AURIFEROUS SPECULARITE-ALUNITE-PYROPHYLLITE DEPOSITS OF THE HICKEY'S POND AREA, NORTHERN BURIN PENINSULA, NEWFOUNDLAND

by

Allan Huard and Cyril O'Driscoll

INTRODUCTION

Location and Access

This study is being conducted on an 8 x 18 km belt of volcanic and intrusive rocks centered 20 km south southwest of Swift Current. This area lies between the western shore of Placentia Bay and the Burin Highway (Figure 1) . It is cut by Sandy Harbour River, Paradise River and the Monkstown Road. This road provides a good section through all the major rock types and good access to the southern part of the study area. The northern part was studied from a camp on Hickey's Pond which is 9 km from the Burin Highway, and connected by a trail suitable for all terrain vehicles.

Previous Work

The area was previously included in 1:250,000 mapping by Anderson (1965) and 1:50,000 mapping by O'Driscoll and Hussey (1978) and O'Driscoll (1978).

The specularite showing at Hickey's Pond was examined in terms of its potential as a source of iron in the 1930's (Dahl, 1934; Bainbridge, 1934). Howland (1938, 1940), in a study which dismissed the deposits' iron potential, noted the presence of alunite ($KAl_3(SO_4)_2(OH)_6$) and remarked on the mineralogical curiosity of its occurrence with specularite. Hussey (1978a,b), with the aid of X-ray diffraction analyses, showed that the "alunite" was actually the Na-rich analogue, natroalunite. He also recognized pyrophyllite as an important constituent at Hickey's Pond and in the surrounding altered rocks. He also suggested that the area may have economic potential in terms of precious metals. Hussey (1978b) discussed a paper by Knight (1977) which reviewed the various modes of occurrence of alunite and its association with various types of ore deposits. The deposits mentioned by Hussey (1978b) include porphyry copper deposits, gold alunite veins, recent hot spring activity, and hydrothermal gold-silver-copper ores associated with caldera collapse structures. In 1982 Selco staked the area in the immediate vicinity of Hickey's Pond. The discovery, in 1983, of a quartz-specularite-alunite-lazulite body, 13 km southwest of Hickey's Pond, (Tuach, 1984) renewed interest in the area and prompted the initiation of this study. APEX Limited staked that showing in the fall of 1983. O'Driscoll (1984), in following up Husseys's suggestion of precious metal potential, demonstrated anomalous gold values in rocks collected by Hussey in the Hickey's Pond area. Seven rocks were analyzed for gold; the highest concentration being 850 mg/t, in a banded rock containing specularite, natroalunite, quartz, pyrophyllite and sericite.

Present Investigation

The present study is intended to: (1) locate other specularite-pyrophyllite-alunite occurrences in the area; (2) study any alteration assemblages associated with these occurrences; (3) analyze the occurrences and different alteration assemblages for gold content; and (4) describe the location of the showings in terms of their stratigraphic level, relation to structures, intrusions or any other feature which could aid in their systematic location.

Physiography

The area is typically flat to gently rolling but rises rapidly to the White Hills in the extreme northern part. Outcrop is abundant except in low-lying swamp areas and in the few wooded regions. In general, stereoscopic examinations of air photos enables very small lineaments to be traced.

GENERAL GEOLOGY

All the alteration assemblages observed are in volcanic rocks of the Late Precambrian Love Cove Group (Figure 1). Isoclinal folding and flattening of the volcanics prevents recognition of facing criteria and estimation of stratigraphic thicknesses. However, metamorphism is slight, with alteration of mafic minerals to chlorite and some alteration of feldspars the only results. Mafic flows, the presumed lowermost units of the volcanic sequence are in fault contact (the Paradise Sound Fault) with Cambrian and older clastic sedimentary rocks of the Musgravetown Group, Random Formation and Bonavista Formation to the east. These flows are commonly porphyritic and may include porphyritic intermediate flows. Higher in the sequence, lithic tuffs with a mafic matrix give way to crystal-lithic tuffs, rhyolite flows and (welded?) tuffs. Small-scale interlayering of these units can be observed in the field, so this stratigraphy is a simplification of a more complex interlayered sequence. More detailed stratigraphy is not yet available, due to the apparently discontinuous nature of the members along strike, and the difficulty in distinguishing depositional repetition from structural repetition. Water-lain sediments are few, but the sequence is overlain conformably (Hussey, 1978a,b) by graywackes and conglomerates of the Sandy Harbour River Formation. The Swift Current Granite outcrops within the volcanic sequences.

