GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

PAPER 72-34

BAY OF ISLANDS MAP-AREA, NEWFOUNDLAND

Harold Williams

GEOLOGICAL SURVEY

OF CANADA

PAPER 72-34

BAY OF ISLANDS MAP-AREA, NEWFOUNDLAND, (12 G)

(Report and Map 1355A)

Harold Williams

DEPARTMENT OF ENERGY, MINES AND RESOURCES

Available by mail from *Information Canada*, Ottawa

from the Geological Survey of Canada
601 Booth St., Ottawa

and

Information Canada bookshops in

HALIFAX - 1687 Barrington Street
MONTREAL - 640 St. Catherine Street W.
OTTAWA - 171 Slater Street
TORONTO - 221 Yonge Street
WINNIPEG - 393 Portage Avenue
VANCOUVER - 800 Granville Street

or through your bookseller

Price: $1.00 Catalogue No. M44-72-34

Price subject to change without notice

Information Canada
Ottawa
1973

BAY OF ISLANDS MAP-AREA (12G), NEWFOUNDLAND

DESCRIPTIVE NOTES

All rocks in the map-area are transported and constitute a succession of structural slices that overlie a subsurface autochthonous Cambro-Ordovician carbonate sequence and Precambrian basement (Williams, 1971). The transported rocks constitute two broad groups: a Cambrian and Ordovician clastic sedimentary succession (Humber Arm Supergroup; Stevens, 1970) that is represented in lower structural slices, and a variety of Lower Ordovician and older igneous and metamorphic rocks that is represented in higher structural slices. Rocks of the higher structural slices can be further subdivided into four distinct rock groups i.e., the Skinner Cove Formation, the Old Man Cove Formation, the Little Port Complex, and the Bay of Islands Complex, each represented in separate slices. There are then a total of five contrasting rock groups among all of the transported rocks in the map-area.

Structural slices that are composed of the same rock group are referred to as a slice assemblage. The five contrasting rock groups define five slice assemblages. In each case the slice assemblage is designated by the same name as the rock group that constitutes each slice within the assemblage, e.g., Little Port Complex comprises the Little Port slice assemblage, etc. The succession of rock units in each slice assemblage is depicted individually in the accompanying map-legend.

The structurally higher slice assemblages, i.e., Skinner Cove, Old Man Cove, Little Port, and Bay of Islands slice assemblages, in most places lie directly upon sedimentary rocks of the Humber Arm slice assemblage, but locally they lie upon one another, everywhere maintaining a consistent order of structural stacking. Thus the Skinner Cove slice assemblage everywhere lies upon the Humber Arm slice assemblage; the Old Man Cove slice lies upon the Skinner Cove slice assemblage; the Little Port slice assemblage lies upon the Old Man Cove slice (or structurally lower slice assemblages); and it is clear from structural section A-B (map 1355A) that continued westward movement of the Table Mountain part of the Bay of Islands slice assemblage would have resulted in that slice assemblage locally lying upon the Little Port slice assemblage near Trout River. There are no known reversals in this stacking order within the map-area, as for example, the Skinner Cove above the Little Port, the Humber Arm above any igneous slices, etc.

The Humber Arm Supergroup is a continuous conformable succession and its subdivisions are those defined by earlier workers (Stevens, 1965, 1970; Brückner, 1966; Lilly, 1967). Several of the formations are dated both within and to the east of the map-area. Graptolites recently collected at Little Port include Dictyonema flabelliforme sociale (Salter) of Tremadocian age (John Riva, pers. comm., 1971); and the Early Ordovician form Anisograptus (L.M. Cumming, G.S.C. loc. 75118, pers. comm., 1967) was collected from black shale blocks from mélange (6b) at Frenchman's Cove. Limestone pebbles from Irishtown conglomerates (2) at McIver's contain Crassifimbra sp. or Onchocephalus sp., Olenellus ? sp. and Pagetides sp., indicating a late Early Cambrian age for the pebbles (W.H. Fritz, G.S.C. loc. 87419, pers. comm., 1972).

