GEOLOGY OF THE ST. JOHN'S PENINSULA

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Introduction

Detailed bedrock mapping of the St. John's region was begun in 1975 as the first stage in the development of a pilot project in environmental geology. With detailed bedrock geological maps as a base, it is hoped that a comprehensive picture of all geological aspects of the physical environment can be built for use in regional and urban planning. This would include:

(1) the distribution and physical properties of the soils and rock units, including the identification of potential building materials, assessment of foundation and excavation factors, and acceptability for waste disposal;

(2) slope stability, including potential for land slides, rock falls, soil creep, etc.;

(3) groundwater distribution and flow;

(4) overburden thickness;

(5) identification of other geological hazards, including seismic instability, flooding hazards, etc.

The basic aim of the project would be to develop methods, techniques, and expertise which can be applied in similar surveys of urban and municipal areas throughout the Province.

For the present, the results of the bedrock mapping will be made available as open file maps at a scale to be decided but not smaller than 1:50,000.

Previous Work

The St. John's Peninsula has been mapped at the 1:250,000 scale by the Geological Survey of Canada (Rose, 1952). Faculty members and students at Memorial University have carried out detailed studies in many parts of the map-area.

General Geology

The map-area can be subdivided into two contrasting geological terranes: a western belt underlain by the predominantly volcanic Harbour Main Group, and an eastern belt underlain by sedimentary rocks of the Conception and

Cabot Groups. Except for the Cambrian sedimentary rocks in the Topsail-Foxtrap area, all the rocks in the map-area are of Precambrian (Hadrynian) age.

Harbour Main Group

The Harbour Main Group is divisible into four units (Units 1-4, Fig. 1). The numbers assigned to these units do not necessarily represent a true stratigraphic order, although Unit 1 is considered here to be the earliest phase of the volcanic rocks.

Unit 1 outcrops south of Pouch Cove and Topsail. It consists mainly of red to reddish-green, dark grey, and reddish-brown rhyolite flows, crystal tuffs, tuffs and agglomerates, which are intruded locally by diabase dykes. No sedimentary rocks have been observed. The rocks are generally massive and compact. although a poorly developed foliation is present in the western part of the unit, near Pouch Cove.

Unit 2 consists of dark purplish-green to green, pillowed and massive basalts which form a continuous belt extending from just south of Pouch Cove to Portugal Cove. The basalts contain discontinuous lenses of red and green tuffaceous sandstone, siltstone, and argillite. The rocks are massive to weakly foliated, except in local shear zones in the east (Fig. 1).

Unit 3 outcrops in a continuous belt along the east shore of Conception Bay from Topsail to Cape St. Francis. In the area between Portugal Cove and Pouch Cove, it consists of pillowed basaltic flows, andesitic to felsic tuffs, and agglomerates, interbedded with arkosic sandstone, green greywacke, siltstone, argillite and chert. Mafic and felsic dykes and sills are abundant. These rocks are generally separated from Units 1 and 2 by a northeast-trending valley, probably a fault zone. The tuffs and fine sediments are generally well foliated. In the area between Portugal Cove and Topsail recognizable pillowed lavas are rare in the unit, and arkosic sandstones are absent.

Rocks in the Topsail area, tentatively assigned to Unit 3, are poorly exposed. Many of the light green to green-black volcanic rocks appear to be lithologically similar to the felsic intrusives common in this unit to the north. Detailed mapping will be required to ascertain their intrusive or extrusive nature.

Unit 4 consists mainly of quartz diorite, gabbro, diabase, and rhyolite with very rare sedimentary rocks similar to those in Unit 3. Although the unit consists mainly of intrusive rocks, it is here included in the Harbour Main because of the difficulty of separating the intrusives from the sedimentary part of the sequence. Quartz diorite occurs as xenoliths in diabase or gabbro while some rhyolitic dykes contain inclusions of earlier diabase. Later diabase dykes cut all these rocks.