DESCRIPTION OF ROCK UNITS

The volcanics can be divided into a predominantly mafic unit, and a predominantly felsic unit. Locally, large areas of either mafic or felsic rocks are suitably divided by this method. In other places, interlayering and intrusions make this binary classification more difficult, and the definition of contacts less precise.

Unit 1

These rocks include dark green to black, porphyritic to massive mafic flows and dark purple porphyritic flows, possibly of intermediate composition. Crude joint sets commonly occur.

Dark colored lithic tuffs are also included. They contain fragments up to 40 cm in diameter that have been flattened on a pervasive, well developed cleavage. This cleavage, striking 030°-040° and dipping vertically to steeply northwest is present in all the volcanics, but is only poorly developed in the more massive, mafic flows.

Unit 2

Crystal-lithic tuffs, crystal tuffs, rhyolite porphyries and probable welded tuffs are the main rock types included in Unit 2. The crystal lithic tuffs are light gray and brown, and include flattened fragments usually less than 20 cm wide. On Hickey's Brook (south of Hickey's Pond) and its main tributary from the west, these tuffs contain pink granite clasts, indistinguishable from the major lithology of the Swift Current Granite. These rocks pass gradationally into crystal tuffs.

Quartz-feldspar porphyries are common where the Swift Current Granite is in contact with this unit. Rounded quartz crystals up to 1 cm in diameter and lesser feldspar occur in a light gray vitreous, siliceous matrix. Their contact with the granite may be gradational in places, which would suggest they are intrusive porphyries at the margins of the granite. However, they are also found kilometres from outcropping granite and are locally seen to contain small, flattened lithic fragments, suggesting an extrusive origin.

Some of the crystal tuffs have a fine banding similar to flow banding, but it is unbrecciated and the tuffs cover large areas. Intense flattening of lithic (ash?) fragments is not accompanied by deformation of crystals. These tuffs are tentatively interpreted to be ignimbrites.

Mafic and felsic dikes are comon in this unit. The felsic dikes are ubiquitous in rocks close to and on strike with the granite. One outcrop of auto-brecciated rhyolite occurs in a quarry north of Monkstown Road.

Unit 3

Hussey (1978a,b) described these sedimentary rocks as being composed largely of volcanic detritus. He concluded that they are in conformable contact with the underlying volcanic rocks.

Unit 4

The Swift Current Granite is concordant to the regional 030°-040° fabric. It is widest in the north and thins towards the south-southwest, pinching out completely near the Monkstown Road. It is typically white to pink, medium grained equigranular biotite-hornblende granite and granodiorite. The regional fabric parallels its margins but is only locally developed in the granite. Weak to strongly foliated zones are most common where the granite narrows. Joint sets and faults are present.

Dikes of coarse granite intrude volcanic rocks at its western contact, north of Sandy Harbour River. In the same area, angular mafic xenoliths 50 cm in diameter are common in the granite.

Unit 5

East of the Paradise Sound Fault late Precambrian to Cambrian sedimentary rocks were mapped by O'Driscoll (1978). These consist of laminated green sandstone and siltstone; red to purple sandstone, shale and conglomerate and minor mafic flows and tuffs of the Musgravetown Group. White quartzite with interbedded green sandstone and siltstone of the Random Formation overlies the Musgravetown Group and is overlain by purple and green shale of the lower Cambrian Bonavista Formation.

Unit 6

The Ackley Batholith outcrops on the western side of the Burin Highway and was mapped by Hussey (1978a,b) and Dickson et al., 1980. In this area it consists of pink, coarse grained, biotite granite. It intrudes rocks of the Love Cove Group post-tectonically and has been dated at 355 ± 5 Ma (Bell et al., 1977).

