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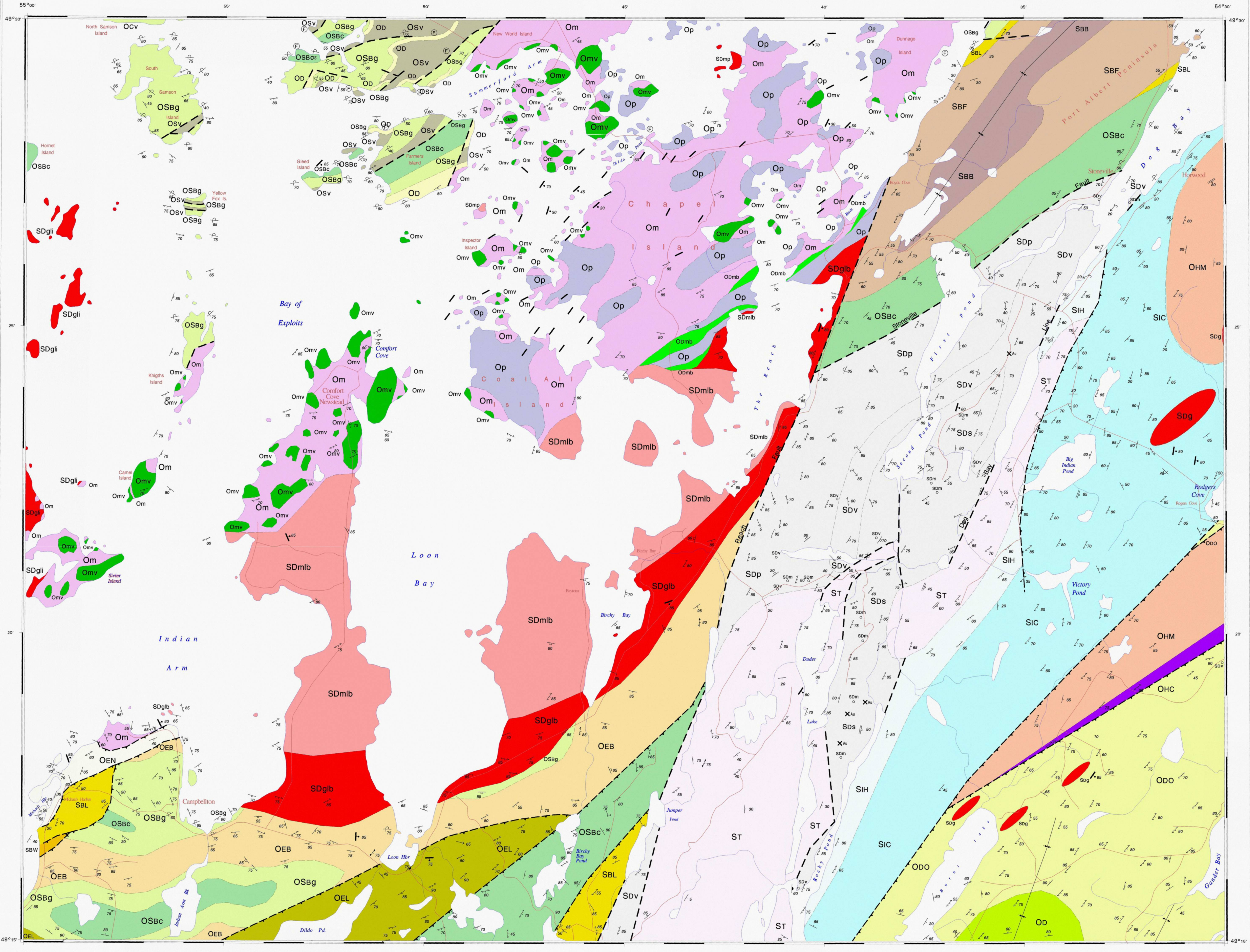

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GEOLOGY

COMFORT COVE - NEWSTEAD

NEWFOUNDLAND

Scale 1:50 000 - Échelle 1/50 000

Kilometres 1 0 1 2 3 4 Kilomètres

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Electrostatic plot produced by the Geological Survey of Canada

Any revisions or additional geological information known to the user would be welcomed by the Geological Survey of Canada

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Magnetic declination 1995, 24°07' W, decreasing 8.6' annually

LOCATION MAP

Geological contact, approximate
Bedding, top known (inclined, overturned)
Bedding, top unknown (inclined)
Pillow lava, top known (inclined)
Strike and dip of compositional layering
Cleavage, first, second
Azimuth and plunge of stretching lineation
Azimuth and plunge of axes of small folds; (vergence sinistral, dextral, unknown)
Fault, thrust or reverse; transcurrent or unknown; position approximate
Strike and dip of shear or mylonite zone; (sinistral, dextral, reverse)
Strike of dyke (dip known, unknown)
Strike and dip of vein, joint
Trace of axis of major anticline, syncline
Glacial striae (direction of ice movement known, unknown)
Fossil locality
Mineral occurence;
Blocks in melange with lithology

