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A REINTERPRETATION OF THE GEOLOGY OF PARTS OF THE HERMITAGE PENINSULA, SOUTHWESTERN AVALON ZONE, NEWFOUNDLAND

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ABSTRACT

The late Precambrian geological development of the Hermitage Peninsula (Newfoundland Avalon Zone) has been perceived, until now, to record only two principal tectonic events, viz. 1) the widespread deposition of volcanic and sedimentary rocks (Connaigre Bay Group), and 2) the subsequent emplacement, into this succession, of gabbroic and granitic plutons (Hermitage Bay Complex).

The Connaigre Bay Group, previously defined as comprising four conformable formations, is now viewed to contain two successions of significantly different age and tectonic history, separated by an erosional unconformity. The older of these corresponds to the Tickle Point Formation (sensu *O'Driscoll and Strong, 1979), a submarine and subaerial sequence of corundum-normative, locally garnet-bearing, felsic volcanic rocks. This succession was intruded by a complex of gabbroic and granitic plutonic rocks (Furby's Cove intrusive suite) that includes a bimodal dyke swarm. The plutonic and adjacent country rocks were subsequently unroofed, and served as basement to a volcano-sedimentary cover, represented by the Connaigre Bay Group, as redefined herein. Within the study area, this group includes a basal, dominantly sedimentary unit and an overlying, dominantly mafic volcanic unit,* viz. *the Sam Head and Doughball Point formations, respectively (cf. O'Driscoll and Strong, 1979). A younger series of diorites and gabbros (Grole intrusive suite) crosscuts the older intrusive rocks, the basal Connaigre Bay Group unconformity, and the overlying sedimentary and volcanic cover rocks. Field relationships clearly illustrate the protracted geological history of the region and establish the complex and composite nature of the Newfoundland Avalon Zone in the late Precambrian.*

The late Precambrian stratified rocks host two significant volcanogenic sulphide showings and several base-metal-poor, massive pyrite occurrences. Almost all of these are found within a limited stratigraphic interval at or near the top of the Tickle Point Formation.

INTRODUCTION

PURPOSE AND SCOPE

Mapping and integrated U–Pb geochronological investigations on the Hermitage Peninsula are being carried out by the authors as part of a larger undertaking to understand the nature, relationship and timing of late Precambrian magmatic and mineralizing events in the southwestern Avalon Zone of the Newfoundland Appalachians (cf. Williams, 1979). This work has significant implications for regional correlation of stratigraphic units and tectonic events across the entire Avalon Zone.

Field work to date has focussed on determining both the internal and external relationships of the Hermitage Bay Complex (*sensu* Colman-Sadd *et al.*, 1979) and the Connaigre Bay Group (*sensu* O'Driscoll and Strong, 1979). Sampling of these and other stratified and plutonic units on the Connaigre Peninsula and northern Fortune Bay for geochronological and related isotopic studies has been completed and the main results of this work are to be published at a later date. Presented below is a summary of our new interpretation of the tectonic history of part of the Hermitage Peninsula. This combines the results of previous geological mapping (Greene and O'Driscoll, 1976; O'Driscoll, 1977) with our geochronological results (R. Tucker, unpublished data) and follow-up mapping carried out by S. O'Brien and C. O'Driscoll in June, 1991.

REGIONAL GEOLOGICAL SETTING

The Connaigre Peninsula (Figure 1) embodies the southwestern extremity of the Avalon Zone, the easternmost