LEGEND

DEVONIAN

ACKLEY BATHOLITH

| 6 | *Massive, pink, coarse grained to megacrystic biotite granite.*

CAMBRIAN AND EARLIER

MUSGRAVETOWN GROUP, RANDOM FORMATION AND BONAVISTA FORMATION

| 5 | *Laminated green sandstone and siltstone; minor red to purple cross-bedded sandstone, shale and conglomerate; minor mafic flows and tuffs. White quartzite with interbedded sandstone and shale. Purple to green slate with pink limestone nodules.*

CAMBRIAN OR EARLIER

SWIFT CURRENT GRANITE

| 4 | *Medium grained, foliated to massive hornblende-biotite granite, granodiorite, and syenite.*

HADRYNIAN OR EARLIER

LOVE COVE GROUP

| 3 | *Green graywacke to arkosic sandstone and conglomerate.*

| 2 | *Predominantly felsic volcanic pyroclastics and flows. Locally altered to sericite (± pyrite ± pyrophyllite ± specularite ± alunite) schists. Minor mafic dikes, flows and tuffs.*

| 1 | *Predominantly mafic flows, tuffs and dikes, with minor intercalated felsic tuffs.*

SYMBOLS

specularite showing and sample site . . . . ×

sample site . . . . ×

geological contact (approximate) . . . . —·—

fault (assumed) . . . . ~~~

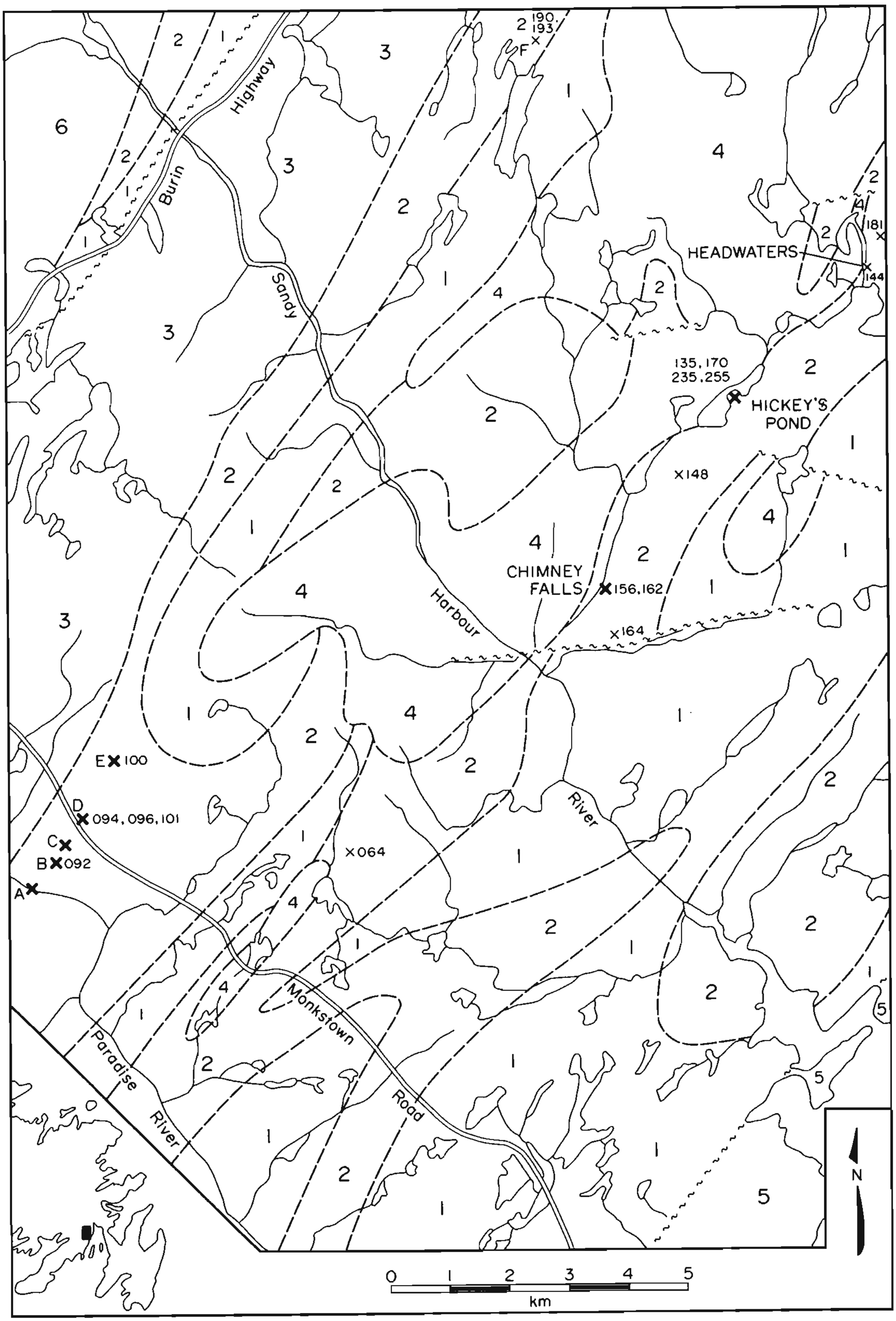

Figure 1: *General geology of the Hickey's Pond Belt.*

AGE RELATIONSHIPS AND GEOCHRONOLOGY

The Late Precambrian stratified rocks are a conformable sequence; however, the detailed stratigraphy is complicated by depositional and structural repetition. In general, mafic flows passing upwards through mafic lithic tuffs and felsic tuffs give way to coarse water-lain clastic sediments. Age relations between the granite and volcanics are contradictory. Whereas dikes of granite in the volcanics suggest the granite is younger, clasts of granite in certain tuffs suggest it is as old or older than these tuffs. These observations can be reconciled if the intrusion is considered to be synvolcanic.

This interpretation is supported by the geochronologic investigation of Dallmeyer et al. (1981). Crystallization dates for the granite and volcanic rocks were 580 ± 20 and 590 ± 30 Ma respectively, by U-Pb determinations on zircon fractions. They concluded that the rocks are comagmatic, and that the granite is subvolcanic.

STRUCTURE

