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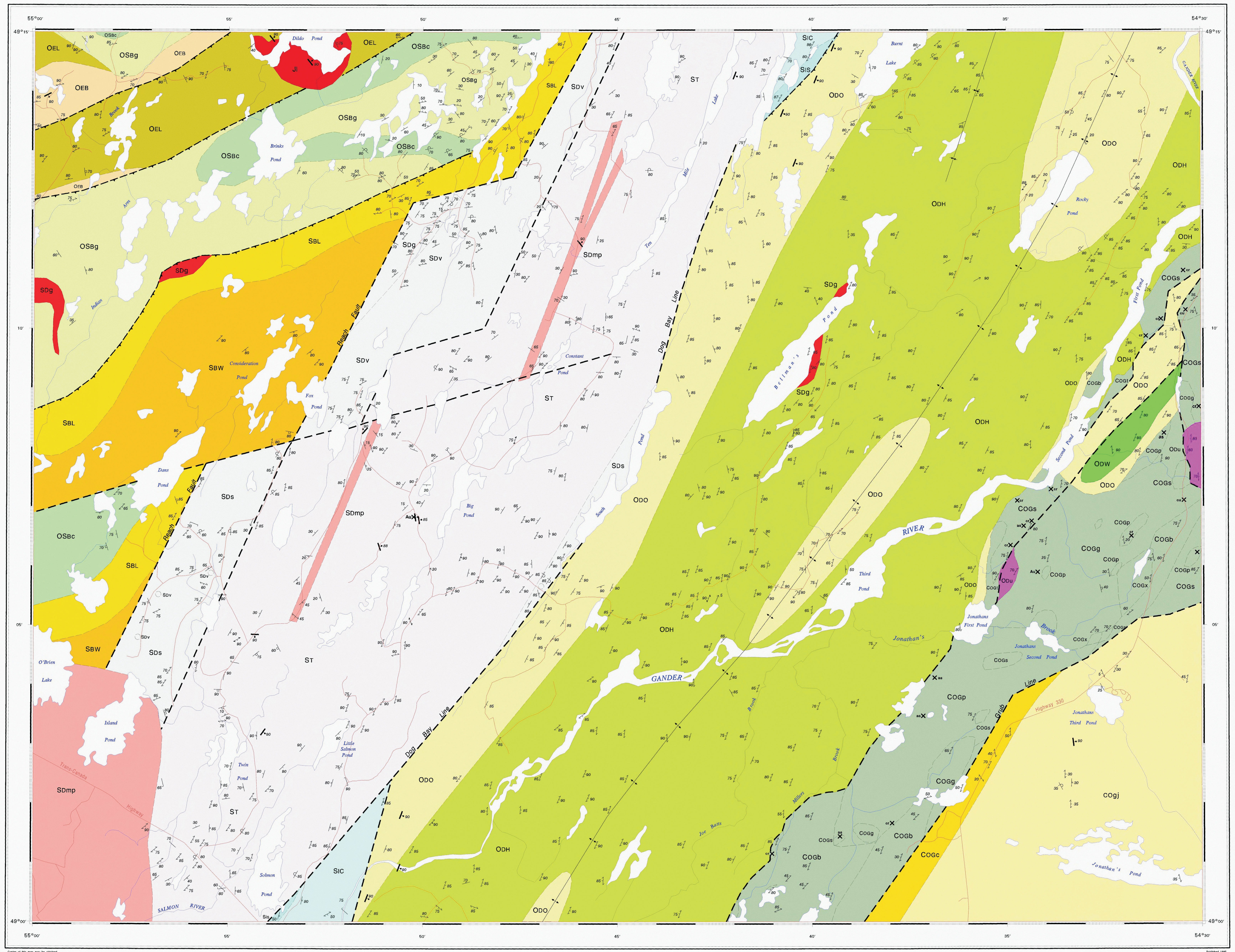


DESCRIPTIVE NOTES

Gander River map-area comprises gently rolling terrane densely covered by coniferous forest growing on organic soils and a thin cover of boulder till deposited from northeast-advancing ice. Natural outcrop is generally poor, particularly in the southwestern part of the area, except for a few prominent rocky hills, and sparse outcrop along the larger brooks and rivers, a fact which discouraged early geological mapping (Blackwood, 1982). However a dense network of forest access roads has uncovered many large, glacially polished rock surfaces and sparked a resurgence in interest in the geology (Evans et al., 1992). This road network, together with a short segment of the Trans Canada Highway in the southwestern corner, and the Gander River, provide easy access to the area.