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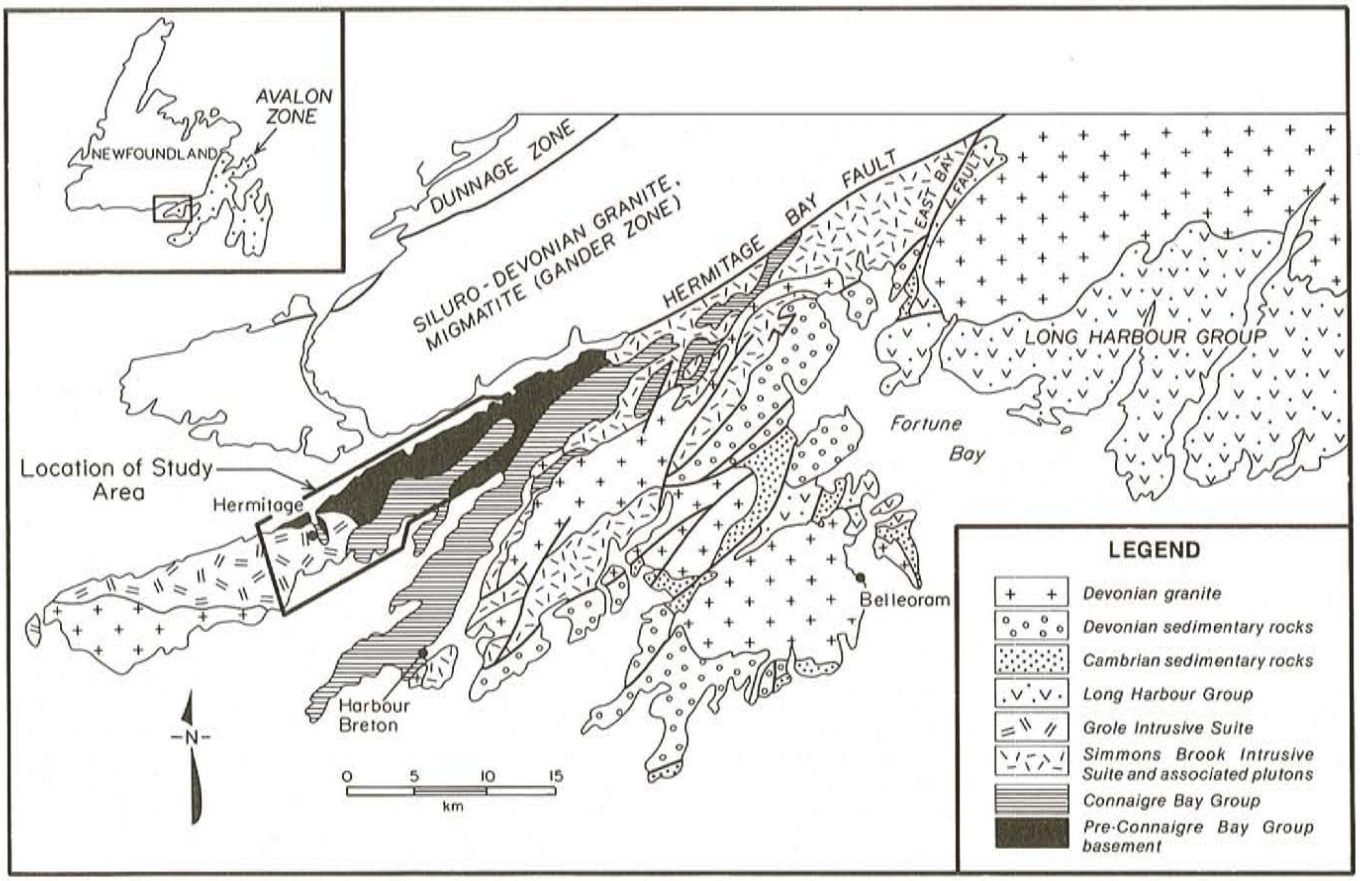

Figure 1. *Generalized geological map of the Avalonian rocks of northwest Fortune Bay, southern Newfoundland.*

of Williams' (1979) tectonostratigraphic divisions of the Newfoundland Appalachians. The Hermitage Bay Fault (Widmer, 1950; Blackwood and O'Driscoll, 1976), a northeast-trending, brittle structure, extends into the offshore under Hermitage Bay (Figure 1), and separates late Precambrian rocks of the Avalon Zone in the southeast from an adjacent lower Paleozoic amphibolite-facies, granite-gneiss terrane in the northwest (Gander and Dunnage zones; Williams, 1979; Colman-Sadd *et al.*, 1990).

The stratified rocks of that part of the Connaigre Peninsula west of the East Bay Fault (Williams, 1971; Figure 1), and more specifically, west of the Simmons Brook Batholith (Williams, 1971) have, in previous studies, been viewed as a single lithostratigraphic entity of undetermined age. Widmer (1950) first mapped these low-grade volcanic and sedimentary rocks and proposed that they be named Connaigre Bay volcanics. Although Widmer (1950) discussed the possibility of the volcanic rocks being Precambrian, he assigned them to the Ordovician on the basis of their similarity to the nearby Long Harbour Series, which White (1939) considered to be of Ordovician age. Greene and O'Driscoll (1976) and O'Driscoll (1977) systematically mapped the Connaigre Bay volcanics and elevated the succession to group status, subdividing it into four formations (see also, O'Driscoll and Strong, 1979; Colman-Sadd *et al.*, 1979). Greene and O'Driscoll (1976) concurred with Widmer's earlier correlation of Long Harbour and Connaigre Bay rocks, but assigned the latter a late Precambrian age, following Williams' (1971) reinterpretation of the age and stratigraphy of the Long Harbour Group.

The Connaigre Bay Group has been viewed as a conformable lithostratigraphic sequence, the base of which is not exposed (cf. O'Driscoll and Strong, 1979). Its stratigraphic subdivisions, as defined by O'Driscoll and Strong (1979), are (in ascending order) the Tickle Point, Great Island, Doughball Point and Down's Point formations (Table 1). Because of nomenclatural duplication, Colman-Sadd *et al.* (1979) subsequently abandoned the name Great Island, replacing it with Sam Head Formation. These units comprise a succession, in excess of 2 km thick, which consists of a lowermost felsic volcanic sequence, overlain by shallow marine tuffaceous sedimentary rocks, which are in turn succeeded by mafic volcanic rocks (O'Driscoll, 1977; O'Driscoll and Strong, 1979). The succession is capped by terrestrial, red to grey clastic rocks.