MINERALS
Asbestos ..... As
Gold ..... Au
Chromite ..... cr
Copper ..... cu

2 E/11	2 E/10 OF 3151	2 E/9
2 E/6	2 E/7 OF 3161	2 E/8 OF 3147
2 E/3	2 E/2 OF 3162	2 E/1

NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO ADJOINING GEOLOGICAL SURVEY OF CANADA MAPS

DESCRIPTIVE NOTES

Comfort Cove-Newstead map-area, which lies within the Exploits Subzone of the Dunnage Zone (Williams et al., 1988), consists of low rocky hills, separated by extensive bogs on the mainland and by shallow sea-water in The Reach and eastern Bay of Exploits. Rock exposures can be examined along the sea coast on myriad islands and reefs, and inland via an extensive network of forest access roads. Outcrop is good on the coasts, and fair inland where large glaciated rock surfaces exhumed by road-building activities supplement rare natural outcrop in streams and on rocky hills. This new outcrop has greatly advanced geological investigations, which in this region were previously virtually confined to coastal regions and large ponds (Patrick, 1956; H.Williams, 1964; Karlstrom et al., 1982). Bouldery till, with local pockets of outwash sand and gravel, deposited by north-northeast-moving ice covers large areas. Much of the soil in the area is organic, particularly in bogs, and covered with scrubby spruce and balsam.

Major faults divide Comfort Cove-Newstead map-area into four sub-areas which record the last stages of the mid-Paleozoic closure of the Iapetus Ocean. The Dog Bay Line, a Silurian terrane boundary, separates the generally west-facing Indian Islands Belt (a Silurian stable shelf assemblage overlying two diverse Ordovician groups) from the Duder Complex (tectonic mélange containing east-facing bedded sections) and the Ten Mile Lake Formation, a late Silurian redbed sequence which locally oversteps the Dog Bay Line. The Stoneville Fault, a ductile-brittle shear zone, and the Reach Fault, a late brittle feature, separate the Duder Complex from mid-Ordovician volcano-sedimentary strata (Exploits Group), overlying late Ordovician to Silurian marine clastic sedimentary rocks (Badger Group) and early Silurian terrestrial volcanic and littoral to shallow marine sedimentary rocks (Botwood Group) all of which form part of a northwest-vergent fold and thrust belt. These strata are in turn thrust upon older rocks of the Dunnage Mélange which in turn is thrust over early to mid-Ordovician volcanics and marble of the Summerford Group and strata of the Badger Group on New World Island. The Red Indian Line, the divider between the Exploits and Notre Dame subzones crosses the northwest corner of the map-area. All older units, including those in the Notre Dame Subzone, are intruded by late Silurian to Devonian granitoid and gabbroic igneous rocks, which were emplaced prior to development of late brittle faults such as the Reach Fault. These faults are in turn overprinted by Jurassic? lamprophyric dykes.

The Indian Islands Belt (H.Williams et al., 1993) within the map-area contains parts of the Ordovician Hamilton Sound (unit OH) and Davidsville (OD) groups as well as the Silurian Indian Islands Group (SI). The Outflow Formation (ODO) of the Davidsville Group, consists of pale gray turbidites with well-developed Bouma cycles a few tens of cm thick passing from basal pebble conglomerate with white quartz wacke pebbles up through greywacke to greenish, finely laminated siltstone and shale of the Hunts Cove Formation (ODH). South of the map-area, Currie (1995) estimated the thickness of the Davidsville Group to be about 1200-1300 meters, and deduced a mid-Ordovician (pre-Caradoc) age. The Outflow Formation contacts the Carmanville Mélange (OHC) along a steeply southeast-dipping shear zone south of Rodgers Cove. The mélange comprises a homogeneous, sheared black shale matrix, commonly pyritic and manganiferous, with rare, large "knockers" of volcanic rocks which form hillocks up to 50 m across along the road to Burnt Lake. The thickness of mélange is essentially that of the shear zone, about 200 m. Mélange grades northward to sheared black graphitic, pyritic, Mn-rich shale of the Main Point Formation, (OHM) which contains Caradocian (D.clingani zone) graptolites just east of the map area (Williams, 1972). Black chert forms lenses and beds up to 20 cm thick within the formation, and locally constitute 10-50 percent of the volume. The thickness of the Main Point Formation is uncertain due to complex deformation. The Main Point Formation is temporally and lithologically identical to the upper part of the Baytona Formation of the Exploits Group. An unconformable contact between basal limestone breccia of the Indian Islands Group and underlying black shale of the Hamilton Sound Group is exposed at two places about 9 km NNE of Rodgers Cove (outside the map-area), where it is approximately conformable to the foliation in underlying rocks. Regionally the contact cuts across the trends of the older rocks at a moderate to high angle. Most of the Indian Islands Group within the map-area belongs to the Charles Cove Formation (SIC), monotonous grey calcareous siltstone with local fossiliferous limestone lenses up to 10 cm thick. Wu (1978) reported a Wenlock brachiopod from this lithology. Much of the Charles Cove Formation between Rodgers Cove and Horwood is hornfelsed by abundant salic dykes and plugs. The Charles Cove Formation is calculated to be about 500-600 meters thick (Currie, 1995) and is overlain by 20-30 metres of grey to black shale of the Horwood Formation (SIH), characterised by 1-3 mm beds of pale buff siltstone. Near Horwood a steep east-over-west reverse fault separates the Charles Cove and Horwood Formations but between Burnt Pond and Rocky Pond the contact appears to be transitional. The Horwood Formation grades upward into red shale and siltstone assigned to the Ten Mile Lake Formation (ST), a transition well exposed along Highway 331 south of Horwood. The Indian Islands Group (but not the Ten Mile Lake Formation) is abruptly truncated by the Dog Bay Line, along which an uncertain, but probably large amount of dextral and east-side-up motion has occurred. The Dog Bay Line has a strong topographic expression along linear lakes and bogs.