Most of the volcanic rocks have a well developed cleavage which strikes 030°-040° and dips vertically to steeply northwest. Most dikes, quartz veins and contacts between flows are parallel to this regional fabric. Clasts in lithic tuffs are flattened on this plane. This hindered positive identification of bedding and prevented determination of younging directions. The cleavage is thought to be axial planar to isoclinal folds with an associated flattening of clasts. Other evidence of folding is the occurrence of tightly folded quartz veins. A single cleavage bedding intersection on Paradise River shows that the beds there are upright. It also shows that the clasts are flattened on the cleavage plane, not the bedding plane which is at a 30° angle to cleavage. Dallmeyer et al. (1983) dated sericite which had crystallized on this regional fabric by $^{40}Ar/^{39}Ar$ age spectra. Two samples from this study area yielded ages of 386 ± 10 Ma and 388 ± 10 Ma. They concluded that the deformation and recrystallization occurred during the Devonian Acadian Orogeny.

The regional fabric is only locally developed in the granite in this area, which has been shown to be pretectonic (Dallmeyer et al., 1981; 1983). It is cut by numerous joint sets and small faults.

A consistent trend is defined by three of the larger faults which all strike 080°. Among the smaller faults which parallel this trend is one which cuts the granite and the alteration zone at Hickey's Pond.

ECONOMIC GEOLOGY

Alteration

Felsic tuffs of Unit 2 have undergone variable degrees of alteration to sericite ± pyrophyllite ± specularite schists with or without pyrite. This alteration has occurred in two belts which parallel the regional fabric, an Eastern belt on the eastern contact of the Swift Current Granite, and a Western Belt to the southwest of the granite. The specularite occurs in three forms, all of which are present in both belts; these are: (1) as smeared bands in deformed schists, (2) as fine disseminations in siliceous rocks which are probably exhalative and (3) as platy crystals in quartz veins.

The Eastern belt of alteration is 9 km long and has 2 specularite showings; the Hickey's Pond deposit and the Chimney Falls deposit. The deposit at Hickey's Pond is very siliceous and rises almost 20 m above the pond and swamp. It consists essentially of banded exhalative rocks with varying amounts of specularite and alunite. Quartz veins with platy specularite cut the deposit, parallel to the regional fabric. Pyritiferous rocks are also abundant.