The Connaigre Bay Group was viewed by all previous workers to be bounded by either faults or intrusive contacts. All intrusive rocks on the Hermitage Peninsula were thought to postdate the deposition of its youngest strata. O'Driscoll and Strong (1979) placed these intrusive rocks into two separate groupings, characterized by distinct ages, petrology and geochemistry. The older group of intrusions were

Table 1. Table of formations for part of the Hermitage Peninsula, comparing present and previous views of the area's geological history

O'Driscoll and Strong, 1979	*This report*
ORDOVICIAN OR EARLIER	**LATE PRECAMBRIAN**
HERMITAGE COMPLEX	GROLE INTRUSIVE SUITE
silicic and mafic dykes	(unseparated)
-----intrusive contact-----	*----------intrusive contact----------*
Furby's Cove Granite	SIMMONS BROOK INTRUSIVE SUITE
-----intrusive contact-----	(unseparated)
Grole Diorite	*----------intrusive contact----------*
----------intrusive contact ----------	CONNAIGRE BAY GROUP
PRECAMBRIAN	Down's Point Formation
CONNAIGRE BAY GROUP	*-----conformable contact-----*
Downs Point Formation	Doughball Point Formation
-----conformable contact-----	*-----conformable contact-----*
Doughball Point Formation	Sam Head Formation
-----conformable contact-----	*----------unconformity----------*
Great Island Formation	FURBY'S COVE INTRUSIVE SUITE
-----conformable contact-----	Hermitage dykes
Tickle Point Formation	*-----intrusive contact-----*
----------base not exposed----------	unnamed granite unit
	-----intrusive contact-----
	unnamed gabbro unit
	----------intrusive contact----------
	TICKLE POINT FORMATION
	----------base not exposed----------

interpreted to be Precambrian in age and comagmatic with Connaigre Bay volcanism; these are the Hermitage Bay Complex (Colman-Sadd *et al.*, 1979; former Hermitage Complex of Greene and O'Driscoll, 1976) and the Straddling Granite (O'Driscoll, 1977; O'Driscoll and Strong, 1979). These plutons were correlated with the Simmons Brook Batholith (Williams, 1971), which intrudes the Connaigre Bay Group east of the Hermitage Peninsula, and lies nonconformably below Devonian strata (Williams, 1971). The younger intrusions locally crosscut lower and mid-Paleozoic strata and postdate the regional deformation of both the Precambrian and Paleozoic rocks. This younger suite consists of the Belleoram, Harbour Breton, Ackley and Pass Island granites (Strong *et al.*, 1974), the last of which is exposed at the southwestern tip of the Hermitage Peninsula. The Pass Island Granite intrudes rocks assigned by previous workers to the Hermitage Bay Complex.

THE PRESENT STUDY

Zircon geochronology by Swinden and Hunt (1991) first challenged previous correlations of the Connaigre Bay Group with other late Precambrian volcanic units of the western Avalon Zone (cf. Colman-Sadd *et al.*, 1990). Subsequent investigation by ourselves (R. Tucker, unpublished data), likewise challenged earlier correlations and further highlighted the need to reassess the nature of the Connaigre Bay Group and its contacts.

Critical, newly discovered and previously known field relationships, supported by geochronological data,

demonstrate that rocks of significantly different age and tectonothermal history have, in the past, been erroneously included in a single lithostratigraphic unit, the Connaigre Bay Group. Furthermore, our data demonstrates that plutonic rocks adjacent to the Connaigre Bay Group, which were previously assigned to a single intrusive complex (Hermitage Bay Complex), are divisible into intrusions that either predate or postdate that group's deposition. Finally, additional evidence (R. Tucker, unpublished data) supports the existence of a third separate suite of late Precambrian plutonic rocks (Simmons Brook Batholith of Williams, 1971), which is coeval with the deposition of the Connaigre Bay Group.

REVISIONS AND REDEFINITIONS

On the basis of data summarized below, the Connaigre Bay Group (Table 1) is redefined to exclude the Tickle Point Formation. The newly defined group is herein viewed to consist of (in ascending order) the Sam Head Formation, the Doughball Point Formation, and the Down's Point Formation. The base of the Connaigre Bay Group is now drawn at a newly recognized unconformity at the base of the Sam Head Formation; the stratigraphic top of the group is not observed in the study area. The nature and position of the boundaries between the Sam Head, Doughball Point and Down's Point formations remain largely the same as previously defined (cf. O'Driscoll and Strong, 1979; Colman-Sadd *et al.*, 1979).

The name Hermitage Bay Complex is abandoned, for reasons described below. A new informal name, Furby's Cove intrusive suite, is used to denote those intrusive rocks beneath the sub-Connaigre Bay Group unconformity, specifically: 1) those parts of the former Hermitage Bay Complex (cf. Colman-Sadd *et al.*, 1979) intruded by the former Furby's Cove Granite of O'Driscoll and Strong (1979); 2) the old Furby's Cove Granite; and 3) the bimodal dyke swarm (Hermitage dykes) that intrudes the above rocks. Except for the dykes, the individual components of the suite remain unnamed at present.