Volcanic rocks of the Woods Island Member (5a) are conformably overlain by Blow-Me-Down Brook sandstones (5) and are considered part of that formation. Probable correlatives occur one-half mile east of Buck Head. A coarse-grained diabase dyke cuts the Woods Island Member (5a) on the north side of Woods Island and a few similar dykes cut Humber Arm sedimentary rocks immediately east of the map-area on the north side of Trout River Pond. These are thought to be genetically related to volcanic rocks (5a).

Detached blocks of volcanic rocks occur among chaotic sedimentary rocks at Rattler Brook near McIver's, and one mile east of North Arm Point. Both localities are at or near tectonic slice boundaries.

Repetitions and omissions of strata throughout the transported clastic terrane combined with the occurrence of wide mélange zones within the successions, e.g., Companion Mélange (6b), clearly indicate that in its present position the sedimentary terrane is a composite structural unit composed of a number of separate transported slices. The sedimentary rocks (1-6) have been interpreted as an offshore, more easterly facies of the western Newfoundland Cambro-Ordovician carbonate succession (Stevens, 1970; Williams, 1971). Ophiolite detritus in the Blow-Me-Down Brook Formation (5) indicates that the Bay of Islands slice assemblage was already moving westward at the time the sandstones were deposited (Stevens, 1970).

Chaotic sedimentary rocks (6a) surround prominent knolls of volcanic rocks (7, 12) near Trout River and the volcanics are interpreted as detached blocks among the chaotic sedimentary rocks. Their presence signifies the earlier westward transport of higher structural slices across the sedimentary rocks. Amphibolites south of Frenchman's Cove are included with map-unit (9) of the Little Port Complex and are thought to have the same significance.

The Skinner Cove Formation (7) sharply contrasts with all other rocks of the area and defines the Skinner Cove slice assemblage (Troelsen, 1947). The rocks are extremely fresh and unaltered compared with volcanics (12, 18) of higher structural slice assemblages. Separate occurrences of the Skinner Cove at Chimney Cove and Beverley Head, south of the type area, may represent remnants of a once continuous slice or else several slices at the same structural level. Small occurrences of volcanic rocks (7) at Big Cove Head suggest subsurface continuity of the Chimney Cove and Skinner Cove rocks beneath the Little Port slice assemblage. The Skinner Cove Formation is undated but its unaltered nature suggests that it is among the stratigraphically youngest volcanic rocks in the map-area. It possibly correlates with the Woods Island Member volcanics (5a).

Polydeformed greenschists (8) define a single slice, the Old Man Cove slice, at Trout River. The slice lies upon the Skinner Cove Formation (7) and is structurally overlain to the east by foliated gabbros (9) of the Little Port slice assemblage. The greenschists (8) are cut by mafic dykes that post-date their polyphase deformation and pre-date their transportation. The greenschists are remarkably similar in lithology and structural style to the Birchy Schist of the Fleur de Lys Supergroup in northeast Newfoundland (Kennedy, 1971).

The Little Port slice assemblage (9-12) structurally overlies sedimentary rocks (1-6) of the Humber Arm slice assemblage in most places. Exposures between Chimney Cove and Bonne Bay are part of a continuous slice. North of Lark Harbour, there are at least three separate superposed slices within the slice assemblage. Several small detached masses of the

Little Port Complex occur at Little Port, and the Bear Cove exposures continue south of the map-area to Serpentine River. Foliated gabbro and amphibolite (9) have prominent tectonic fabrics everywhere in the slice assemblage. In most places the main foliation within the gabbroic rocks (9) parallels an original layering, but locally the main foliation clearly crosses the layering and at Pearl Island and Big Cove Head the main foliation is itself deformed by later folds; all the structures pre-date transportation of the slice assemblage. Quartz diorite (10) cuts and includes amphibolites (9) at Pearl Island and locally it has a well-developed later tectonic fabric. The quartz diorite forms elongate bodies that parallel the main foliation in the surrounding gabbroic rocks (9) and the northeast regional trend of the Little Port slice assemblage. Northwest of Lark Harbour the succession of superposed slices trends northwest and there the main foliation in gabbroic rocks (9) and the long dimension of quartz diorite bodies all trend in the same northwest direction. Quartz diorite (10) is remarkably similar in mineralogy, texture and geological setting to rocks of the Twillingate batholith in northeast Newfoundland (Williams, 1963; Williams et al., 1972). Recent chemical analyses further enhance this comparison and suggest a similar origin for both.

