MINERAL POTENTIAL OF CLASTIC SEDIMENTARY BASINS IN NEWFOUNDLAND

by

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INTRODUCTION

An evaluation of the potential for sedimentary, clastic-hosted base metal sulphide deposits in Newfoundland continued during the summer of 1982. The emphasis switched from detailed section work (Dean and Meyer, 1982) to a regional stream sampling and prospecting program with concentration in areas with anomalous lake sediment geochemistry. Three main areas of interest were outlined: (1) the Southeast Avalon Peninsula, an area located northwest of Route 10 between Capahayden and Portugal Cove South and underlain by the Hadrynian Drook Formation of the Conception Group; (2) the Northwest Avalon Peninsula, an area due west of Carbonear which is underlain by the Hadrynian Carbonear Formation of the Hodgewater Group, and (3) Humber Arm North, an area northwest of Corner Brook which is underlain by the highly deformed Cambrian clastics of the Humber Arm Allochthon (Fig. 1, 2 and 3). In addition to stream sampling, three sections were mapped and sampled in detail, one from each area on the Avalon Peninsula and the third in the Anguille Mountains, immediately north of the Codroy Valley. General prospecting of quartz veins, mineralized outcrop and float was conducted while silt sampling. Chip samples of shale also were collected where possible. The silt samples are being analyzed for Zn, Pb, Ni, Cu, Co, Mn, Fe, Ag, Cd, and L.O.I.

Southeast Avalon

Lake sediment geochemistry of the southeastern Avalon Peninsula indicates Pb, Zn, Co and Ag anomalies northwest of Route 10 in the Chance Cove Brook and Portugal Cove Brook watersheds (Davenport *et al.*, 1975; Butler and Davenport, 1979). A follow-up stream sediment sampling program was carried out over the barren landscape. The program faced formidable sampling conditions in the area due to the harsh climate and low relief which inhibit silt and soil development. The original plan of 300 m spacing of samples was severely constrained and not always possible. Special effort was made in areas having anomalous lake sediment geochemistry, above and below brook junctions, and where brooks entered ponds or steadies. A total of 166 silt samples were collected and are presently undergoing the 9-element analysis.

The Southeast Avalon Peninsula is underlain by Hadrynian rocks which were mapped by Williams and King (1979). The oldest rocks exposed consist of bimodal volcanics of the Harbour Main Group which form hills and ridges north of Chance Cove Brook. Overlying the volcanics, with local disconformity, is the Conception Group. The Drook Formation is the most extensive formation of this Group and underlies 90% of the sampled area. Outcrop consists of white weathering green siliceous argillites, siltstones and sandstones which exhibit graded sequences over 0.5-1.5 m. White angular feldspar grains and the highly siliceous nature of the sediments suggest a reworked volcaniclastic origin. The Drook Formation is intruded by fine to medium grained Whalesback Gabbro, exposed as rounded hills in the Chance Cove Brook watershed.

Overlying the Conception Group is a sandstone-shale sequence, the St. John's Group, and younger, mainly terrestrial clastics of the Signal Hill Group. The

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two groups, exposed in a 6 to 7 km wide monocline which is parallel to the coast, are conformable with the Conception Group in the north, but juxtapose it at the Frenchman's Cove Fault in the south. The St. John's and Signal Hill Groups record the shoaling up of the Conception marine basin and southward progradation of a delta front, respectively.

Visible mineralization in the Drook Formation consists of well formed crystals of pyrite within the coarse clastics and 1-5 mm aggregates of sugary textured pyrite + chalcopyrite and pyrrhotite in the fine grained clastics. Chalcopyrite and galena mineralization is hosted within quartz veins intruding the Drook Formation, and in large angular quartz boulders in the sampled area. This may prove to be the source of the lake sediment anomalies and may be more viable exploration targets for base and precious metals. Fifteen chip samples of quartz were collected across the area for analysis for Cu, Pb, Zn, Ag, Au, W and Sn.

North of the sample area, between Fermeuse and Renews Harbours, anomalous Zn and associated Cu and Pb values showed up in the 1975 lake sediment geochemical survey (Davenport *et al.*, 1975). The area is underlain by the Fermeuse Formation, the thickest and most extensively exposed formation of the St. John's Group. The Fermeuse Formation consists of light to dark gray shales with lenticular intercalations of fine grained sandstone in its stratigraphically higher sections. Disseminated pyrrhotite (+ chalcopyrite) was discovered in the shales on the south side of Fermeuse Harbour. A 75 m section of middle to upper Fermeuse Formation was mapped and sampled in detail north of Fermeuse Harbour at Clears Cove. Samples will be analyzed for the same elements as were the Caradocian shales of Central Newfoundland (Dean and Meyer, 1982), facilitating comparisons and further shale studies on the island.