The name Simmons Brook intrusive suite is suggested to replace Simmons Brook Batholith (Williams, 1971). This new, informally proposed name refers to the largely pink to grey, medium- to coarse-grained, granitic to tonalitic plutonic rocks of late Precambrian age on the Connaigre Peninsula that are coeval with or intrusive into parts of the Connaigre Bay Group. These plutons are intruded by members of the Grole intrusive suite (see below).

The name Grole Diorite, used by O'Driscoll and Strong (1979) to denote the mafic portion of their Hermitage Complex, is dropped, for reasons outlined below. The new, informally proposed name, Grole intrusive suite, refers to the quartz diorites, diorites, gabbros and related rocks of late Precambrian age that intrude the Connaigre Bay Group, the Simmons Brook intrusive suite and adjacent older units of the Hermitage Peninsula.

TICKLE POINT FORMATION

The oldest rocks on the Hermitage Peninsula (Figure 2) occur within this stratigraphic unit. The formation, the base of which is unexposed, is principally composed of pink to purple and green felsic volcanic rocks that have a buff, and in many cases, rusty colour on weathered surfaces. Massive, and in many places featureless, rhyolite flows containing disseminated pyrite are its most common lithological component; occurring in lesser proportions are flow-banded variants and crystal- and crystal-lithic tuffs of felsic composition. A distinctive petrographic feature is the presence of rare garnet microphenocrysts in some rhyolites (O'Driscoll, 1977). The Tickle Point Formation also contains basalt and andesite flows interstratified with the felsic volcanic rocks.

O'Driscoll (1977) defined the Tickle Point Formation as the basal stratigraphic division of the Connaigre Bay Group, noting that its upper contact with overlying sedimentary rocks was locally marked by conglomerate. In the absence of evidence to the contrary, this upper contact was assumed to be conformable. Our new mapping indicates, however, that the external contacts of the Tickle Point Formation are not only tectonic and intrusive but are also unconformable, rather than conformable. The relationship of the Tickle Point Formation to surrounding rocks (see below), in addition to other regional relationships outlined elsewhere in this account, necessitate the removal of the Tickle Point from the Connaigre Bay Group. Rhyolite of the Tickle Point Formation has yielded zircons that are dated at 682.8 $\pm$ 1.6 Ma (Swinden and Hunt, 1991).

FURBY'S COVE INTRUSIVE SUITE

As originally defined by Greene and O'Driscoll (1976), the Hermitage Complex incorporates the gabbroic to granitic rocks that occupy the southwestern half of the Hermitage Peninsula, northeast of the Pass Island Granite. The complex was divided by O'Driscoll (1977) and O'Driscoll and Strong (1979) into the Grole Diorite and Furby's Cove Granite. Colman-Sadd *et al.* (1979) replaced the name Hermitage Complex with Hermitage Bay Complex, retaining the original nomenclature of its subdivisions.

Our recent investigations reiterate earlier observations that the granitic and gabbroic to dioritic phases previously included within the Hermitage Bay Complex are intrusive into the Connaigre Bay Group as defined by O'Driscoll and Strong (1979). However, our work indicates at least three separate intrusive bodies occur within the boundaries of the former Hermitage Bay Complex; two of these are temporally distinct, unrelated plutonic complexes. We employ the new, informal name Furby's Cove intrusive suite to denote those intrusions within the study area that predate the deposition of the Connaigre Bay Group, namely: 1) the granitic body previously referred to as Furby's Cove Granite by O'Driscoll and Strong (1979), 2) the unnamed mafic rocks of the former Hermitage Bay Complex that are intruded by this granite, and 3) a bimodal dyke swarm (Hermitage dykes) sited in 1) and 2) above. All are viewed to be genetically related.