The region between the Dog Bay Line and the Stoneville Fault and the Reach Fault displays two diverse assemblages. The Port Albert Peninsula exposes rocks of the Badger and Botwood groups, and resembles rocks west of the Reach Fault and south of the Loon Bay batholith. Both areas have been included in the Botwood Belt by Williams et al. (1993). The region south of Stoneville is underlain by late Ordovician and Silurian tectonic mélange (Duder Complex, SD) unconformably overlain by middle to late Silurian redbeds (Ten Mile Lake Formation,ST). The contact between the two regions is a southwest-trending shear zone up to a kilometre wide (Stoneville Fault) exposed on the shore around Stoneville. The Duder Complex (SD) consists of a central belt of gabbro, basalt, felsite, fragmental volcanics and tuff, brecciated and boudined by a homogenised, steeply dipping, sheared matrix of greenish-black mudstone and shale (unit SDv). Many of the igneous blocks are extremely large, exceeding 100 metres in length, giving rise to steep, elongate hillocks of mafic igneous rock jutting out of flat ground underlain by poorly exposed shale and siltstone. The block-in-matrix nature of the unit is particularly obvious along the sea-shore at Horwood and below the Pentecostal Church at Stoneville. To the west of this volcanic belt intensely sheared shale and siltstone, well exposed along a new woods road leaving Highway 340 near gridref 674716, contains rare large blocks of igneous rocks. East of the central belt an east-facing bedded section of olive to buff, micaceous siltstone-shale rhythmites (SDs) bedded on centimeter scale contains meter-scale conglomerate and olistostrome beds and numerous mafic dykes, some of boudined and rotated. The source of the blocks within the Duder Complex is unknown. Blocks of possible Badger conglomerate (with fossiliferous limestone clasts) and Baytona Formation (black chert) have been found south of the map area. The basalt and gabbro blocks resemble the Loon Harbour Volcanics chemically but not petrographically. The age of the protolith(s) of the Duder Complex is unknown, but assumed to be early to middle Ordovician. The age of deformation is constrained to late Ordovician and early Silurian time since it affects the late Ordovician-early Silurian Badger Group, but not the late Silurian? Ten Mile Lake Formation (ST). Around Duder Lake, the Duder Complex is overlain by a distinctive red sequence with generally low dips (Ten Mile Lake Formation, ST) which consists mainly of of purple to crimson shale interbedded with thin pink sandstone beds, and rare, thick (1-10 metres) pink to grey-green sandstone beds. Ripple marks, mud-cracks and cross-bedding are ubiquitous. The unit is deduced to be no more than a few tens of meters thick, and to unconformably overlie the Duder Complex. The Ten Mile Lake Formation displays significant cleavage and steep dips only within a few hundred metres of major faults. The formation oversteps the Dog Bay Line between Rocky Pond and Southwest Pond without obvious displacement, and conformably overlies the Wenlock or younger Horwood Formation.