The Chimney Falls deposit is 4 km to the south-southwest of Hickey's Pond. It consists predominantly of soft sericite-pyrophyllite-specularite schists which are in fault contact with the Swift Current Granite to the west. Waterfalls 10 m high mark the place where Hickey's Brook flows from the granite into the easily eroded schists. X-ray diffraction work using the technique of Papezik et al. (1978) showed that one sample of this schist contains 81% pyrophylite.

At numerous other locations in this belt there are occurrences of sericite ± pyrophyllite schist with or without pyrite. Among these is a pyritiferous-sericite-pyrophyllite schist zone at the headwaters of Hickey's Brook, 3 km north-northeast of the Hickey's Pond deposit. A coarsely spaced cleavage crenulates the schistosity there. The schists are in fault contact with the Swift Current granite to the west. Another deposit 800 m northeast of there was shown to have 66% pyrophyllite (Hussey, 1978b).

The Western belt of altered volcanic rocks contains the specularite showing found by Tuach (1984) and four others discovered in the course of this study. The five showings span 2.5 km, with numerous schists between them. The occurrence 20 m north of the Monkstown Road (Location D) is similar to that at Hickey's Pond but is smaller and contains lazulite in the quartz veins. A small road cut on the Monkstown

Road 200 m west has exposed pyritiferous sericite schists with a thin, conformable chert body interbedded. The showing to the south of here (Location C) is smaller still but also has lazulite and platy specularite in quartz veins. Approximately 300 m south of this is another body (Location B) as large as the one on the Monkstown Road. Specularite-rich bands up to 15 cm thick, alternating with white to tan chert have been complexly folded. This outcrop stands a few metres above the low-lying, swampy surroundings, as do those at locations C and D. These three occurrences (Locations B, C and D) are very siliceous and relatively resistant to erosion. They are the middle three occurrences in this belt of five.

Specularite showings are also found both north and south of these three (Locations A and E). These showings are soft, deformed specularite-sericite schists surrounded by abundant pyritiferous schists.

Minor specularite in quartz veins occurs along strike with the western belt (Location F), 13 km north-northeast from the northernmost showing. The intervening distance is mostly barren of alteration and specularite mineralization, though minor pyritiferous schists were found.

The Eastern belt of alteration is found in felsic tuffs of Unit 2 that are in contact with the Swift Current Granite to the west. At Chimney Falls and the sericite-pyrophyllite schist showing at the headwaters of Hickey's Brook, the altered rocks are in fault contact with the granite to the west. To the east, alteration diminishes and the rocks pass from unaltered felsic tuffs to mafic volcanics. The zone is terminated on the north, where the volcanics pinch out into granite. To the south, the alteration has not been traced beyond the 080° striking fault 1 km south of the Chimney Falls showing. It seems however, that the volcanics of unit 2 continue to the south of the fault, having undergone apparent dextral displacement (see map). These rocks should be explored further for alteration zones, especially since the granite outcrops to the west, as it does over the length of the known Eastern alteration belt.

The Western belt of alteration is more distant from the granite, but examination of the map shows that it is approximately on strike with the northwestern flank of the granite. However, a narrow belt of mafic volcanics separates the alteration belt and the granite. Possibly, this means that the granite in the Western belt did not intrude as highly into the sequence as it did near the Eastern belt. Rocks on strike with the Western belt, south of Paradise River were not examined. Given the apparent continuity of this belt, however, this area deserves further study.

GOLD ASSAYS

Rock samples were analyzed for gold by neutron activation by Chemex Ltd., Vancouver. Table 1 shows the data for 16 of the 137 samples analyzed. For a more complete list of the analyses see O'Driscoll and Huard (1984). By considering these data, and the locations of the samples, the following inferences can be drawn:

(1) Gold concentration in any given rock type can vary profoundly; e.g. samples 092 and 235 are, at least megascopically, similar. However, their gold concentrations are 5 and 5400 mg/t respectively.

(2) The soft, sericite-pyrophyllite schists with and without specularite and/or pyrite generally have low (200 mg/t) gold concentrations.