Mafic dykes (11) are locally sheeted with chilled margins against adjacent dykes. The dykes (11) cut quartz diorite (10) and nearby mafic volcanic rocks (12). The dykes are massive, though everywhere altered and brecciated, and they are clearly post-tectonic and genetically unrelated to gabbros (9) and quartz diorites (10). The dykes (11) are interpreted as intrusions coeval with volcanic rocks (12). They are most common at the high-angle contacts between quartz diorite (10) and volcanic rocks (12).

Volcanic rocks (12) are mainly altered green and red mafic flows and pillow breccias. Silicic volcanic rocks (12a) are light grey with abundant quartz phenocrysts and are possibly rhyolites. Where mafic volcanics (12) abut older deformed gabbros (9) in the vicinity of Little Port the contact is marked by prehnite alteration and internal penetrative brecciation (fluidization) within the volcanics. The contact is interpreted as a steep unconformity along which younger volcanic rocks adjoin and in places surround and enclose a fragmented older terrane (9, 10). This surface was the locus for subsequent alteration and brecciation.

The Bay of Islands slice assemblage contains a typical ophiolite rock suite (15-18). As earlier defined the Bay of Islands Igneous Complex (Smith, 1958) also included gabbros (9) and quartz diorites (10) and excluded rocks of map-units 13, 14, 17, 18 and 19, that all form an integral part of the same structural slices and that are here considered part of the Bay of Islands Complex.

Black amphibolite inclusions (13) exhibit tectonic fabrics and resemble amphibolites (9) within the Little Port Complex.

Aureole rocks (14) beneath ultramafic rocks (15) include a variety of lithologies with metamorphic grade decreasing away from the ultramafic contact. Pyroxene-hornblende granulites, locally banded, occur at the ultramafic contact and grade outward into garnetiferous amphibolites, black amphibolites and polydeformed greenschists. Some of the polydeformed greenschists within the aureole resemble the Old Man Cove Formation (8). At Pond Point, garnetiferous black pelitic schists occur at the outer margin of the aureole and the pelitic schists grade outwards into relatively unmetamorphosed dark grey to black argillites (R.K. Stevens, pers. comm., 1971). Near Stowbridge Head, dark, soft and greasy serpentinized (?) schists

containing about 50 per cent coarse-grained pink garnet occur at the ultramafic (15) contact. The aureole rocks (14) are separated from underlying rocks of the Humber Arm slice assemblage west of Stowbridge Head by a mélange zone.

The aureole rocks are tentatively interpreted as transported "tectonic underpinnings" structurally welded to the ultramafics during earliest transport along a structural surface now marked by mylonitized peridotite and aureole rocks (14). Final emplacement into their present positions was accomplished along a structural surface of a different attitude that truncates the ophiolite succession of rock units and that is marked by serpentinite mélange.

Ultramafic rocks (15) are schistose and serpentinized at their basal contact with the aureole rocks (14) and they contain thin bands of garnet-amphibole rock. At the top of the ultramafic unit, the ultramafic rocks (15) are interlayered with gabbroic rocks (16) in the contact zone. Lower parts of the gabbro unit (16) are banded and grade upward into more massive gabbros. Small bodies of quartz diorite (16a) occur near the top of the gabbro unit on North Arm Mountain and Blow-Me-Down, and a distinctive coarse-grained hornblende gabbro (16b) occurs within the gabbro unit on Blow-Me-Down. The hornblende gabbro (16b) and related leucocratic gabbroic rocks commonly produce intrusion breccias where they cut darker gabbroic rocks. Mafic dykes (17) cut the gabbros and increase in abundance upward into a zone entirely composed of sheeted dykes. This zone is in turn overlain by mafic pillow lavas (18), thus completing the ophiolite sequence (15-18). Sedimentary rocks (19) are interpreted to overlie volcanics (18) for the following reasons: (a) the sedimentary rocks contain volcanic detritus and are lithologically unlike nearby sandstones (5) structurally beneath the North Arm Mountain massif; (b) the contact between the sedimentary rocks (19) and volcanic rocks (18) is of variable relief and has no topographic expression to suggest a subhorizontal thrust surface, whereas the subhorizontal contact between the ophiolite suite and structurally underlying sediments is a pronounced topographic break; (c) high gravity values suggest dense mafic rocks in subsurface beneath the sediments (19) (Weaver, 1967); and (d) the position of the sediments (19) surrounded by volcanic rocks (18) suggests that the sediments lie in the axial zone of a syncline above volcanics (18) and thus form the highest stratigraphic unit of the succession.