Gander River map-area spans the boundary between the Gander and Dunnage zones of the Appalachian orogen (GRUB Line, Williams et al., 1988). East of the GRUB Line the late Cambrian- early Ordovician Gander Group comprises feldspathic psammites with black shale toward the top. To the west of the GRUB Line the Exploits Subzone of the Dunnage Zone falls into three divisions. Between the GRUB and Dog Bay lines a disrupted lower Ordovician ophiolite (Gander River Complex) is imbricated with unconformably overlying clastic sedimentary rocks of both local (Davidsville Group) and distant (Weirs Pond Formation) derivation. The Davidsville Group is juxtaposed against the Indian Islands Group, a Silurian marine shelf assemblage, along high angle reverse faults interpreted to hide an unconformity. The Indian Islands Group is truncated to the west by the Dog Bay Line, a Silurian terrane boundary (Williams et al., 1993). Between the Dog Bay Line and the Reach Fault the Duder Complex (Silurian tectonic mélange, including km-scale fragments of units of unknown origin) is unconformably overlain by middle or late Silurian red shale and sandstone of the Ten Mile Lake Formation. West of the Reach Fault stratified rocks belong to the Arenig to Caradoc Exploits Group (volcanic rocks, chert and black shale) overlain by the Badger Group of late Ordovician to early Silurian siltstone, greywacke and conglomerate and the Botwood Group (Silurian terrestrial volcanics and littoral to shallow marine micaceous sandstone). All stratified rocks are intruded by gabbro dykes apparently related to the Late Silurian to Devonian Mount Peyton igneous suite of gabbro and granite which outcrops in the southwest corner of the map-area. Several small stocks of granite and porphyry occur north of the batholith, and small porphyry and igneous breccia bodies intrude the Davidsville Group between Burnt Lake and Bellmans Pond. All are assumed to be of similar late Silurian to Devonian age. The youngest rocks are a stock of pegmatitic biotite-titanaugite gabbro of probable Jurassic age at Dildo Pond.

The Gander Group (unit **COG**) consists of a lower, mainly psammitic, unit (Jonathons Pond Formation, **COGj**) and an upper unit of pelite (Cuff Pond pelite, **COGc**). The Jonathons Pond Formation (O'Neill, 1991) consists of monotonous white to pale green feldspathic sandstone and pebble sandstone with minor interbedded black pelite and rare calc-silicate lenses. The psammite consists predominantly of rounded, embayed or slightly sutured quartz with subordinate plagioclase and minor sericite and chlorite in beds 15 to 100 cm thick, which exhibit flute casts east of Joe Batts Pond. Pebbles, where present consist of similar psammite or pelite fragments (shale chips) presumed to be derived from intercalated pelitic layers. Epidote-rich calc-silicate lenses up to 10 cm thick and a metre long occur sparsely where pelitic layers are absent and amphibolite layers up to 1 metre thick are present in a few outcrops. Black pelitic schist rich in pyrite and graphite commonly forms thin interbeds in the upper part of the Jonathons Pond Formation, which is gradational to the overlying Cuff Pond pelite. The Cuff Pond pelite comprises black pyritic and graphitic schist with 10-40 percent of sandstone beds up to a metre thick. This unit is well exposed along Highway 330 southwest of Jonathons Third Pond. The age and thickness of the Gander Group are not well constrained. The depositional age must be younger than 540 Ma detrital titanite and zircon found within it (O'Neill, 1991) and older than the overlying Arenig Indian Bay Big Pond Formation (Wonderly and Neuman, 1984), that is mid-to late Cambrian or Tremadoc. The thickness of the Cuff Pond pelite is unlikely to excede a few hundred metres, and may be much less, allowing for complex deformation. The thickness of the Jonathons Pond Formation is unknown, since the base is not exposed, and the formation is intricately folded, but a thickness of hundreds or even thousands of metres is suggested by the very widespread occurrence of the formation.