Rocks west of the Reach Fault and south of the Loon Bay batholith form a stack of north vergent thrust slices. Units of the Exploits Group (OE) occur in isolated slices. The Arenig upper New Bay Formation (OEN) of thin to medium-bedded, dark grey-green, turbiditic mudstone and siltstone with rare granule sandstone and pebble conglomerate and olistostrome beds (Hughes and O'Brien, 1994) appears in a single thrust slice between Michaels Harbour and Campbellton. No contact between the New Bay Formation and the Llanvirn Loon Harbour Volcanics (OEL) has been found in this map-area. The main part of the Loon Harbour Volcanics around Dildo Pond consists of spectacular basalt breccia with amygdaloidal, angular basalt blocks up to 20 cm across rimmed by devitrified glass, and set in a green tuffaceous matrix. The upper part of the Loon Harbour Volcanics at Loon Harbour contains amygdaloidal basalt flows with rare interstitial carbonate lenses, and grey fragmental rhyolite or dacite. Further east in the Birchy Bay Pond region greenish salic tuff and flows? are present. The basaltic volcanics are of non-arc chemistry (K.L. Currie, unpublished data). Between Dildo Pond and Loon Harbour the Loon Harbour Volcanics grade stratigraphically upward through salic volcanics to silicified salic tuff and chert belonging to an overlying composite unit of chert and black shale which can be divided into two units to the west (Strong Island Chert and Luscombe Shale, O'Brien, 1993). However in the map-area much of the chert unit is blackened in the hornfels aureole of the Loon Bay batholith and cannot be reliably distinguished from numerous black cherty intervals within the shale. The two sub-units have therefore been amalgamated into the Baytona Formation (OEB). West of Indian Arm Brook, multi-coloured chert (red, green, white) typical of the Strong Island Formation is present. At Loon Harbour, thick, bedded cherts are black, and rich in pyrite and pyrolusite. The upper part of the Baytona Formation (thin black shale beds in chert) at the mouth of Indian Arm Brook and in Campbellton has been dated by graptolites to the D.clingani zone of the Caradoc (S.H. Williams, et al., 1993). To the west the lower chert is known to be of Llanvirn age (S.H.Williams et al., 1993). A near conformable contact

between Baytona Formation and greywacke of the overlying Badger Group (OSB) can be observed east of the mouth of Indian Arm Brook. H.Williams et al. (1993) introduced the name Badger Group for late Ordovician and Silurian, coarsening-upward clastics extending more than 100 kilometres southwest from New World Island to the vicinity of Badger. The lower greywacke-rich part of this turbiditic sequence (OSBg) has loosely been termed "Samson" and the upper conglomeratic part (OSBc) termed "Goldson", but it is uncertain that all "Samson" greywackes or all "Goldson" conglomerates are correlative. The greywacke near Campbellton is massive with rare pebbly beds, but to the east and south large amounts of homogeneous fine-grained green turbiditic siltstone and dark grey mudstone occur in the lower part of the unit The pebble to cobble conglomerate intervals within the greywacke become thicker and more numerous toward the top of the section. The boundary between greywacke and conglomerate is drawn where the proportion of conglomerate excedes 50 percent. Clasts in the conglomerate are commonly moderately to well-rounded and consist predominantly of siltstone, granitoid plutonic rocks, some of them gneissic, subordinate epidotised mafic volcanics, and small but highly visible components of red chert and fossiliferous (Caradoc to Llandovery) limestone. Greenish siltstone and dark-grey mudstone and shale beds up to a meter thick occur within the conglomerate.

A contact between the Badger Group and overlying Botwood Group (SB) is exposed just north of the map-area near Port Albert. Although attitudes above and below the contact are almost parallel, a weak cleavage in the Badger Group may be truncated along the contact suggesting an unconformity. The basal unit of the Botwood Group, the Lawrenceton Formation (SBL), comprises subaerial basalt, commonly amygdaloidal and columnar, with distinctive red or green patchy colouration, and thin lenses of red, interflow siltstone. The Lawrenceton Formation where exposed on opposite sides of a syncline occupying the Port Albert Peninsula is thin and appears to pinch out to the southwest. The same lithology occurs in a thrust allochthon near Michaels Harbour, and in a fault wedge south of Jumper Pond. On the Port Albert Peninsula the Lawrenceton Formation is overlain by fine-grained greenish, micaceous sandstone with numerous tuff beds (Farewell sandstone, SBF), but the contact with underlying rocks is nowhere exposed. A thin belt of distinctive buff or rusty sandstone along the Reach Fault has been assigned to the Farewell sandstone. A poorly exposed region in central Port Albert Peninsula is rich in tuff, dykes and minor plutons, and has been assigned to the Brimstone Head Formation (SBB), a unit consisting predominantly of tuff and ignimbrite with subordinate tuffaceous sandstone. These rocks are well exposed just north of the map-area in roadcuts on the way to Farewell Harbour. A small thrust allochthon of Wigwam Formation (SBW), homogeneous pale green to buff micaceous sandstone, commonly rather thin-bedded and well ripple- marked, occurs south of Michaels Harbour. The Wigwam Formation is probably approximately time equivalent to the Farewell sandstone, but of somewhat different petrographic character. The Farewell sandstone must be older than the 422±2 Ma age obtained from a dike cutting the unit just north of the map-area (Elliot et al., 1991). This age may approximate the age of salic igneous rocks in the Brimstone Head Formation. Much of the Botwood Group is of Llandovery-Wenlock age (Williams, 1972).