The volcanogenic rocks in the area between Bauline and Cape St. Francis generally appear to form a west-dipping sequence, although pillow lavas (Unit 2) to the east are overlain by east-dipping sediments. South

LEGEND

PRECAMBRIAN

[13] Gabbro and diabase

[12] Rhyolite intrusives

[11] Holyrood batholith

CAMBRIAN

[10] Red, green, grey to grey-black sandstone, shale, and limestone; minor basal conglomerate

PRECAMBRIAN

CABOT GROUP (7-9)

[9] BLACKHEAD FORMATION: Red and green-grey arkosic sandstone, siltstone and shale

[8] SIGNAL HILL FORMATION: 8a, green-grey sandstone and argillite; 8b, red sandstone and argillite; 8c, red pebble conglomerate, sandstone and argillite

[7] ST. JOHN'S FORMATION: Grey to black sandstone, siltstone, and shale

CONCEPTION GROUP (5-6)

[6] Green-grey, red, thin- to medium-bedded greywacke, siltstone, shale, and chert with minor airfall crystal tuff and tuff; 6a, thick- to medium-bedded greywacke, siltstone, argillite, and chert

[5] Green-grey laminated to massive arkosic sandstone with intercalated green argillite and rare pillowed basalt; 5a, tilloid

HARBOUR MAIN GROUP (1-4)

[4] Rhyolitic, quartz-dioritic and gabbroic to diabasic intrusives, rare mafic volcanic and sedimentary rocks

[3] Interbedded basaltic pillowed lava, felsic to intermediate crystal tuff, tuff, agglomerate, massive arkosic sandstone, greywacke, argillite and chert

[2] Basaltic pillowed lava, minor red and green sandstone, siltstone, argillite, and chert