Northwest Avalon

A regional Zn anomaly over the Carbonear Peninsula was outlined by a lake sediment geochemical survey of the Central Avalon Peninsula (Butler and Davenport, 1979). A smaller work area was delineated within the regional anomaly using the highest Zn values, and associated Pb and Ag values. This anomalous zone corresponds with the outcrop expression of the Carbonear Formation according to a geological compilation by King (1980).

The topography of the sample area is rugged, with low to moderate relief. In the southern half, forest, bogs and ponds dominate the lowlands and contrasted with dry rocky uplands. The northern half is largely barrens and burnover. Silt sampling was difficult and time consuming due to the poor silt development along the small brooks which connect the boggy lowlands. A total of 76 silt samples were collected from the work area.

The sampled area is underlain by the Carbonear Formation, the lower unit of the Hadrynian Hodgewater Group. It conformably overlies the Conception Group which outcrops in a small north trending, doubly plunging anticline at the center of the work area. The folding was thought to be Precambrian in age by Hutchinson (1953) but more recent work indicates the main orogenic event on the Avalon Peninsula to be Acadian (O'Brien and King, 1982). This event is probably responsible for the gentle folding on the Carbonear Peninsula, as well as the strong subvertical, north trending cleavage that is pervasive throughout the work area.

The Carbonear Formation consists of variably interbedded and laminated fine grained sandstone, siltstone and shale. Gray siltstone and fine grained sandstone are dominant, and contain dark gray to black shaley or silty laminations. The laminations are