(3) The highest gold concentrations are found in (exhalative?) siliceous bodies, usually with disseminated specularite, but all such rocks do not have high concentrations (e.g. sample 092).

(4) The eastern belt, especially the Hickey's Pond deposit, has the highest gold concentrations.

DISCUSSION

The proximity of the highest gold values to the Swift Current Granite may suggest a genetic relationship with the granite. However, it must be remembered that the contact with the volcanics is faulted and their relative positions at the time of mineralization is the critical factor when considering the relationship to the granite. The Swift Current Granite may best be modelled as the core of a gently south-southwesterly plunging anticline. Granite is also found isolated (in map view) from the main granite body, e.g. the small body which crosses the Monkstown Road. Granite may be present at shallow depths, under the volcanics on the flanks and nose of the anticline. Therefore, the presence of outcropping granite is not a necessary prerequisite in considering further exploration for auriferous alteration zones.

The area exhibits characteristics similar to "epithermal" gold producing areas in the volcanic environments in the southwestern United States and western Canada (Buchanan, in press; Panteleyev, 1984) and the Carolina Slate Belt (Worthington and Kiff, 1970; Spence et al., 1980; Worthington et al., 1980). These characteristics include the alteration assemblages (sericite-pyrophyllite-alunite) and the presence of siliceous exhalations. Structural similarities have not been observed, probably due to the intense deformation in the study area.

CONCLUSION

Elevated gold concentrations have been demonstrated for certain rocks in this study area. The most promising area thus far is the quartz-specularite- alunite deposit at Hickey's Pond. In evaluating the area's gold potential, the following factors must be considered: (1) The deposit north of the Monkstown Road is a recent discovery (1983) and in 1984 this study showed it to be part of a belt at least 2.5 km long with elevated gold concentrations. Other promising areas may include southern continuations of the two alteration belts described here. (2) Regional examination indicates that similar volcanic units extend for tens of kilometres both north and south of the study area. (3) Similar altered volcanic assemblages occur throughout these late Precambrian volcanic rocks on the Burin Peninsula and have not been prospected for gold.

REFERENCES

Anderson, F.D.
1965: Belleoram, Newfoundland. Geological Survey of Canada, Map 8-1965.

Bainbridge, T.
1964: Memoranda relating to iron deposits at Placentia Bay, Newfoundland. Davenport and Company, Aldwych, W.C.2, London, England. Unpublished report, 11 pages.

Bell, K., Blenkinsop, J., and Strong, D.F.
1977: The geochronology of some granitic rocks from eastern Newfoundland and its bearing on Appalachian evolution. Canadian Journal of Earth Sciences, volume 14, pages 456-476.

Buchanan, L.J.
1981: Precious metal deposits associated with volcanic environments in the southwest. Arizona Geological Society Digest, volume 14, pages 237-262.

Dahl, O.M.
1934: Third report on the iron deposits at Hickey's Pond, Placentia Bay, Newfoundland. Davenport and Company, Aldwych, W.C.2, London, England. Unpublished report, 9 pages.

Dallmeyer, R.D., Odom, A.L., O'Driscoll, C.F. and Hussey, E.M.
1981: Geochronology of the Swift Current Granite and host volcanic rocks of the Love Cove Group, southwestern Avalon Zone, Newfoundland: evidence of a late Proterozoic volcanic-subvolcanic association. Canadian Journal of Earth Sciences, volume 18, pages 699-707.

Dallmeyer, R.D., Hussey, E.M., O'Brien, S.J. and O'Driscoll, C.F.
1983: Chronology of tectonothermal activity in the western Avalon Zone of the Newfoundand Appalachians. Canadian Journal of Earth Sciences, volume 20, pages 355-363.

Dickson, W.L., Elias, P. and Talkington, R.W.
1980: Geology and geochemistry of the Ackley Granite, southeast Newfoundland. *In* Current Research. *Edited by* C.F. O'Driscoll and R.V. Gibbons, Newfoundland Department of Mines and Energy, Mineral Development Division, Report 80-1, pages 110-119.