Eastern Bay of Exploits is underlain by the Dunnage Mélange (Om), the south-eastern boundary of which is marked by a south-over-north reverse fault near Campbellton and by the Loon Bay batholith further to the northeast. The Reach Fault separates the Dunnage Mélange from Badger and Botwood groups on the Port Albert Peninsula. The mélange contains local bedded sections (Omb), particularly on Chapel Island, abundant quartz-feldspar porphyry (Coaker Porphyry, Op) and abundant mafic dykes and minor plutons of uncertain, possibly Silurian age. The matrix of the Dunnage Mélange consists largely of black, grey, green and local red shale which lacks bedding but exhibits strong, steeply-dipping phacoidal cleavage. Nebulous, streaky contorted layers (former beds?), and recumbent folds of cleavage are ubiquitous. Pebbly shale and disaggregated greywackes occur locally. Clasts in the mélange comprise mainly mafic volcanic rocks and micaceous quartz greywackes, but a variety of other lithologies occur in lesser amount including silicic volcanic rocks, limestone, conglomerate, chert, psammitic schist, basalt containing fossiliferous Middle Cambrian limestone (Kay and Eldridge, 1968), fragmental volcanic rocks with cobbles of granodiorite, mixtite with cobbles of quartzite and limestone, and massive ferruginous manganiferous chert. The largest blocks, masses of fragmental and pillowed basalt and gabbro (Omv), range from 50 metres to more than a kilometre in diameter, and can be mapped separately (H.Williams, 1994). The second most abundant lithology in the mélange, micaceous quartz greywacke, forms rounded masses surrounded by swarms of smaller disaggregated blocks. Many of the gabbro and greywacke blocks resemble the Exploits Group to the southwest, and some volcanic blocks could derive from the Summerford Group to the north (Hibbard and Williams, 1979). The source of most of the rarer blocks is unknown. The Dunnage Mélange contains within it a coherent southeast-facing bedded section of greywacke, conglomerate and coticule-bearing shale (Omb) stretching from southern Chapel Island to Boyds Cove. The location and facing of this section, and apparent gradational contacts with mélange, are consistent with it being stratigraphically above the bulk of the mélange. Other local bedded sections, for example at Camel Island, also contain coticule lenses. The northeastern part of the mélange is cut by a myriad of quartz-plagioclase porphyry sills and plugs (Coaker Porphyry, Op). Many or all of these bodies appear to represent apices of an underlying pluton. The porphyry exhibits billowy, fluted contacts with hornfelsed mélange matrix, suggesting intrusion into a soft host. Biotite is the predominant mafic mineral, but muscovite phenocrysts occur on Inspector Island. Rounded, serpentinised mafic to ultramafic nodules 1-30 cm in diameter, and garnet xenocrysts rich in pyrope and grossular form a sparse but persistent component of the porphyry. The Coaker Porphyry has been dated by U-Pb zircon as 467±5 Ma (Elliot et al., 1991). Since it cuts the mélange, original mélange formation must be of Llanvirn or older age, although subsequent tectonic reworking is probable. Mélange contacts Caradocian black shale of the Dark Hole Formation along a complex, steeply southeast-dipping zone on eastern Farmers Island which may be a sheared stratigraphic contact (H.Williams, 1994). A small, zoned gabbro-diorite-monzonite intrusion (SDmp) forms two interlocking rings cutting the porphyry on northern Chapel Island (Puncheon pluton) The age of this intrusion, and a circular gabbro body on Grapnel Island (SDg), is unknown, but may be similar to the Loon Bay batholith, which cuts both mélange and porphyry.

Parts of New World, Farmers and South Samson islands, as well as smaller nearby islands, belong to the Badger Belt of Williams et al. (1993). in which the Badger Group is present but the Botwood Group is absent. Within the map-area the Badger Group is underlain by mafic lavas and pyroclastic rocks with intercalated limestones (Summerford Group, Osv) and by black shale and chert (Dark Hole Formation, OD). Parts of the Summerford Group are probably approximately coeval with the Dunnage Mélange, but contacts between the Summerford Group and Dunnage Mélange are faulted. The limestone of the Sumerford Group within the map area forms thin lenses, commonly partially or completely recrystallised to marble and typically more deformed than their surroundings. These lenses have yielded Tremadoc and Llanvirn fossils (Elliot et al., 1989). Associated volcanic rocks (Osv) comprise massive and pillowed basalt, agglomerate, tuff and tuffaceous sandstone, the latter two with varying amounts of fragmental, interstitial carbonate. Parts of the volcanic rocks have non-arc chemistry (E-type MORB, Jacobi and Wasowski, 1985). The stratigraphically overlying Dark Hole Formation, black shale and siltstone with intercalated white and green chert, forms small scattered, variably deformed outcrops. Graptolite occurrences in this formation gave one early Caradoc age for a locality on Summerford Arm (Elliot et al., 1989), but mainly mid-Caradoc (D.clingani zone) ages. Turbiditic greywacke and siltstone of the Badger Group (OSB) conformably overlie the Dark Hole Formation on Farmers Island. The greywacke (OSBg, "Sansome greywacke"), typically consisting of rhythmically repeated sandstone-siltstone couplets 3 to 10 cm thick with rare lenticles of pebble to cobble conglomerate, contains Ashgill to lower Llandovery fossils (McKerrow and Cocks, 1978), and grades upward into matrix-supported, grey-green polymict conglomerate (OSBc, "Goldson conglomerate") with generally well-rounded cobbles to boulders of granitoid rocks, greywacke, tubidites, limestone and chert. Fossils in the limestone range from Caradoc to Llandovery in age.