[1] Red to grey-black rhyolitic flows, crystal tuff, and agglomerate

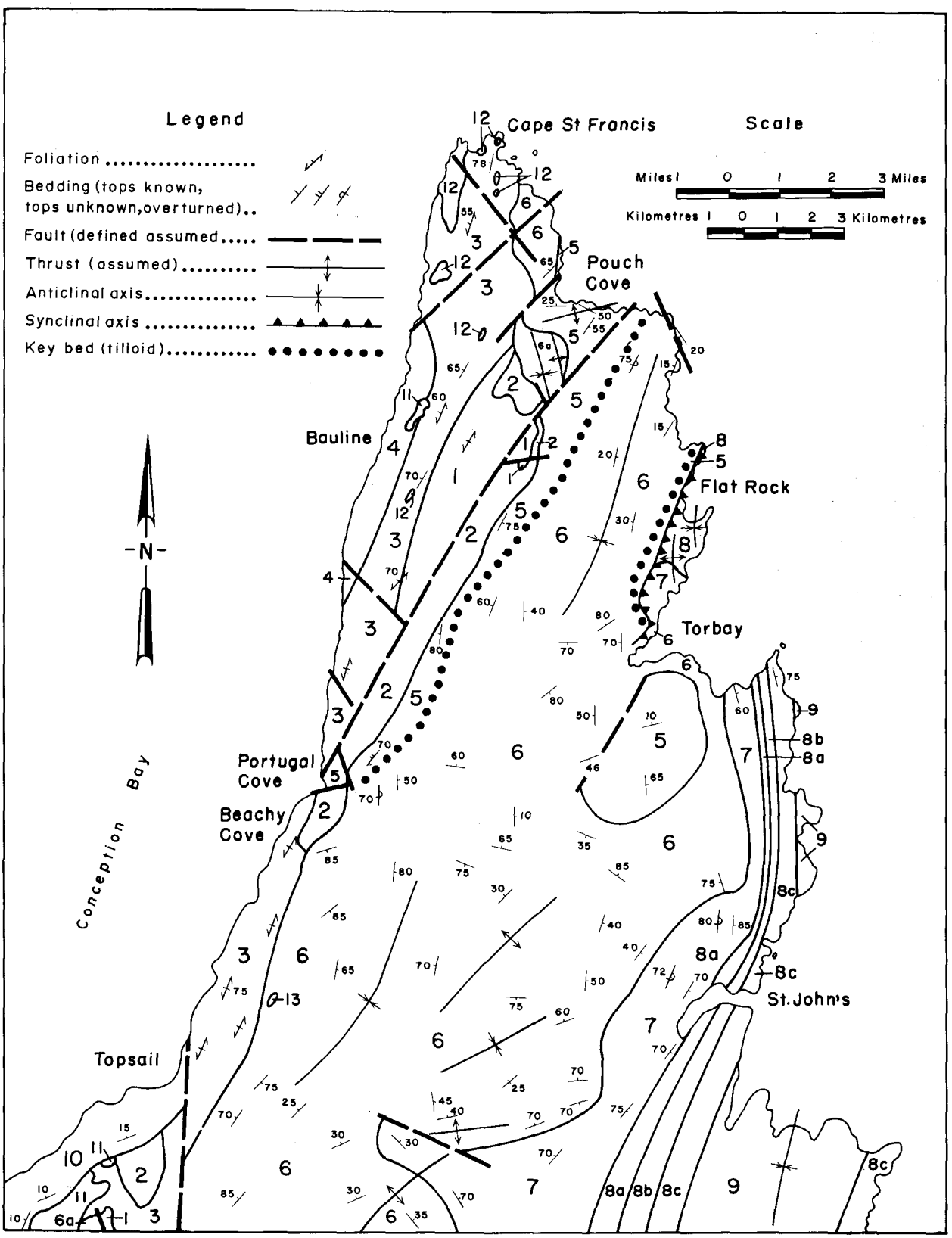

Fig. 1 - Geological map of the St. John's Peninsula

of Bauline, the stratigraphy is uncertain because of the lack of reliable criteria to indicate the stratigraphic tops of individual beds. Detailed mapping is required to resolve the stratigraphy of these units.

Conception Group

The Conception Group is divisible into two units; a lower unit of arkosic sandstone (Unit 5) and an upper siliceous turbidite sequence (Unit 6).

Unit 5 consists of laminated to thinly bedded, light to dark grey arkosic sandstones and greywackes with subordinate intercalated green argillites. Red equivalents of these rocks are developed locally in the Portugal Cove area, west of the Harbour Main volcanics. Small scale cross laminations in this unit indicate a general paleocurrent direction from north to south.

Several beds of tilloids (5a) occur near or at the top of Unit 5. The tilloids are characterized by subangular to rounded pebbles, cobbles and boulders, up to 0.6 m. in diameter, embedded in a green to purplish green sandy matrix. The pebbles consist of quartzite, diabase, gabbro, mafic volcanics, rhyolite, argillite, greywackes, and granite. Scattered pebbles are also found in the red and grey arkosic sandstone in the Portugal Cove area and in some of the tuff beds of the Harbour Main volcanics. These rocks have been interpreted as Precambrian tillite or glaciomarine sediments (Brueckner and Anderson, 1972). The tilloids are the only important key beds in the area.

In Shoe Cove Brook pillowed basaltic flows are interbedded with the arkosic sandstones, indicating that deposition of the Conception Group may have proceeded contemporaneously with Harbour Main volcanism.

In the Flat Rock and Pouch Cove areas, arkosic sandstones of Unit 5 are conformably overlain by cherty sediments through a narrow transition zone. The arkosic sandstones do not occur in the area south of Portugal Cove where the Harbour Main volcanics are overlain directly by cherty sediments of Unit 6.

Unit 6 consists mainly of green to green-grey greywacke, siltstone, argillite, and chert with minor amounts of reworked tuff and crystal tuff. In general, the basal part of the unit is characterized by a sequence of thick-bedded, coarse- to medium-grained greywackes with minor argillite and chert. Red and green thick-bedded greywacke, argillite and chert in the Topsail and Pouch Cove areas are tentatively treated as the basal part of this unit, although the contacts with surrounding rocks at these localities have not been observed. In both localities, the sediments strike nearly perpendicular to the trend of Harbour Main volcanics, indicating possible fault contact.

The upper part of Unit 6, consisting of red, purple and green siltstones, and argillites with relatively minor greywacke and tuffs, is overlain by the St. John's Formation through a transition zone. These rocks are exposed at Torbay, and in and adjacent to the City of St. John's.

Although they appear to form a mappable unit, they are not separated from the remainder of Unit 6 here because of the scarcity of outcrop and intricate structures in the inland area.

Graded bedding, convolute laminations, and relatively rare cross laminations are the most important sedimentary structures in Unit 6. Invariably these structures indicate a paleocurrent direction from north to south.

Cabot Group

The Cabot Group consists, in ascending stratigraphic order, of the St. John's, Signal Hill, and Blackhead Formations.

The St. John's Formation (Unit 7) conformably overlies the Conception Group. It is divisible into two members. The lower member consists of a basal transition zone overlain by a sequence of thin- to thick-bedded, laminated black shales with intercalated calcareous sandstones. The upper member consists of thinly interbedded black shales and siltstone or fine-grained sandstone with some thick beds of sandstone near the top. In contrast to the regular parallel bedding in the lower member, erosional channelling, cross-bedding and ripple marks are common in the upper member. The basal part of the upper member contains rounded to elliptical markings which were named Aspidella terranovica (Murray and Howley, 1881). The origin of these markings has been a controversial subject for many years; they have been described as fossils (Billings, 1872) and as inorganic sedimentary structures (Hsu, 1972).