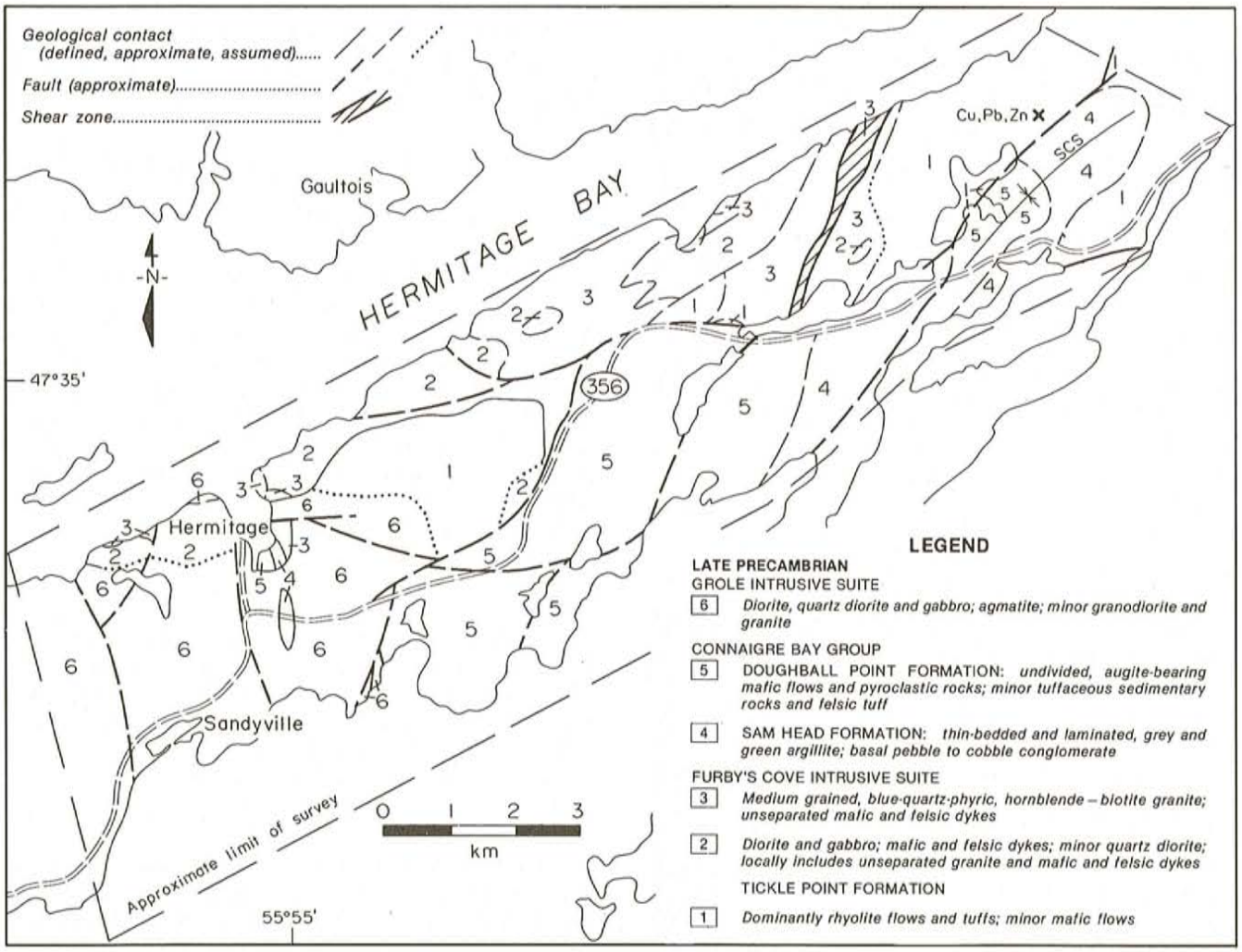

Figure 2. *Geological map of part of the Hermitage Peninsula west of Connaigre Bay. X–Frenchman Head showing, SCS–Salmonier Cove syncline.*

UNNAMED GABBRO COMPONENT

The gabbroic phase of the Furby's Cove intrusive suite predates rocks of the Connaigre Bay Group, as presently defined, and postdates the Tickle Point Formation. It was mapped by Greene and O'Driscoll (1976) and O'Driscoll (1977) and included with other mafic intrusions (now found to be younger) in their Hermitage Complex. The rocks are best exposed in coastal sections at and between Furby's Cove and Hermitage. They consist of variably altered, medium-grained, green to dark-grey gabbro to quartz diorite. Mafic minerals consist of subhedral chloritized amphibole and pyroxene. Plagioclase occurs in equal amounts as the mafic minerals and is usually cloudy and corroded. Blue quartz is present where the gabbros and granites are in contact and probably indicates a mixing zone between the two rock types.

UNNAMED GRANITE COMPONENT

The granite phase of the Furby's Cove intrusive suite, first delineated in part by Widmer (1950), was subsequently mapped and named Furby's Cove Granite by O'Driscoll (1977). It consists of a series of narrow sheets and larger bosses of homogeneous, pink to white, equigranular, blue-quartz-bearing granite. It intrudes the older mafic plutonic rocks of the complex and is intimately associated with them. Locally, some field evidence exists for commingling of both granitic and mafic magmas. The granite hosts a major ductile shear zone in the northern part of the study area (Plate 1). There the granite separates the older gabbroic phase of the Furbys Cove intrusive suite from the Tickle Point Formation.

HERMITAGE DYKES

A bimodal dyke swarm, informally referred to here as the Hermitage dykes, forms an integral part of the Furby's Cove intrusive suite. The dykes, which number in the hundreds, occur on a scale of a few centimetres to a decametre in width, have either rectilinear or irregular boundaries, and are diabasic and granitic in composition (Plate 2). The felsite and blue-quartz-phyric dykes are comparable to the fine-grained marginal phases of the granitic component of the

Plate 1. *Mylonitic granite of the Furby's Cove intrusive suite within ductile shear zone, south shore of Hermitage Bay.*