The ophiolite succession (15-18) is in most respects similar to the Betts Cove Ophiolite Complex (Upadhyay et al., 1971) of northeast Newfoundland and both are interpreted to represent Early Ordovician oceanic crust and mantle (Church and Stevens, 1971; Williams et al., 1972; Williams and Malpas, 1972). Dykes (11) and volcanic rocks (12) of the Little Port Complex are similar to dykes (17) and volcanic rocks (18) of the Bay of Islands Complex. Dykes (11) and volcanic rocks (12) are not related to earlier deformed gabbros (9) and quartz diorites (10) of the Little Port Complex. If the dykes (11, 17) and volcanic rocks (12, 18) are all coeval and related to an ocean spreading episode, then gabbros (9) and quartz diorites (10) must be interpreted as older crustal remnants caught up in this spreading episode. Similarities between the Little Port Complex and the Twillingate batholith further suggest that both the Bay of Islands Complex and the Little Port Complex were transported from a terrane like that presently exposed in Notre Dame Bay of north-central Newfoundland.

The Old Man Cove Formation and rocks of the Little Port and Bay of Islands Complexes were all variously deformed and/or metamorphosed before

emplacement into their present position. This is especially clear as underlying sedimentary rocks show no evidence of similar metamorphism or intense deformation.

Sheeted dykes (11, 17) are almost everywhere internally brecciated (fluidized) and this phenomenon has locally affected underlying gabbroic rocks (16) and overlying volcanic rocks (12, 18). The internal brecciation is also locally evident in quartz diorite (10) and amphibolite (9). The phenomenon post-dates metamorphism in the Little Port Complex metamorphic rocks (9, 10) but it pre-dates or is coeval with alteration in dykes (11, 17) and volcanic rocks (12, 18). It is interpreted to pre-date final emplacement of the higher structural slices because it is absent in underlying sedimentary rocks. Williams and Malpas (1972) have interpreted the phenomenon as gas brecciation penecontemporaneous with metamorphism in rocks formed at an ocean ridge environment.

Post-emplacement structures are most evident in pelitic sedimentary rocks of the Humber Arm Supergroup (1-6). They locally exhibit tight folds about north- to northeast-trending axes with a related penetrative axial plane cleavage that dips steeply west.

Leading edges of higher structural slices are in most places marked by thick serpentinite mélange zones. Trailing edges are less apparent and commonly hidden by post-emplacement high-angle faults along which the overlying slice is downthrown. Strike-slip faults that bound Table Mountain to the north and south are tear faults that mark the sides of the northwestward transported massif and that do not continue westward toward the coast. The three slices of the Bay of Islands slice assemblage in the map-area, i.e., Table Mountain, North Arm Mountain, and Blow-Me-Down, are all broadly synclinal in form with similar orientations. South of the map-area, Lewis Hills massif of the Bay of Islands Complex appears to be rotated 90 degrees with respect to similar massifs within the map-area (Williams and Malpas, 1972).