The Red Indian Line, dividing the Exploits from the Notre Dame Subzone passes just north of South Sansome Island. Greywacke and tuff of the early Ordovician Chanceport Group (Op) of Notre Dame Subzone appear on North Sansom Island.

Igneous rocks of late Silurian to Devonian age cut all older rocks throughout Comfort Cove- Newstead map-area. Uralitised, but otherwise unaltered, north to northeast-trending gabbro dykes (SDm) from 1 to 50 metres wide cut the Dunnage Mélange, Duder complex, Ten Mile Lake Formation and Charles Cove Formation. All swarms are believed to be of similar age. The Loon Bay batholith forms a composite body consisting of a southeastern marginal biotite tonalite to granodiorite with prominent anhedral quartz (SDglb), and a main pluton varying from coarse, foliated biotite-hornblende diorite on the southeast to massive medium-grained tonalite to granodiorite on the northwest (SDmlb). A screen of hornfelsed sedimentary rocks, well-exposed in the village of Birchy Bay, separates the two plutons except at the extreme northeast end where the quartz-prominent phase cuts tonalite. The surface of the younger phase, studded with irregular, cm-scale polycrystalline quartz, contrasts sharply with that of the main phase which exhibits ovoid to irregular masses of plagioclase up to 2 cm across. Original hornblende in the main pluton has been coated with or replaced by biotite. Both phases contain rare angular blocks of hornfelsed country rocks, and diffuse, more mafic, rounded, probably cognate enclaves. Neither contains prominent pegmatitic phases. The batholith is surrounded by by a hornfels aureole 100-200 m wide which locally contains andalusite spots. A sparse dyke swarm associated with the batholith occurs throughout the northwest half of the map-area. Dykes and batholith have been dated by U-Pb zircon at between 409 and 404 Ma (Elliot et al., 1991). A small portion of the Long Island batholith (SDgli) outcrops on islands on the western margin of the map sheet. These rocks closely resemble the Loon Bay batholith, and may be continuous with it at depth. Just east of the Dog Bay Line feldspar porphyries occur in a belt parallel to the line as dykes and as breccia matrix in the Charles Cove and Outflow Formations. North of Rodgers Cove these porphyries were termed the "Tims Harbour pluton" by Currie et al. (1980), but no discrete pluton is present. The youngest rocks in the map-area are coarse biotite-titanaugite lamprophyre dykes (Jl) believed to be of Jurassic age (Strong and Harris, 1975). A prominent example cuts breccia of the Reach Fault in a road cut on highway 340 about 4 km south of Boyds Cove.