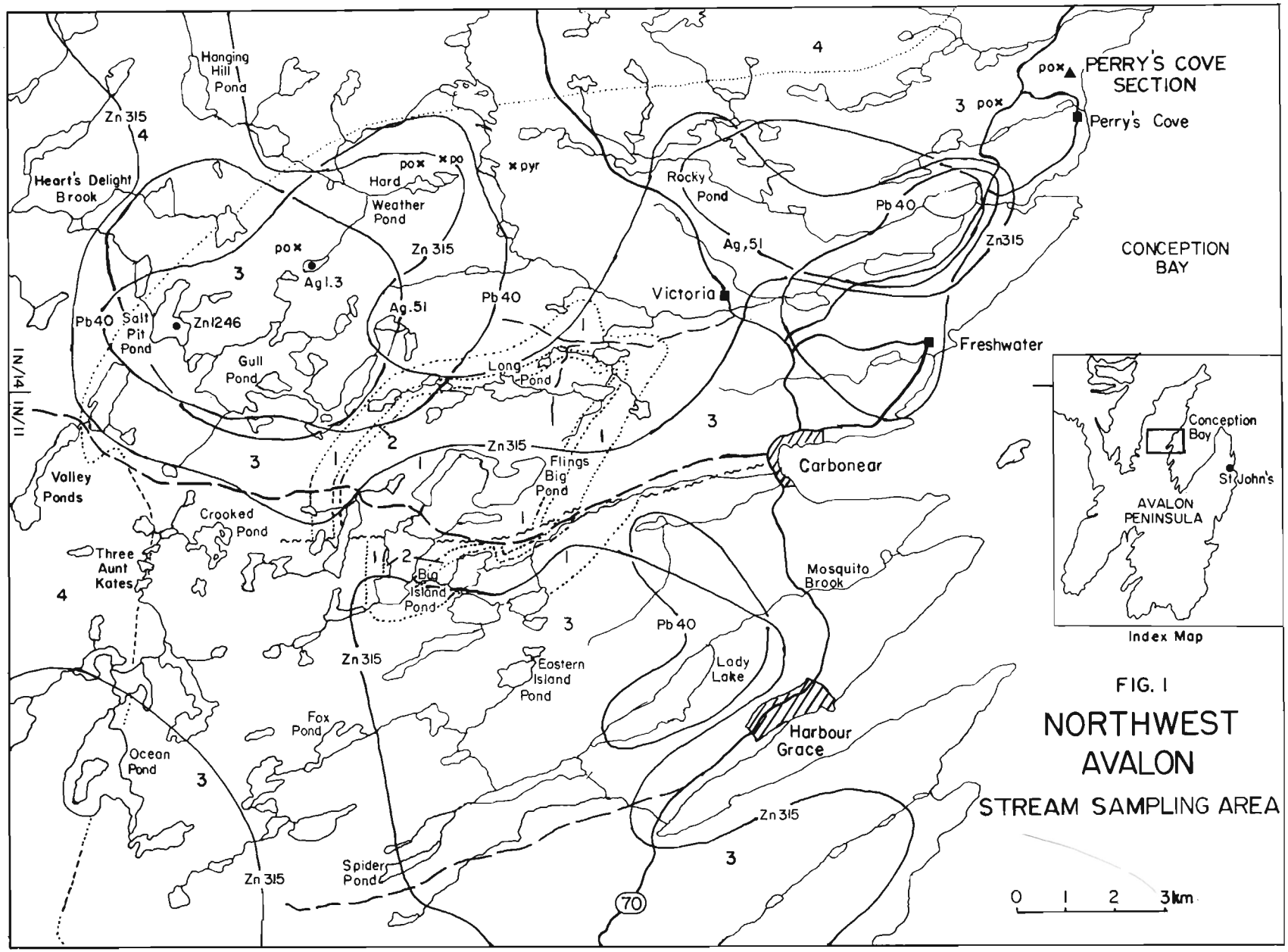


FIG. 1

NORTHWEST AVALON

STREAM SAMPLING AREA

LEGEND FOR NORTHWEST AVALON

HADRYNIAN

HODGEWATER GROUP

4 HALLS TOWN FORMATION: massive, green, quartzitic sandstone, siltstone and silty slate, with minor red slate and siltstone.

3 CARBONEAR FORMATION: gray to black slate and siltstone in the lower part, with continuous to discontinuous and lensoid, black shaly and silty laminations and stringers. The siltstones increase in number and thickness, and grade into sandstones in the upper part of the formation.

CONCEPTION GROUP

2 HIBBS HOLE FORMATION: well-bedded, strongly cleaved, red slates, with some massive beds, and minor red siltstone; green beds of the same lithology occur locally.

1 DROOK FORMATION: green to greenish gray argillite or argillaceous siltstone, sandstone, cherty beds - especially near the base, and a coarse green basal conglomerate.

Geology from: GSC Memoir 275 by Hutchinson, 1953; GSC Memoir 341 by McCartney, 1967; and I.G.C.P. project 27, Memoir No. 2 by King, 1980.

Lake Sediment Geochemistry from Mineral Development Division, Open File Release: NFLD 1003, by Butler & Davenport, 1979.

