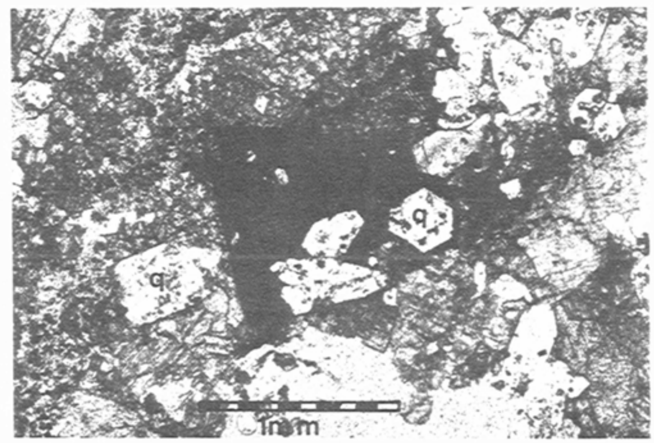


Figure 15.4. *Tennantite (dark) with inclusions of quartz (q), which contain inclusions of dolomite (very small dark rhombs); photomicrograph, ordinary light.*

The host rock of the tennantite is dolomite, ranging in crystal size approximately from 0.01 to 1.6 mm, with coarser crystals present in veinlets. The micritic texture of the limestone predecessor is apparent under crossed nicol prisms in the extinction position. Organic matter is concentrated in small, irregular solution zones. Scattered euhedral quartz crystals, about 0.08-1.44 mm long with very small inclusions of euhedral dolomite, make up perhaps 10-15 per cent of the rock. Such quartz is absent from normal dolostone of map unit 2 in this area and evidently related to the metallic mineralization. The tennantite has replaced the dolomite but not the quartz, which impinges on it (Fig. 15.3) or forms inclusions (Fig. 15.4). The paragenesis, therefore, is (1) calcite, (2) dolomite, (3) quartz, (4) tennantite.

Discussion

The eugeosynclinal belt of the Innuitian Orogen, exposed in northern Ellesmere and Axel Heiberg islands, has the ingredients for a variety of mineral deposits – siliceous to mafic volcanic rocks, granitic to ultramafic intrusions, various types of carbonate and clastic sediments, unconformities, and innumerable faults. That mineral deposits have not been found earlier in the region reflects the

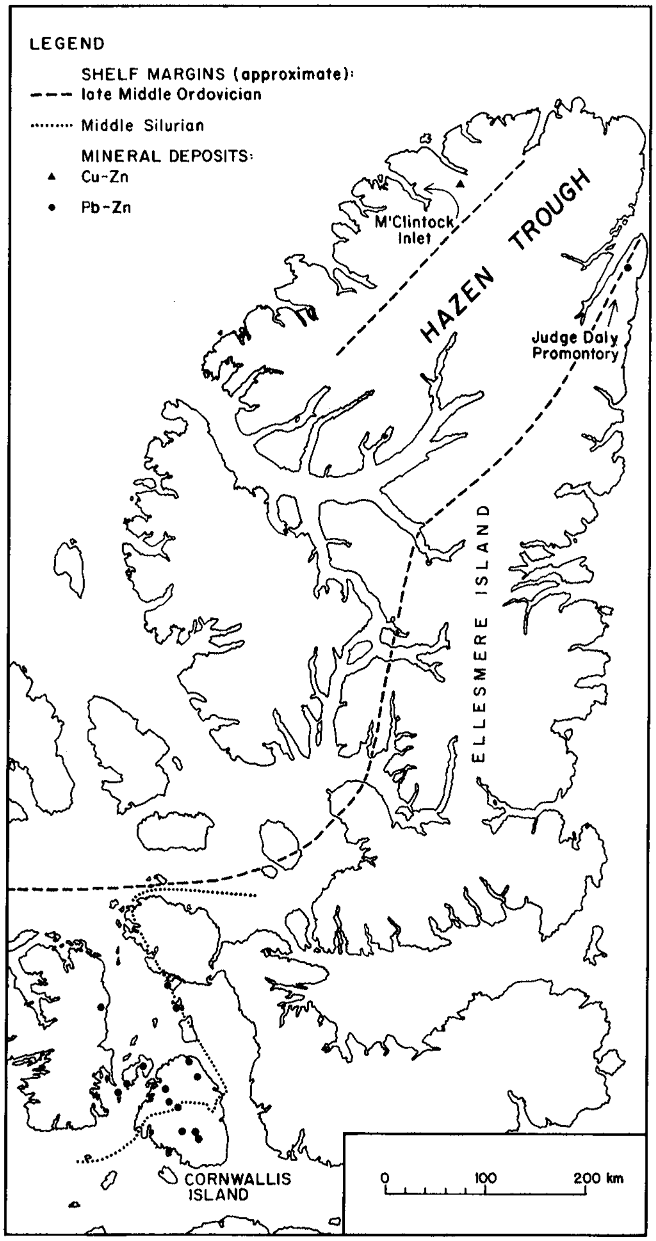


Figure 15.5. *Mineral deposits in eastern Queen Elizabeth Islands and their relationship with Hazen Trough. For outcrop control see Trettin and Balkwill, 1979, Fig. 4, 5. Mineral deposits of Cornwallis region after Kerr, 1977, Fig. 1.*

reconnaissance nature of the geological work and the lack of prospecting. This lack, of course, is due to the poor accessibility of this belt, which is flanked by the permanent ice pack of the Arctic Ocean on the northwest, and major mountain ranges on the southeast. These logistic and economic handicaps, however, are ignored in the following discussion in view of probable increases in metal demand and possible advances in Arctic exploration and exploitation technology.

The present deposit is too small to be of economic value but could be used as a guide for initial exploration. Two characteristics may be significant:

1. It occurs in a dolomitized shelf carbonate unit of Late Ordovician age, deposited probably fairly close to the northwestern margin of the Hazen Trough during the later part of the Ordovician (Fig. 15.5). It is interesting to note that the major deposits of the Cornwallis Pb-Zn district, which occur in the upper Middle Ordovician Thumb Mountain Formation (Kerr, 1977), occupy a comparable position on the southeastern margin of the Hazen Trough (if the southeastward migration of the trough margin is taken into consideration). The same applies to a small Pb-Zn deposit on northeastern Judge Daly Promontory (Fig. 15.5), presently owned by Norcen Energy Resources Limited and examined by the writer in 1980. It occurs in dolostone of the lower Copes Bay Formation (latest Cambrian to earliest Ordovician), less than 10 km southeast of the early Ordovician shelf margin. Connate waters, expelled from organic carbon-rich pelitic sediments of the Hazen Trough are a possible source for base metal deposits in both adjacent shelf areas (cf. Jackson and Beales, 1967). This hypothesis, however, seems more appropriate for the deposits of the southeastern shelf, which are far from any known igneous source than for the present deposit. The difference in mineralogy – galena and sphalerite in the Cornwallis district and on Judge Daly Promontory versus tennantite in the present area – also suggests a different origin.
2. The deposit is close to a major fault zone that locally contains ophiolite slices and appears to have been active repeatedly. It could have been an avenue of migration for fluids derived from various igneous or sedimentary sources.

In summary, initial prospecting could focus on (a) Ordovician shelf carbonate deposits such as the Zebra Cliffs Formation (original Members A and B) or Member B of the Cape Discovery Formation; and (b) on the present fault zone or comparable major fault zones involving ophiolite slices. Finally, it would be worthwhile investigating whether the unconformity between map units 2 and 3, seen east of the head of M'Clintock Inlet, extends into the present area and whether or not any mineralization may be associated with it.

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