The structure of parts of Comfort Cove-Newstead map area has been examined in detail (Karlstrom et al., 1982; Elliot et al., 1989, Lafrance and P.F.Williams, 1992; O'Brien, 1993). Pre- Caradoc folding and cleavage of the Dunnage Mélange can be demonstrated by ubiquitous truncation and hornfelsing of cleavage and folds of cleavage by the Llanvirn Coaker Porphyry. Some of the truncated structures may be of olistostromal origin, but the pervasive cleavage and folding of cleavage must represent pre-Caradoc hard-rock deformation. The earliest deformation observed throughout the map-area (D_1 of Lafrance and Williams, 1992) comprises small scale thrusts ramps and flats. which are ubiquitous in the Badger Group, together with associated folds which are commonly intrafolial. Similar structures occur in the Hamilton Sound Group and in an adjoining fringe of the Outflow Formation up to a kilometer wide. Lafrance and Williams (1992) deduce the sense of thrust motion associated with D_1 to be northwest-over-southeast. D_1 structures have not been observed in the Botwood or Indian Islands groups, (structures in the Indian Islands Group assigned by Karlstrom et al. (1982) to D_1 are here assigned to D_2.), and the Badger Group is unconformably overlain by the Botwood Group at Port Albert and Change Islands, north of the map-area, suggesting that D_1 preceded deposition of the Llandovery Lawrenceton Formation, and hence was latest Ordovician to earliest Silurian in age. D_2 is treated by Lafrance and Williams (1992) as a single progressive event dominated by regional dextral ductile faulting, and including development of the regional cleavage, formation of the large gently plunging folds which dominate the outcrop pattern, small dextral folds, and abundant dextral movement indicators closely associated with the faults. Gently northeast plunging, kilometer-scale folds, for example on the Port Albert Peninsula, formed with the steep regional cleavage approximately axial planar to the folds. Along the shore north of Stoneville the cleavage is rotated counter-clockwise as much as 15° with respect to the axial plane of the folds. West of the Dog Bay Line the regional cleavage dips steeply east, and the folds are slightly overturned toward the west. East of the line the Indian Islands Group and Outflow Formation exhibit tight, upright, north-northeast-trending folds with vertical axial plane cleavage, as can be seen in highway cuts near Horwood. These structures overprint D_1 structures in the Hamilton Sound Group and adjacent Outflow Formation locally producing downward-facing folds, for example at Rodgers Cove (cf. Karlstrom et al., 1982). Small-scale steeply plunging dextral folds with the regional cleavage axial planar to the folds overprint shallowly plunging folds on both sides of the Dog Bay line, and are particularly common in the Duder Complex where they may be examined in trenches in the gold prospects east of First Pond and Duder Lake. The Dog Bay Line and Stoneville Fault are marked by zones of phyllonite with shallowly plunging lineations, and sparse mylonitised quartz veins. Around Dog Bay, the Dog Bay Line and Stoneville Fault form a single zone of deformation, but to the southwest the two zones diverge, leaving an area of Duder Complex which is much less deformed. Based on map-pattern the Dog Bay Line appears to be younger than the Stoneville Fault, and to cut it at a low angle. Units east of the Dog Bay Line exhibit post-folding high-angle, east-over-west reverse dextral faulting, which has modified all known contacts between the Outflow Formation and Indian Islands Group. Similar structures appear to be common in the southwest part of the map-area, and one superb example can be examined on the shore northwest of Campbellton. D_2 structures affect the Llandovery-Wenlock Botwood and Indian Islands groups, but are truncated by the latest Silurian Loon Bay batholith. Deformation is therefore of mid- to late Silurian age. Youngest deformation in the map area is witnessed by a set of north-northeast trending sinistral brittle faults, notably the Reach Fault, which exhibits 15 km of sinistral motion. This motion post-dates the Loon Bay batholith, which it truncates, but precedes emplacement of an undeformed Jurassic? lamprophyre dyke in the fault plane. A lamprophyre on Gleed Island is reported to be deformed by a fault of this set (Elliot et al., 1991), so the motion may be of Mesozoic age.

A speculative synthesis of the structure of this region assumes the Outflow Formation to form cover to an ophiolite and arc-volcanic suite obducted southeast onto the margin of Gondwana in early Ordovician time (Colman-Sadd et al., 1992). Rocks between the Dog Bay and Red Indian lines represent filling of a basin formed by rifting of a mid-Ordovician (post-obduction) west-facing volcanic arc. Initial basin opening in late Arenig time led to Formation of the Dunnage Mélange, while the Loon Harbour Volcanics and Baytona Formation are back-arc basin deposits in this model. The Caradoc-Llandovery Badger Group resulted from rapid filling of the basin after cessation of volcanism due to arrival of Laurentia at the subduction zone. Post-Caradoc sinistral southeast thrusting of the Hamilton Sound Group over the Outflow Formation resulted from compression due to arrival of Laurentia, but subsequent shortening was accomodated by early Silurian westward dextral subduction of the floor of the basin, possibly along the Stoneville Fault eventually juxtaposing the Botwood Group, accumulated on the western (active) margin of the closing basin, and the Indian Islands Group, accumulated on the eastern (passive) margin. On this model, the Duder complex lay in the collision zone, a relic of the accretionary wedge prism preserving remnants of subducted units from the back-arc basin. The pervasive dextral transpressive regime noted by Lafrance and Williams (1992), followed closure in Wenlock or Ludlow time and created the Dog Bay Line. The Ten Mile Lake Formation was deposited in the brief interval between collision and climactic plutonic activity in late Silurian time. Late sinistral transcurrent faulting which created the Reach Fault and parallel faults on New World Island post-dated some Silurian to Devonian pluton emplacement but pre-dated others, notably the Mount Peyton igneous suite south of the map area, although some reactivation may have been related to opening of the Atlantic Ocean in Mesozoic time.