KEY FOR FIGURES 1, 2, AND 3

pyrite	pyr
pyrrhotite	po
chalcopyrite	cp
galena	gn

Lake sediment metal values and geochemical contours in parts per million Zn 315

zinc	Zn
lead	Pb
silver	Ag
cobalt	Co
copper	Cu

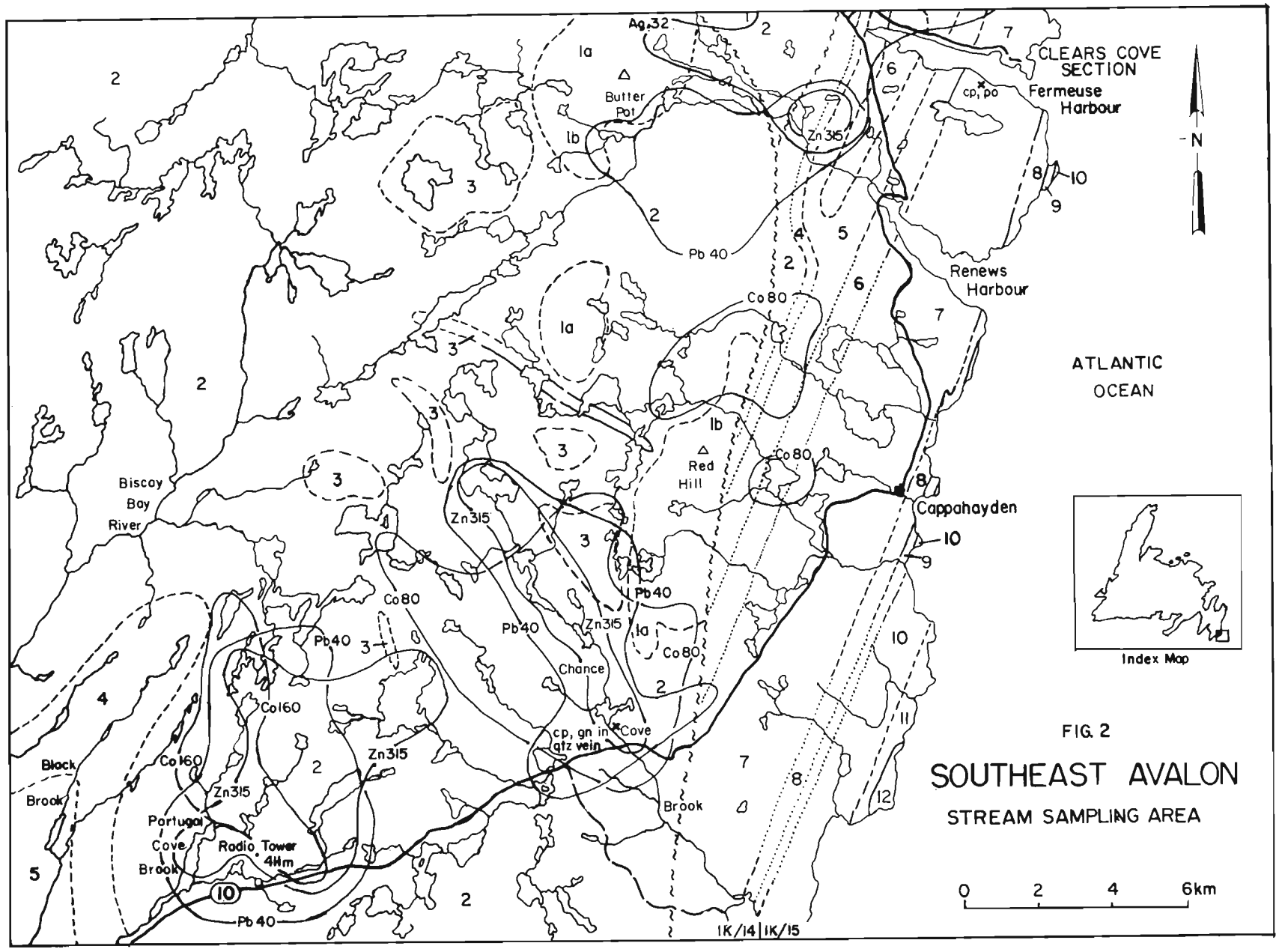


FIG. 2

SOUTHEAST AVALON

STREAM SAMPLING AREA

LEGEND FOR SOUTHEAST AVALON

HADRYNIAN

SIGNAL HILL GROUP

12 CAPE BALLARD FORMATION: gray shale and siltstone with minor purple shale, thick-bedded gray sandstone and quartz granule conglomerate.

11 FERRYLAND HEAD FORMATION: thick-bedded light gray sandstone with alternating units of thin-bedded dark gray sandstone and siltstone.

9 CAPAHAYDEN FORMATION: fissile parallel-laminated light gray siltstone.

ST. JOHN'S GROUP

8 RENEWS HEAD FORMATION: irregular thin-bedded dark gray sandstone with minor shale.

7 FERMEUSE FORMATION: gray to dark gray and black shale with thin lenses of buff-weathering sandstone and siltstone. Mainly light gray thin-bedded shale and sandstone toward base.

6 TREPASSEY FORMATION: medium- to thin-bedded gray sandstone and shale, graded sandstone beds with shale tops.

CONCEPTION GROUP

5 MISTAKEN POINT FORMATION: medium-bedded gray to pink sandstone and green to purple and red shale, minor thin tuff horizons.

4 BRISCAL FORMATION: thick-bedded coarse gray sandstone, thick-bedded olive to gray argillite, coarse pale red sandstone and arkose.