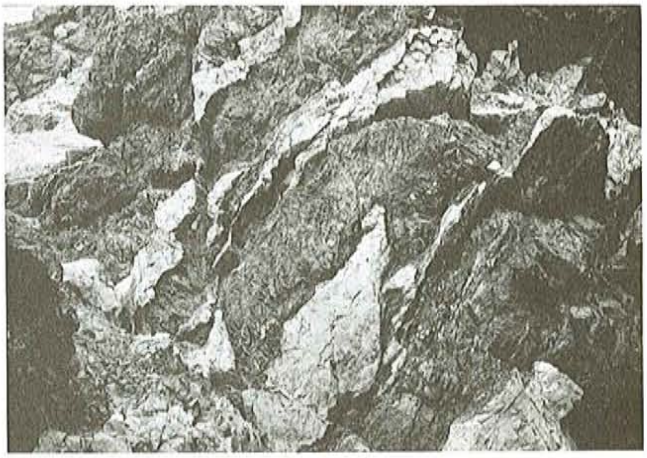

Plate 2. *Tectonized Hermitage dykes, Hermitage Harbour. Field of view approximately 10 m.*

intrusive suite. The dykes occur in both the gabbroic and the granitic components of the suite and, significantly, are sited in a zone parallel to the Hermitage Bay Fault. Similar dykes elsewhere on the Hermitage Peninsula, away from the main dyke swarm, are reported to contain garnet microphenocrysts (O'Driscoll, 1977). Some of the dyke material occurs as detritus in conglomerates nonconformably overlying the Furby's Cove intrusive suite. Other dykes in this zone, however, may be related to younger magmatic events, coeval with deposition of the Doughball Point Formation and emplacement of the Grole intrusive suite.

The external boundaries of the Furby's Cove intrusive suite are either intrusive or unconformable contacts (Figure 2). Each of the three components of the suite intrude the Tickle Point Formation. A newly documented, erosional unconformity locally separates the granite component of the suite from overlying sedimentary and succeeding volcanic rocks. These stratified rocks, dated as late Precambrian (R. Tucker, unpublished data), comprise the Sam Head and Doughball Point formations of O'Driscoll and Strong (1979), respectively. Those parts of the former Hermitage Bay Complex that intrude these two formations are now known to constitute a younger plutonic suite, separate from and intrusive into the Furby's Cove intrusive suite, as defined herein.

CONNAIGRE BAY GROUP

SAM HEAD FORMATION

The name Sam Head Formation was proposed by Colman-Sadd *et al.* (1979) to denote the succession of sedimentary rocks within the Connaigre Bay Group that overlies the Tickle Point Formation. Within the boundaries of the present study area (Figure 2), these rocks occur in the Salmonier Cove syncline (O'Driscoll, 1977) and as large enclaves within diorite in and around the community of Hermitage. In both areas, these sedimentary rocks are conformably overlain by mafic volcanic rocks of the Doughball Point Formation (O'Driscoll, 1977).

The characteristic rock types of the Sam Head Formation, within the study area, are homogeneous, grey and green, laminated argillites and sandstones containing rare limestone lenses (O'Driscoll, 1977). These may be graded, crossbedded, rippled or massive. Polymictic conglomerates are, in places, developed either at or near the base of the formation. Locally, such as in some exposures in the Salmonier Cove syncline, the conglomerates are red and purple.

The Sam Head Formation unconformably overlies both the granitic phase of the Furby's Cove intrusive suite and the Tickle Point Formation. On the southeast shore of Hermitage Harbour, a thin succession of Sam Head Formation is preserved as an enclave in diorite of the Grole intrusive suite. The sedimentary rocks lie in depositional contact with granite of the Furby's Cove intrusive suite, and are overlain by basalt of the Doughball Point Formation. The basal conglomerate of the Sam Head Formation contains rounded to subangular blocks of the directly underlying granite (Plate 3). In addition

Plate 3. *Basal conglomerate of the Connaigre Bay Group, containing clasts of granite from the underlying Furby's Cove intrusive suite, Hermitage Harbour.*

to granite detritus, the basal conglomerate also includes clasts of diabase and felsite, presumably derived from the bimodal dyke swarm that forms part of the Furby's Cove intrusive suite in the immediate area. The surface of the unconformity has been affected by minor brittle faulting and is the site of intrusion of a late plagioclase-porphyry dyke.

The base of the Sam Head Formation in the Salmonier Cove Syncline is marked by coarse-grained conglomerate, which, in the core of the structure, lies directly upon rhyolite of the Tickle Point Formation. Angular discordance has not been documented at the contact at this locality, because bedding orientations are not developed in the underlying volcanic rocks. The relationships between the Sam Head Formation and granite of the Furby's Cove intrusive suite (which intrudes the Tickle Point Formation), indicate that the Sam Head–Tickle Point depositional contact represents a significant tectonic break.

DOUGHBALL POINT FORMATION

The name Doughball Point Formation (O'Driscoll, 1977; O'Driscoll and Strong, 1979) denotes the predominantly volcanic succession of chiefly basaltic composition within the Connaigre Bay Group that overlies the sedimentary rocks of the Sam Head Formation. O'Driscoll and Strong's (1979) formational definition and boundaries are retained here.

The Doughball Point Formation is characterized by grey and green, mafic flows and pyroclastic rocks but also contains a minor component of felsic volcanic material (O'Driscoll, 1977). Both the massive flows and the pyroclastic rocks, which are dominantly agglomerates, are of basaltic to andesitic composition and commonly pyroxene-phyric.