The largest mineral deposits in the map-area occur in the igneous rocks of the Bay of Islands slice assemblage. Chromite and asbestos occur in the ultramafic rocks (15) and chalcopyrite and sphalerite in the volcanic rocks (18). A few smaller base metal occurrences are known in gabbroic rocks (16) of the Bay of Islands Complex and volcanic rocks (12) of the Little Port slice assemblage. In the Bay of Islands Complex massive lenses or layers of chromite occur at North Arm Mountain and smaller lenses and disseminations at Blow-Me-Down. In both cases the chromite is restricted to upper parts of the ultramafic zone (15) and near the overlying gabbroic layered rocks (16). The largest base metal occurrence in the map-area is the York Harbour deposit at Blow-Me-Down. It has worked around the turn of the century and yielded about 100,000 tons of high-grade copper-zinc ore. Since that time a number of mining companies have held options on the property and surface diamond drilling and underground drilling from a newly constructed exploration adit outlined several additional massive sulphide lenses. The mineralized zones consist of massive to disseminated pyrite, chalcopyrite, and sphalerite in mafic volcanic rocks (18). Regionally the mineralized zones are at or near the base of the volcanic unit (18) and its contact with sheeted dykes (17). More locally the sulphide pods appear to occur along a complex contact between two volcanic units of similar appearance but of different magnetic susceptibility (Pelton and Hallof, 1971). The Jumbo Lode at Mt. St. Gregory and several nearby base metal mineral occurrences also occur regionally at or near the dyke (17)-volcanic rock (18) contact.

REFERENCES

Brückner, W.D.
1966: Stratigraphy and structure of west-central Newfoundland; in Poole, W.H. (editor), Guidebook - Geology of parts of Atlantic Provinces, Ann. Meeting; Geol. Assoc. Can. and Mineral. Assoc. Can., p. 137-151.

Church, W.R., and Stevens, R.K.
1971: Early Paleozoic ophiolite complexes of the Newfoundland Appalachians as Mantle-Oceanic crust sequences; J. Geophys. Res., v. 76, p. 1460-1466.

Kennedy, M.J.
1971: Structure and stratigraphy of the Fleur de Lys Supergroup in the Fleur de Lys area, Burlington Peninsula, Newfoundland; Proc. Geol. Assoc. Can., v. 24, p. 59-71.

Lilly, H.D.
1967: Some notes on stratigraphy and structural styles in central-west Newfoundland; Geol. Assoc. Can., Spec. Paper no. 4, p. 201-212.

Pelton, W.H., and Hallof, P.G.
1971: The applied potential method in the search for massive sulphides at York Harbour, Newfoundland; Presented at the AIME Annual Meeting, New York, N.Y., February, 1971.

Smith, C.H.
1958: Bay of Islands igneous complex, western Newfoundland; Geol. Surv. Can., Mem. 290, 132 p.

Stevens, R.K.
1965: Geology of the Humber Arm, west Newfoundland; M.Sc. Thesis, Memorial Univ. of Newfoundland.

1970: Cambro-Ordovician flysch sedimentation and tectonics in west Newfoundland and their possible bearing on a proto-Atlantic Ocean; Geol. Assoc. Can., Spec. Paper no. 7, p. 165-177.

Troelsen, J.C.
1947: Stratigraphy and structure of the Bonne Bay-Trout River area; Ph.D. dissertation, Yale Univ.

Upadhyay, H., Dewey, J.F., and Neale, E.R.W.
1971: The Betts Cove ophiolite complex, Newfoundland: Appalachian Oceanic crust and mantle; Proc. Geol. Assoc. Can., v. 24, p. 27-34.

Weaver, D.F.
1967: A geological interpretation of the Bouguer anomaly field of Newfoundland; Can. Dominion Observat., v. 35, no. 5, p. 233-251.

Williams, Harold
1963: Twillingate map-area, Newfoundland; Geol. Surv. Can., Paper 63-36, 30 p.

1971: Mafic - ultramafic complexes in western Newfoundland Appalachians and the evidence for their transportation; A review and interim report; Proc. Geol. Assoc. Can., v. 24, p. 9-25.

Williams, Harold, and Malpas, John
1972: Sheeted dykes and brecciated dyke rocks within transported igneous complexes, Bay of Islands, western Newfoundland; Can. J. Earth Sci., v. 9, p. 1216-1229.

Williams, Harold, Malpas, J.G., and Comeau, R.
1972: Bay of Islands map-area, Newfoundland; in Report of Activities April to October, 1971, Geol. Surv. Can., Paper 72-1, Pt. A, p. 14-17.