O'Neill (1991) proposed the name Gander River Complex (**COG**) for the intricate assemblage of plutonic and volcanic rocks which form a continuous belt from 3 to 8 kilometres wide along the east side of the Gander River. This belt consists of six units, namely pyroxenite, serpentinite, gabbro, basalt flows and fragmentals, trondhjemite (generally brecciated) and plagioclase porphyry or dacite. Contacts between these units are commonly faulted. Although the Gander River Complex is generally assumed to be a disrupted ophiolitic allochthon emplaced in early Arenig time (Colman-Sadd et al., 1992), field relations do not permit confident reconstruction of its form. Coarse deep greenish black pyroxenite(**COGp**) occurs in a large area west of Jonathons First Pond. Large (3 mm to 6 cm) pyroxene crystals float in a matrix of serpentine. Microscopic examination shows that the rock consists mainly of diopsidic augite, commonly with exsolved orthopyroxene lamellae, and small amounts (<15%) of orthopyroxene. Alteration to tremolite, bastite (for orthopyroxene), talc, carbonate and prehnite is ubiquitous. Locally the pyroxenite exhibits a crude layering defined by size variation of crystals. Mappable amounts of deep green serpentinite (**COGs**) occur mainly along the west margin of the Gander River Complex, but also as isolated pods within the pyroxenite. Although the unit consists largely of a felted mass of serpentine, magnesite is an important constituent in many specimens, and locally forms monomineralic layers interspersed with serpentine. Talc, tremolite and remnant clinopyroxene occur in variable amounts. Magnesite layers are locally rich in chromite seams which can be readily recognised by their colour. Quartz veins commonly occur in the serpentine- magnesite rock. Gabbro (**COGg**) forms a mass several kilometres across north of Jonathons Third Pond which is well exposed on Highway 330 near Island Pond Brook. Gabbro varies from massive to strongly foliated, and from medium-grained to pegmatitic. The rock consists of strongly saussuritized andesine, diopsidic augite variably altered to amphibole and chlorite and other secondary minerals (carbonate, prehnite, epidote). Pegmatitic pods up to a metre across are invariably leucocratic. Gabbro locally grades to tonalite, comonly with development of igneous breccias with tonalite matrix. The gabbro is cut by numerous finely comminuted breccia veinlets. Volcanic rocks (**COGb**) form a discontinuous fringe along the southeast side of the complex, with another occurrence along the Gander River. Flows consist of amygdaloidal massive to pillowed, plagioclase phenocrystic basalts and basalt breccia profusely veined with epidote and carbonate. The southwestern end of the belt of volcanics is rich in green tuffaceous phyllites interspersed with rare basalt flows. Some of these phyllitic rocks resemble the Davidsville Group (**OD**) and may be tectonically interleaved with the Gander River complex. Trondhjemite (**COGt**) forms small pods and plugs which are invariably brecciated, in some cases to the extent that rounded fragments "float" in a fine-grained comminuted matrix. The rock consists essentially of quartz and oligoclase, with no mafic minerals except trace amounts of opaque. Minor secondary chlorite, epidote and carbonate may be present. Plagioclase porphyry, similar to but finer-grained and less brecciated than trondhjemite, forms a large, but poorly exposed body north of Jonathans Third Pond.