Mafic volcanic rocks of the Doughball Point Formation conformably overlie the Sam Head Formation in the Salmonier Cove syncline. The contact is well preserved south of the map area at Great Island (O'Driscoll, 1977). Augite-porphyritic mafic dykes that intrude the Sam Head Formation are compositionally similar to the overlying Doughball Point Formation flows and are viewed as feeders to the flows (O'Driscoll, 1977). Mafic hornfels is widely developed in the Doughball Point Formation adjacent to the Grole intrusive suite. Contact migmatites are locally developed at this boundary (Plate 4; O'Driscoll, 1977).

SIMMONS BROOK INTRUSIVE SUITE

The Simmons Brook intrusive suite is a new, informal name, designating the granitic and tonalitic rocks that intrude the Connaigre Bay Group and older sequences, and is overlain nonconformably by Devonian strata (cf. Williams, 1971). The suite lies east of the Hermitage Peninsula study area (Figure 1), but it is interpreted to be coeval with volcanic rocks of the Connaigre Bay Group in that area. In several places, intrusive rocks of mafic composition are spatially associated with felsic phases of the Simmons Brook intrusive suite. Some of these are related to the younger Grole intrusive suite, but others may be comagmatic with the Simmons Brook felsic

Plate 4. *Migmatite developed at the contact of the Grole intrusive suite and the Connaigre Bay Group, roadcut on Route 356 east of Hermitage.*

rocks. Still others may be mafic parts of the Furby's Cove intrusive suite.

The various plutonic members of the Simmons Brook intrusive suite have not been defined fully, and the principal batholith comprising this suite (Williams, 1971; Greene and O'Driscoll, 1976) was not studied during the course of the 1991 field investigations. Our present understanding of the regional geological setting of these rocks is based on previous geological mapping (Williams, 1971; Greene and O'Driscoll, 1976), coupled with lithogeochemical and U–Pb geochronological data (O'Driscoll, 1977; R. Tucker, unpublished data).

GROLE INTRUSIVE SUITE

The Grole intrusive suite is an informal name designating the gabbroic, dioritic and related plutonic rocks of the former Hermitage Bay Complex that are intrusive into Sam Head and Doughball Point formations of the Connaigre Bay Group. Its component parts are unseparated at present, and are not identified on Figure 2.

The suite consists of black and dark-green to grey, medium- to coarse-grained gabbro, diorite, quartz diorite and granodiorite. Coarse-grained, black gabbro consists of large crystals of euhedral, largely unaltered, amphibole, pyroxene, biotite and plagioclase. Medium- to fine-grained phases are mineralogically similar. The quartz diorite contains up to 10 percent quartz.

Lithologically, these younger mafic rocks differ from the older Furby's Cove intrusive suite in that they are relatively homogeneous and unaltered, contain significantly fewer dykes, and are associated with the distinctive, coarse-grained, black gabbro phase. Diorite and quartz diorite that together form the chief component of the younger complex are, in many localities, net-veined by granite, which locally coalesces to form small bosses. In at least two localities, the younger diorite displays an incipient, centimetre-scale, gneissic

banding. The banding is interpreted to be the result of intrusion into actively deforming zones within and at the margins of the diorite body. The Grole intrusive suite intrudes the Tickle Point Formation, the Furby's Cove intrusive suite, and the stratigraphically higher Sam Head and Doughball Point formations (Greene and O'Driscoll, 1976; Figure 2), as well as the intervening unconformity. The timing of the intrusion with respect to regional structures such as the Salmonier Cove syncline is unknown. However, the Grole intrusive suite crosscuts moderately dipping strata above the unconformity at a high angle, indicating that perhaps some deformation of the Sam Head–Doughball Point cover occurred prior to its intrusion.

STRATIGRAPHIC POSITION OF KNOWN MINERALIZATION

The late Precambrian stratified rocks are host to two significant volcanogenic sulphide showings (Frenchman Head and Winter Hill) and several base-metal-poor, massive pyrite occurrences (Sears, 1990). Almost all the occurrences are found within a limited stratigraphic interval.

The Frenchman Head showing consists of three mineralized outcrop areas that represent a single stratigraphic horizon (Sears, 1990) near the top of the Tickle Point Formation (Figure 2). Mineralization consists mainly of pyrite, sphalerite, chalcopyrite and galena, disseminated within silicified felsic volcanic rocks (Sears and O'Driscoll, 1989). The mineralized felsic rocks are overlain by carbonatized and chloritized mafic volcanic rocks.

The Winter Hill showing, which is located northeast of the study area, is a stratabound deposit that is presently mapped within the lower part of the Sam Head Formation. It consists of a lower stringer zone containing chalcopyrite and pyrite and an upper zone containing disseminated to layered, massive sphalerite, galena, pyrrhotite, pyrite, and chalcopyrite. The true thickness of the mineralized zone is 3 to 9 m (Sears, 1990). Diamond drilling shows that the zone at Winter Hill is underlain chiefly by fragmental felsic and silicified rocks, having lesser amounts of mafic tuffs and flows (Sears, 1990). The drillhole data could possibly indicate that mineralization at Winter Hill is located at the top of the dominantly silicic Tickle Point Formation, below the unconformity at the base of the Sam Head Formation. Sears (1990) stated that the Winter Hill and associated showings in the area represent deposition during a hiatus in volcanism and a change from a felsic-dominated to a mafic-dominated environment. Quartz cobble conglomerates are known to exist in the area and require re-examination to determine if they represent a major break in the stratigraphic section.