The Signal Hill Formation (Unit 8) conformably overlies the St. John's Formation and is divisible into three members: a lower member (8a) consisting of green-grey, fine- to medium-grained, thick-bedded sandstone with green argillite and rare air fall tuffs; a middle member (8b) of red, medium- to coarse-grained, thick-bedded sandstone with minor red argillites; and an upper member (8c) of red pebble conglomerate with minor red sandstone and argillite. Crossbedding and ripple marks, both large and small-scale, are the predominant sedimentary structures. These structures, and the imbrication of the pebbles in the red conglomerate, indicate a general paleocurrent from north to south. The Signal Hill Formation is conformably overlain by the Blackhead Formation.

The Blackhead Formation (Unit 9) also consists of three members: a lower member of interbedded red arkosic sandstone, red and green siltstone, and shale; a middle member of green to green-grey, arkosic sandstone with minor green shale; and an upper member of red sandstone with red siltstone and shale. Dark red breccias overlying the red conglomerate of the Signal Hill Formation at Flat Rock are considered to be equivalent to the Blackhead Formation. The predominant sedimentary structures are large-to small-scale crossbedding, ripple marks, and thixotropic soft-sediment deformation, indicating paleocurrents from north to south.

Cambrian

Cambrian sedimentary rocks (Unit 10) occur in the Topsail area where

they overlie the Harbour Main Group and the Holyrood Granite with angular unconformity. The rocks are also brought into contact with the Harbour Main volcanics by the Topsail fault.

The Cambrian rocks consist of a basal conglomerate, followed by red, green and black shales, thin quartzitic sandstones and rare grey limestone beds. These rocks and their fossils have been well described by Howell (1926) and Hutchinson (1962).

Intrusive Rocks

Medium- to coarse-grained granite (Unit 11) of the Holyrood Batholith is exposed in the Topsail area, west of the Topsail fault. The granite is pinkish white and is composed mainly of quartz, orthoclase, and plagioclase in variable proportions with subordinate biotite and chlorite. Various amounts of mafic inclusions or xenoliths are present locally, particularly near the intrusive contact with the volcanic rocks of the Harbour Main Group. The granites are unconformably overlain by Cambrian sediments.

Several small bodies of quartz diorite occur in the area northeast of Bauline, intruding and metamorphosing the volcaniclastic sediments of the Harbour Main Group. The relationship of these bodies to granite in the Topsail area was not established.

Light green-grey to dark grey intrusive bodies (Unit 12) of sodic rhyolite (Papezik, 1970) with small, white plagioclase phenocrysts are common in Unit 3 and 4 of the Harbour Main Group. These rocks are generally massive but may be flow-banded and brecciated near the intrusive contact with country rocks. Their relationship with other intrusive rocks is uncertain; some rhyolites are found to contain diabasic inclusions but are in turn cut by diabase dykes.

Small gabbro intrusives (Unit 13) are found southeast of Beachy Cove and in the Cape St. Francis area, intruding the sediments of the Conception Group and the volcanic rocks of the Harbour Main Group.

Diabase dykes and sills are especially abundant in Unit 3 and 4 of the Harbour Main Group, but rare in the lower part of the Conception Group (Unit 5). There are at least two ages of diabase in the map area. The earlier diabase weathers whitish brown and is porphyritic with large plagioclase and rare pyroxene phenocrysts. The later diabase is generally fine-grained and weathers dark brown. The later diabase invariably has chilled margins against the porphyritic diabase. The earlier diabase may contain lenses of gabbro, and also contains xenoliths of quartz diorite.

Structural Geology

Major folds in the map-area include north-north-east to north-east trending folds in the Conception and Cabot Groups. The fold axes have been deflected toward the west in the southern part of the map sheet. Tight folding occurs in the St. John's Formation and the Conception Group, particularly in Units 5 and 6 to the south of Pouch Cove.

Major faults include several north-east and north-north-east trending strike faults and south-east trending normal faults. The most significant of these is probably the Topsail fault at the southwestern corner of the map sheet, where Cambrian sediments are brought into contact with the Precambrian Harbour Main volcanics. The Topsail fault is also considered to extend northward beneath Conception Bay and may be responsible for the deformation of the Harbour Main volcanics along the east side of the Bay. Several high-angle west-dipping thrust faults occur along the coast in the area between Torbay and Cape St. Francis. At Flat Rock the Conception Group is thrust over the Cabot Group.

Economic Geology

No mineral showings of economic interest were found in the map-area.

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