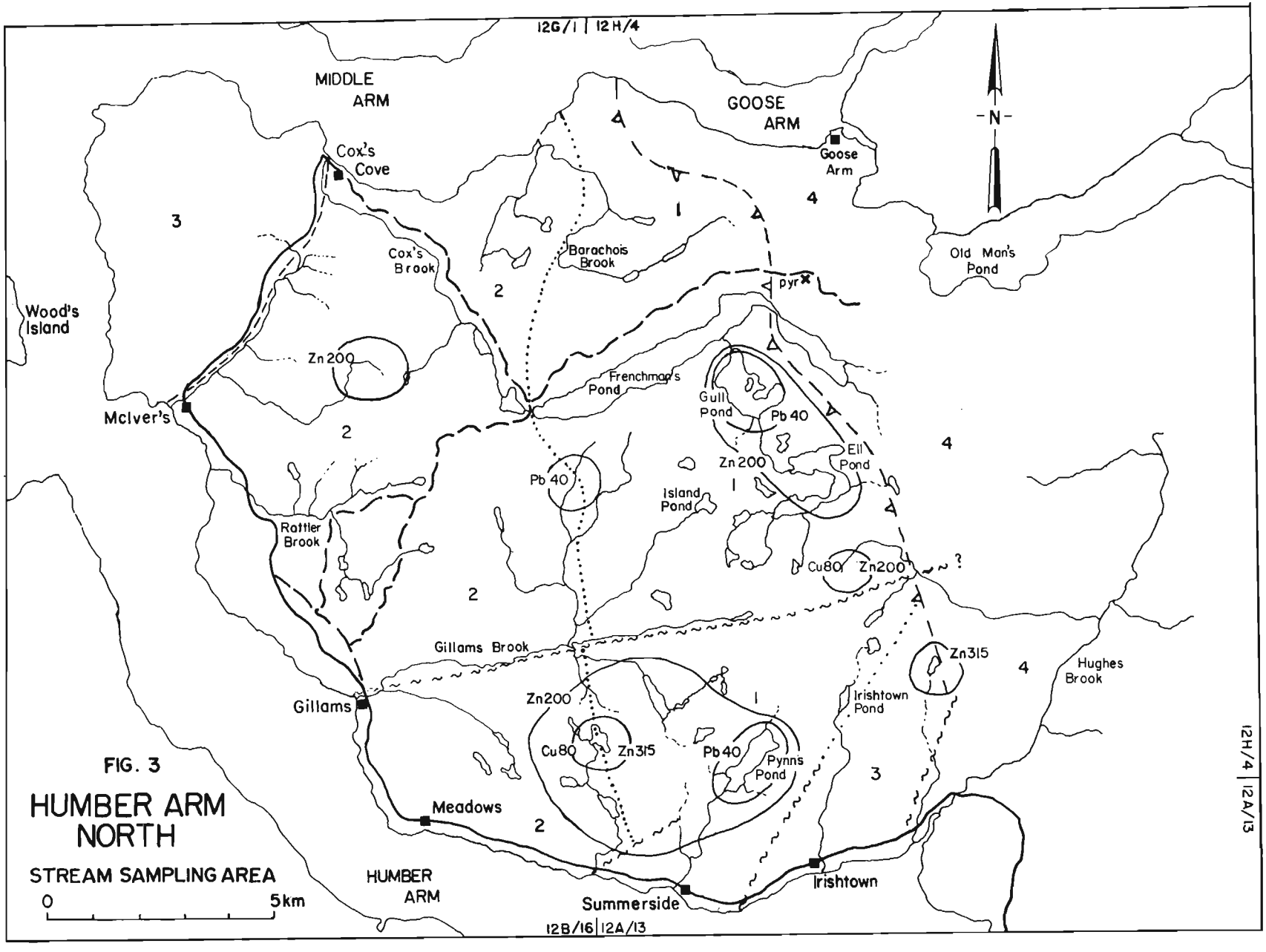
3 WHALESBACK GABBRO: fine- to medium- and coarse-grained massive gabbro.

2 DROOK FORMATION: parallel-bedded olive green to gray and buff argillaceous chert, siliceous siltstone and sandstone, silicified tuff, locally includes thick sandstone beds alternating with shale and siltstone, minor purple argillite.

1 HARBOUR MAIN GROUP: poorly bedded, bimodal volcanic rocks; 1a, pink to gray silicic tuff and agglomerate, pink to red rhyolite and welded tuff; 1b, altered green to purplish massive basalt.

Geology from GSC Memoir 389 by Williams and King, 1979.

Lake Sediment Geochemistry from Mineral Development Division, Open File Releases: NFLD 879, by Davenport et al., and NFLD 1003, by Butler and Davenport.