Howland, A.L.
1938: Precambrian iron bearing deposits of southeastern Newfoundland. Geological Survey of Newfoundland. Unpublished report, 43 pages.

1940: Specularite-alunite mineralization at Hickey's Pond, Newfoundland. American Mineralogist, volume 25, pages 34-45.

Hussey, E.M.
1978a: Geology of the Sound Island map area (west half), Newfoundland. *In* Report of Activities for 1977. *Edited by* R.V. Gibbons, Newfoundland Department of Mines and Energy, Mineral Development Division, Report 78-1, pages 110-115.

Hussey, E.M.
1978b: Sound Island map area (west half). Newfoundland Department of Mines and Energy. Mineral Development Division, Open File Report 1M/16(212), 39 pages.

Knight, J.E.
1977: A thermochemical study of alunite, enargite, luzonite, and tennantite deposits. Economic Geology, volume 72, pages 1321-1336.

O'Driscoll, C.F.
1978: Harbour Buffett. Newfoundland Department of Mines and Energy, Mineral Development Division, Map 7873, map with marginal notes.

O'Driscoll, C.F.
1984: The Hickey's Pond Belt: auriferous specularite-alunite-pyrophyllite-sericite mineralization near Placentia Bay, Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Open File Report 1M/16(221), 12 pages.

O'Driscoll, C.F. and Huard, A.
1984: Preliminary gold analyses in the Hickey's Pond Belt. Department of Mines and Energy, Mineral Development Division, Open File Report 1M/16(222), 7 pages.

O'Driscoll, C.F. and Hussey, E.M.
1978: Sound Island (1M/16). Newfoundland Department of Mines and Energy, Mineral Development Division, Map 7863.

Panteleyev, A.
1984: Precious metals in the Cordillera: A focus on the transition from porphyry copper to hotspring settings. Canadian Institute of Mining and Metallurgy, Program with abstracts, pages 8-9.

Papézik, V.S., Keats, H.F., Vahtra, J.
1978: Geology of the Foxtrap pyrophyllite deposit, Avalon Peninsula, Newfoundland. Canadian Mining and Metallurgical Bulletin, volume 71, pages 152-160.

Spence, W.H., Worthington, J.E., Jones, E.M. and Kiff, I.T.
1980: Origin of the gold mineralization at the Haile Mine, Lancaster County, South Carolina. Mining Engineering, volume 32, pages 70-73.

Tuach, J.
1984: Metallogenic studies of granite associated mineralization in the Ackley Granite and the Cross Hills Plutonic Complex, Fortune Bay, Newfoundland. *In* Current Research. *Edited by* M.J. Murray, J.G. Whelan and R.V. Gibbons, Newfoundland Department of Mines and Energy, Mineral Development Division, Report 84-1, pages 245-253.

Worthington, J.E. and Kiff, I.T.
1970: A suggested volcanogenic origin for certain gold deposits in the Slate Belt of the North Carolina Piedmont. Economic Geology, volume 65, pages 529-537.

Worthington, J.E., Kiff, I.T., Jones, E.M. and Chapman, P.E.
1980: Application of the hot springs or fumarolic model in prospecting for lode gold deposits. Minering Engineering, volume 32, pages 73-79.

TABLE 1

SAMPLE ≠	SAMPLE DESCRIPTION	Au (mg/t)
064	pyritiferous quartz sericite schist	10
092	siliceous rock with abundant disseminated specularite	<5
094	sericite-pyrophyllite schist	<5
096	siliceous rock with abundant disseminated specularite	<5
100	sericite-specularite schist	<5
101	pyritiferous quartz-sericite schist	<5
135	chert with fine specularite-rich bands	350
144	pyritiferous sericite-pyrophyllite schist	10
148	quartz-sericite schist	<5
156	specularite-rich band in chert	335
162	pyritiferous quartz-sericite-specularite schist	105
164	pyritiferous quartz-sericite schist	<5
170	quartz vein with pyrite	2530
181	quartz-sericite schist	100
190	chlorite-sericite schist	<5
193	quartz vein with minor specularite	<5
235	fine specularite in chert	5400
255	massive, fine-grained specularite	4710

Table 1: *Gold analyses for selected samples in the Hickey's Pond Belt.*