Gold mineralisation occurs within the Duder complex within sheared, silicified shales and siltstones associated with basaltic and dacitic megaboudins at the Klutha prospect east of First Pond, and in altered shear zones cutting large masses of gabbro east of Duder Lake (Goldstash, Stinger and Corvette prospects, see Churchill and Evans, 1992 for more details). Anomalous Au concentrations have also been reported from Mn-rich chert of the Caradocian Baytona Formation at Loon Harbour (Sangster, 1992), and two small prospect pits were dug in this horizon on the shore at Campbellton. A shaft was sunk in a large ferruginous, Mn-rich chert on the north shore of Chapel Island at some unknown time, presumably also in search of gold. Other parts of the Baytona and Main Point Formations exhibit similargeology and geochemistry and may also be prospective for gold. Both of these formations are also very rich in pyrite (up to 20 percent locally), and may have some base metal potential. A few flecks of molybdenite occur along the Badger-Botwood contact east of Dunnage Island.

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TABLE OF FORMATIONS

JURASSIC
- Jl — Titanaugite-biotite lamprophyre dykes

SILURO-DEVONIAN
- SDg — Trondhjemite, granodiorite, granite, porphyry, SDgli-Long Island batholith; SDglb-Loon Bay batholith, quartz megacrystic portion; salic dykes, porphyry, igneous breccia
- SDm — Gabbro, diorite, tonalite; SDmlb-Loon Bay batholith, diorite and tonalite portion; SDmp-Mount Peyton igneous suite

Age column: Ludlow? SILURIAN; Wenlock-Llandovery; SILURIAN and ORDOVICIAN Ashgill-Llandovery; ORDOVICIAN Caradoc; Llanvirn-Llandeilo; Arenig; Tremadoc

NOTRE DAME SUBZONE

CHANCEPORT SLICE

CHANCEPORT GROUP (OCg-OCc)
- OCc — White, red, green chert, tuff, greywacke
- OCv — Pillow lava with interpillow chert
- OCg — Greywacke, argillite, minor conglomerate, chert

EXPLOITS SUBZONE

BADGER BELT

BADGER GROUP (OSBg-OSBc)
- OSBc — Grey conglomerate, chert, clasts ("Goldson type")
- OSBg — Greywake/siltstone turbidites ("Sansome type")

conformable contact

- OD — DARK HOLE FORMATION; black graptolite shale, chert

conformable contact

SUMMERFORD GROUP (OSv)
- Osv — Basalt, tuff, minor felsite; limestone lenses

DUNNAGE SLICE

- OD — DARK HOLE FORMATION; black graptolite shale, chert

conformable contact

- Op — COAKER PORPHYRY; quartz porphyry; ultramafic inclusions, garnet xenocrysts

intrusive contact

DUNNAGE MELANGE (Om-Omb)
- Omb — Bedded shale and siltstone, olistostrome beds
- Omv — Mafic volcanic and gabbro rafts in melange
- Om — Melange, variably tectonised and metamorphosed blocks in a scaly, phacoidal matrix

BOTWOOD BELT

- SBB — BRIMSTONE HEAD FORMATION; ignimbrite, tuff, sandstone
- SBF — FAREWELL FORMATION green mica sandstone; tuff
- SBW — WIGWAM FORMATION; buff and green mica sandstone
- SBL — LAWRENCETON FORMATION; basalt, rhyolite, red siltstone

unconformity?

BADGER GROUP (OSBg-OSBc)
- OSBc — Grey conglomerate, chert clasts ("Goldson type")
- OSBg — Greywake/siltstone turbidites ("Sansome type")

conformable contact

EXPLOITS GROUP (OEN-OEB)
- OEB — BAYTONA FORMATION; black shale, multicolour chert
- OEL — LOON HARBOUR VOLCANICS; basalt, agglomerate, tuff
- OEN — NEW BAY FORMATION; siltstone, shale, olistostromes

DUDER BELT

- ST — TEN MILE LAKE FORMATION; red shale, pink/green sandstone

unconformity on SD

- SD — DUDER COMPLEX; tectonic mélange; SDm-gabbro blocks; SDs-bedded greywacke and conglomerate; SDv-disrupted volcanic rocks with and siltstone matrix; SDp-paper schist of shale and siltstone with rare large blocks of other lithologies

INDIAN ISLANDS BELT

INDIAN ISLANDS GROUP (SIS-SIH)
- SIH — HORWOOD FORMATION; shale with thin buff siltstone beds
- SIC — CHARLES COVE FORMATION; siltstone, limestone lenses
- SIS — SEAL ISLAND FORMATION; limestone and limestone breccia

unconformity

HAMILTON SOUND GROUP (OHM-OHC)
- OHC — CARMANVILLE MELANGE; tectonised olistostromes, OHCv-volcanic rafts
- OHM — MAIN POINT FORMATION; pyritic graptolite shale and chert

tectonic contact

DAVIDSVILLE GROUP (ODO-ODH)
- ODH — HUNTS COVE FORMATION; grey shale rhythmites, green and red shale
- ODO — OUTFLOW FORMATION; greywacke, sandstone/shale

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