12G/1 | 12H/4
MIDDLE ARM
GOOSE ARM
N
Cox's Cove
Goose Arm
Cox's Brook
Barachois Brook
Old Man's Pond
pyr
Wood's Island
Zn200
Frenchman's Pond
Gull Pond
Pb40
McIver's
Ell Pond
Island Pond
Rattler Brook
Cu80
Zn315
Gillams Brook
Hughes Brook
Irishtown Pond
Gillams
Pynn's Pond
Meadows
HUMBER ARM
Summerside
Irishtown
12B/16 | 12A/13
12H/4 | 12A/13
FIG. 3
HUMBER ARM NORTH
STREAM SAMPLING AREA
0
5km

LEGEND FOR HUMBER ARM NORTH

AUTOCHTHONOUS CARBONATE TERRANE

UPPER CAMBRIAN TO MIDDLE ORDOVICIAN

4 ST. GEORGE AND TABLE HEAD GROUPS: medium- to thick-bedded limestone and dolomite with thin shale units.

HUMBER ARM ALLOCHTHON

MIDDLE CAMBRIAN TO LOWER ORDOVICIAN

3 COOKS BROOK FORMATION: thin platey limestone beds which alternate with black shales. The middle part of the formation contains limestone breccia.

LOWER TO MIDDLE CAMBRIAN

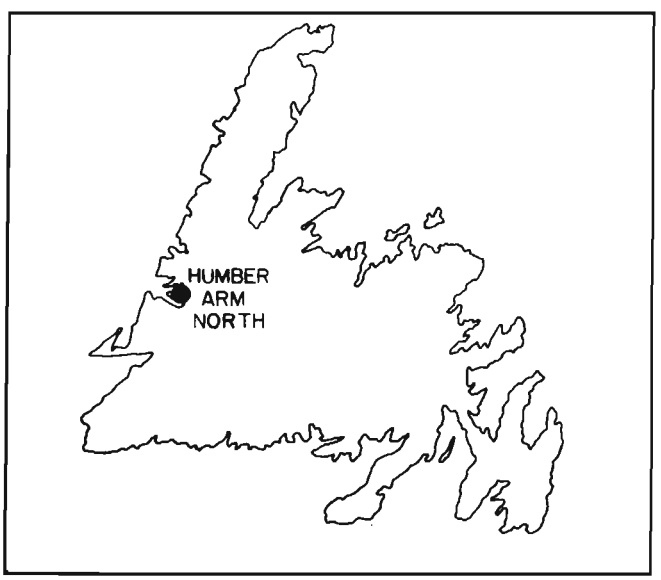
2 IRISHTOWN FORMATION: dark brown, gray, black, and locally voilet shales, with interbeds of siltstone, white and brown quartzite, graywacke, dolomite and conglomerate.

LOWER CAMBRIAN AND OLDER (?)

1 SUMMERSIDE FORMATION: the lowest beds are dark gray shales; these are overlain by brownish-green and reddish quartzites and siltstones; the upper part consists of distinctive red and green, shales and slates, overlain by silvery blue, black banded shales.

Geology from Stevens (1965), and Williams et al. (1981), GSC Paper 82-1A.

Lake Sediment Geochemistry from Mineral Development Division, Open File Releases: 12G/74 and 12H/570.



INDEX MAP FOR FIG. 3

continuous to discontinuous and lensoid, wavy to contorted, and variable in thickness from 1 mm to 2 cm. The Carbonear Formation is finer grained in its eastern exposures along Conception Bay where it is referred to as soft gray to black slate by Hutchinson (1953) and McCartney (1967). In the west, the Carbonear Formation grades upward into the massive, light green quartzitic sandstone of the Halls Town Formation, the upper unit of the Hodgewater Group. The Hodgewater Group is the central Avalon Peninsula's equivalent of the St. John's and Signal Hill Groups to the east (King, 1980).

Mineralization is present throughout the upper Carbonear Formation, but to a lesser degree in its lower stratigraphic levels. The sulphides consist of 1-5% disseminated pyrrhotite + pyrite and preferentially occur in the coarser laminations and beds. Large rusty sulphide-bearing outcrops are present north of Gull Pond and immediately north and east of Hard Weather Pond. In the latter area chalcopyrite and galena occur locally with the pyrrhotite. A weakly mineralized 36 m coastal section of the upper Carbonear Formation, north of Perry's Cove, was mapped and sampled in detail. Quartz chip samples and whole rock samples were collected from across the area and are presently being analyzed along with the silts and section samples.

Humber Arm North

Localized Zn, Cu and Pb anomalies are present in lake sediments overlying Cambrian clastics of the Humber Arm Supergroup (Butler and Davenport, 1980). The Humber Arm area lies east of the Bay of Islands. It is bounded to the south by the Humber Arm, to the north by Middle Arm, to the west by the McIver's-Cox's Cove road and to the east by a line joining the town of Goose Arm in the north to the mouth of Hughes Brook in the south.