Lead isotope ratios of samples taken from the Frenchman Head and Winter Hill showings indicate that both deposits formed during the same mineralizing event and contain lead that came from the same source (S. Swinden, personal communication, 1991). It is significant that one of the few-known equivalents of the Tickle Point Formation in the Avalon Zone elsewhere in the Canadian Appalachians is host to the former Stirling base-metal mine in Nova Scotia. Rocks of the Stirling belt have been dated by U–Pb (zircon) method at 674 ± 1 Ma (Barr *et al.*, 1991). These rocks are close to the age of the Tickle Point Formation of (682.8 ± 1.6; Swinden and Hunt, 1991), and like that formation, are significantly older than the more typical 630 to 600 Ma and 580 to 550 Ma Avalonian sequences (cf. Bevier and Barr, 1990; O'Brien *et al.*, 1990).

SUMMARY AND DISCUSSION

The stratigraphic and intrusive relationships outlined above have necessitated our redefinition of several of the major lithostratigraphic and lithodemic units of the Hermitage Peninsula.

The Connaigre Bay Group, as previously defined by O'Driscoll and Strong (1979), is now known to contain two successions of notably different age and tectonic history, separated by an erosional unconformity. The older of these is an extensive sequence of corundum-normative, locally garnet-bearing, felsic volcanic rocks, assigned by O'Driscoll and Strong (1979) to the Tickle Point Formation. The original name and rank of this unit has been retained; however, it has been excluded from the redefined Connaigre Bay Group.

The submarine and subaerial volcanic rocks of the Tickle Point Formation were intruded by gabbroic to granitic plutonic and hypabyssal rocks of the Furby's Cove intrusive suite prior to the deposition of a volcano-sedimentary cover, the redefined Connaigre Bay Group. A genetic relationship may exist between some or all parts of the Furby's Cove intrusive suite and the Tickle Point Formation; the former possibly represents the magmatic roots of an arc recorded by the Tickle Point volcanic rocks. The magmatic equivalents of the Connaigre Bay cover sequence are thought to be the granitic to tonalitic plutonic rocks of the Simmons Brook intrusive suite.

The bimodal, Hermitage dykes represent a major period of extension within the pre-Connaigre Bay Group basement that is unrelated to subsequent Connaigre Bay Group volcanism. The positioning of the mid-Paleozoic, Hermitage Bay Fault adjacent to this dyke swarm is significant, and may indicate that the zone-bounding fault is located near the position of an older, tectonically weakened zone within the pre-Connaigre Bay Group basement.

The relationship of the ductile shear zone within the granitic phase of the Furby's Cove intrusive suite to rocks above the sub-Connaigre Bay Group unconformity is, as yet, unknown. Ductile fabrics are not developed in any of the Connaigre Bay Group rocks exposed along the projected strike of the north-northeast-trending zone of mylonite. The shear zone has been mapped southward from the coast of Hermitage Bay to a point near the contact of the Tickle Point Formation with the Connaigre Bay Group. The possibility remains that ductile fabrics within the Furby's Cove intrusive suite predate deposition of these younger Precambrian rocks; this hypothesis is to be tested in future field investigations.

In this part of the Hermitage Peninsula, the redefined Connaigre Bay Group includes a basal, dominantly sedimentary unit (Sam Head Formation) and an overlying, dominantly mafic volcanic unit (Doughball Point Formation). The mafic rocks pass conformably upward into red and grey terrestrial clastic sedimentary rocks of the Down's Point Formation (Table 1) elsewhere on the Hermitage Peninsula (O'Driscoll, 1977). Lithologically, this sequence is like many of the late Precambrian volcano-sedimentary assemblages elsewhere in the Newfoundland Avalon Zone, which were deposited at various times between approximately 630 Ma and the end of the Precambrian (Krogh *et al.*, 1988; O'Brien *et al.*, 1990). On the basis of field relationships alone, however, it is not possible to establish with which of these Avalonian volcano-sedimentary groups, if any, the Connaigre Bay Group can be correlated.

In summary, the earliest stages of the late Precambrian geological evolution of the Hermitage Peninsula is now known to involve the formation, extension, uplift and unroofing of a complex arc-like system. These events were followed by deposition of a volcano-sedimentary cover and intrusion of coeval, batholith-scale granitic to tonalitic plutons. Various elements of the basement, as well as the cover and its magmatic roots, were subsequently intruded by significantly younger late Precambrian gabbroic and dioritic plutons. Documentation of the field relationships that illustrate this protracted geological history establishes conclusively the complex and composite nature of the Newfoundland Avalon Zone in the late Precambrian.

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