Topographically, the area resembles a large dissected plateau sharply rising 150-200 m above sea level and having several interior mountains reaching altitudes of 300-400 m. The southern half of the area is predominantly drained by the deeply incised, west flowing Gilliams and Rattler Brooks, their many tributaries, and by much smaller brooks which drain south into the Humber Arm. The northern half is drained by short brooks which empty into the northeast trending Frenchmans Pond Valley, which itself drains northwest into Cox's Cove Brook. A small area north of Frenchman's Pond is drained by Barachois Brook and the broad valley which parallels the McIver's-Cox's Cove road drains southwest via an unnamed brook. Silt development was good to excellent in the area due to the relief and vegetation in western Newfoundland.

The area is underlain by the highly deformed Summerside and Irishtown Formations of the Humber Arm Supergroup (Brückner, 1966). The older Summerside Formation is described by Stevens (1965) as consisting of a lower arenaceous unit and an upper argillaceous unit. The lower unit is composed of green and red argillaceous sandstones which are locally subarkosic or conglomeratic. The upper unit is characterized by a distinctive red and green slate sequence containing very thin beds (1-3 cm) of laminated siltstone which are internally contorted. The slates grade upward into silvery blue and gray, well cleaved shales having closely spaced black bands (2 to 5 cm apart) which average 1 cm thick. The Irishtown Formation (referred to as the Meadows Formation by Stevens, 1965) is composed of dark brown, gray, and black shales, with interbeds of siltstone, white and brown quartzite, graywacke, dolomite, and conglomerate (Brückner, 1966). In addition, thick units of dark brown to black shales were observed, typically isoclinally folded, and containing intercalations of thin white siltstone averaging 3 mm in

thickness. Throughout the area, a north-northeast trending, vertically dipping foliation characterizes the regional structural fabric.

To the west of the Summerside and Irishtown Formations lies the Bay of Islands Igneous Complex. To the east lies an autochthonous carbonate (and clastic) sequence interpreted as representing an early Paleozoic continental shelf (Williams *et al.*, 1982). The Summerside and Irishtown Formations form part of the Humber Arm Allochthon, which is interpreted as a continental slope/rise sequence deposited to the east of the continental shelf, and later thrust westward across it (Williams *et al.*, 1982).

Mineralization in the area consists of rich concentrations of pyrite in quartz sandstone; nodules, lenses and veinlets of pyrite in carbonaceous shale; and minor disseminated sulphides scattered throughout the area. A 20 m section of well cleaved carbonaceous shales of the upper Table Head Formation is exposed in a roadcut north of Frenchman's Pond. Pyrite is present in amounts up to 5%, as small rounded nodules, disseminated crystals, sugary textured lenses (<1 cm thick), and veinlets parallel to the cleavage. The shales are similar in appearance to Caradocian shales seen in Central Newfoundland (Dean and Meyer, 1982) and were chip sampled in 3 m intervals. An additional 24 shale chip samples were collected from outcrops in brooks from across the area and are presently being analyzed.

Banded pyrite was observed in fine grained quartz sandstone float found in Barachois Brook. The mineralized float, which contains 30-40% pyrite, is possibly derived from the lower arenaceous unit of the Summerside Formation. There is a large roadcut of shale and interbedded sandstone of the Irishtown Formation on the north side of the arterial road in Corner Brook between the paper mill and the bus station. The 6-10 cm thick quartz sandstone interbeds contain up to 75% pyrite. Samples of this unit are currently being analyzed for the presence of additional metals.

Brooms Brook Section

A 22 m section of black, laminated mudstones and siltstones was mapped and sampled in detail on the northeast bank of a tributary of Brooms Brook in the southern Anguille Mountains of Western Newfoundland. Brooms Brook enters the Grand Codroy River from the north, halfway between the towns of Millville and O'Regans. A road, which deteriorates into a horse trail, leads 3.5 km along the northwest side of Brooms Brook to where the tributary flows in from the northwest. The section is 2.5 km upstream, within the Friars Cove Formation of the Mississippian Anguille Group (Knight, 1982).

The southeast facing section is bounded to the northwest by a zone of fault breccia (less than 15 cm thick) with calcite infilling and coarse crystalline masses of pyrite. The top of the section, and part of the middle, are covered in slumped riverbank deposits. Evidence of large scale folding and faulting of this formation is present downstream.

The section is composed of mudstones and siltstones which are black and very finely laminated. Beds range in thickness from 2 to 30 cm, and are moderately fractured and veined with calcite. The top half of the section is more carbonaceous and sulphur-rich. Traces of chalcopyrite are present in a third of the intervals, as thin veinlets as well as disseminations on fracture planes. Small euhedral crystals of galena were observed on similar fracture planes, but are less abundant. Bands and lenses of pyrite 2 to 4 mm thick are present near the top of the section. All chip samples are undergoing complete analysis for Cu, Pb, Zn, Ag, Ba, Fe, Mn, C, Ni, Co, As, U, and F, as well as

major elements. Comparisons will be made with sections from across the province in a further in depth study.

CONCLUSIONS

A total of 438 silt samples were collected from the three delineated work areas. In addition, 48 whole rock and 30 quartz chip samples were taken and three sections were mapped and sampled in detail. The most significant mineralization occurs within the Northwest Avalon where the upper Carbonear Formation hosts 2-5% sulphides (dominantly pyrrhotite) in most exposures. The silt and rock samples are presently being analyzed and results will be released on open file when available.

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REFERENCES

Brückner, W.D.
1966: Stratigraphy and structure of West-Central Newfoundland. *In* Guidebook - Geology of Parts of Atlantic Provinces. *Edited by* W. H. Poole. Annual Meeting, Geological Association of Canada and Mineralogical Association of Canada, pages 137-151.

Butler, A.J. and Davenport, P.H.
1979: Lake sediment geochemical survey of the Central Avalon area, Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Open File - Nfld. 1003, St. John's.

1980: Lake sediment geochemical survey of southwestern Newfoundland, Newfoundland Department of Mines and Energy, Mineral Development Division, Open File: Nfld. 1150, 12A (249), 12B (237), 12G (74), 12H (570), 110 (88), 11P (62).

Davenport, P.H., Butler, A.J. and Howse, A.F.
1975: A lake sediment geochemical reconnaissance survey over the Harbour Main Group and Bull Arm Formation, Avalon Peninsula, Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Open File - Nfld. 879.

Dean, P.L. and Meyer, J.R.
1982: Metallogenic study of Mid-Ordovician cherts and shales of Central Newfoundland. *In* Current Research. *Edited by* C.F. O'Driscoll and R.V. Gibbons, Newfoundland Department of Mines and Energy, Mineral Development Division, Report 82-1, pages 175-187.

Hutchinson, R.D.
1953: Geology of Harbour Grace Map-Area, Newfoundland; Geological Survey of Canada, Memoir 275, 43 pages.

King, A.F.
1980: The birth of the Caledonides: Late Precambrian rocks of the Avalon Peninsula, Newfoundland and their correlatives in the Appalachian - Orogen. Proceedings, "The Caledonides in the U.S.A.". International Geological Correlation Project: Caledonide Orogen; I.G.C.P. 1980, Blacksburg, Virginia, 8 pages.

Knight, I.
1975: Geological mapping, Carboniferous rocks, Cape Anguille Mountains, Southwest Newfoundland. *In* Report of activities. *Edited by* J.M. Fleming, Newfoundland Depart-

ment of Mines and Energy, Mineral Development Division, Report 75-1, pages 31-41.

1982: Geology of Carboniferous Bay St. George Subbasin. Newfoundland Department of Mines and Energy, Mineral Development Division, Map 82-1.

McCartney, W.D.
1967: Whitbourne Map-area, Newfoundland. Geological Survey of Canada, Memoir 341, 133 pages.

O'Brien, S. and King, A.F.
1982: The Avalon Zone in Newfoundland. *In* Field Guide for Avalon and Meguma Zones. *Compiled by* A.F. King. The Calendonide Orogen, IGCP Project 27, Nato Advanced Study Institute, Atlantic Canada, August, 1982.

Stevens, R.K.
1965: Geology of the Humber Arm, west Newfoundland. M.Sc. Thesis, Memorial University of Newfoundland, 121 pages.

Williams, H. and King, A.F.
1979: Trepassey Map Area, Newfoundland, Geological Survey of Canada, Memoir 389, 24 pages.

Williams, H., Gillespie, R.T. and Knapp, D.A.
1982: Geology of Pasadena Map Area, Newfoundland. *In* Current Research, Part A, Geological Survey of Canada, Paper 82-1A, pages 281-288.