The Davidsville Group (**OD**) comprises clastic sedimentary rocks whose base rests directly on the Gander River Complex. The stratigraphy of the Davidsville Group has been a problem since its original (unsatisfactory) definition by Kennedy and McGonigal (1972) because it consists largely of homogeneous, dark grey shale whose intense cleavage masks isoclinal folding and fault imbrication, both of which are known to be present from favourable exposures. O'Neill and Blackwood (1989) informally divided the group into a basal Weirs Pond Formation, a medial Hunts Cove Formation of shale rhythmites and an upper Outflow Formation with sandstone and pebble conglomerate interlayered with shale rhythmites. Currie (1992) pointed out that "Weirs Pond Formation" as used by O'Neill and Blackwood (1989) includes two diverse units, namely a calcareous quartz sandstone, limestone and limy shale unit accumulated on a stable marine shelf, and turbiditic conglomerate ranging from basal brecciated Gander River Complex with minor sedimentary infilling to upper pebbly or granule sandstone interbedded with greenish shales. The name Weirs Pond Formation is here restricted to the marine shelf sequence.

Within the map-area Weirs Pond Formation (**ODW**) occurs in a large fault slice intersected by Highway 330. The rocks consist predominantly of fine to coarse-grained sandstone with local pebble beds containing trondhjemite, porphyry and rare jasper pebbles. Grains are well-rounded, well-sorted and sedimentary structures generally well preserved. The matrix (<20 percent) is slightly calcareous. On Highway 330 north of Island Pond Brook black graphitic slate is interbedded with grey-green calcareous phyllite and limestone beds up to 2 metres thick. These occurrences are incongruent with the Gander River Complex and coarse conglomerate and breccia, and are interpreted to be a fault sliver. However the Weirs Pond Formation is known to lie unconformably above the Gander River Complex east of the map-area (O'Neill, 1991). The thickness of the Weirs Pond Formation is unknown, No fossils have been recovered from the outcrops described, but the Weirs Pond Formation has been dated as late Arenig to Llanvirn by brachiopods, trilobites and conodonts (McKerrow and Cocks, 1977; Currie et al., 1981).

The turbiditic part of the Davidsville Group consists of basal Outflow Formation overlain by Hunts Cove Formation. This relation can be observed at numerous localities (Currie, 1995a), but is strikingly well exposed at the type locality of the Outflow Formation on the east side of The Outflow of Gander Lake (gridref 561239, NTS 2 D/15), on Highway 330 (gridref 843537, 2 E/1) and on a woods road near South Pond (gridref 619381). Brecciated Gander River Complex with sedimentary infilling (sand, pebble conglomerate) grading into coarse clast to matrix-supported conglomerate with clasts of Gander River Complex in a serpentine and chromite-bearing matrix outcrops sporadically along and within the western margin of the Gander River Complex from Barrys Ponds (gridref 915584, 2 E/1 and 2 E/8) as far as Gander Lake the thickness of the material varies rapidly due to both depositional factors and tectonic excision. Along Highway 330 where such breccias are folded into (and with) the Gander River Complex (gridref 817482), fault imbricated with the complex (828506) and (gradationally) above the complex (842531). Gradation from such basal breccia to pebble conglomerate and sandstone can be observed along Highway 330 near gridrefs 842531 and 817482. The lower part of the Outflow Formation comprises thick beds (30-100 cm) grading upward from pebble or cobble conglomerate to laminated sandstone and grey-green siltstone-shale laminae. Serpentine pebbles are characteristic of this lower part, but the bulk of the debris is everywhere felsic, mainly blue quartz, porphyry, and grey feldspathic psammite clasts. Bed thickness and grain size decrease upward and much of the formation has bed thicknesses of 5-10 cm. Thick (to 1.5 m) beds of graded or massive sandstone occur rarely in the upper part of the formation. The Outflow Formation grades to Hunts Cove Formation by thinning of beds and increase in proportion of siltstone-shale rhythmites. The boundary is arbitrarily defined at 25 percent sandstone, which corresponds to an average bed thickness of about 3 cm. The apparent thickness of the Outflow Formation varies from a minimum of about 60 m along Highway 330 (where the base of the formation is faulted off), to almost 500 m on the west shore of Gander Bay (where small folds are present in the section). Based on measured sections and map patterns, the best estimate for the thickness of the formation is 200-300 m.

The Hunts Cove Formation includes the "shale" portion of the Davidsville Group including siltstone and mudstone rhythmites, mudstone-shale rhythmites and several varieties of shale. The formation could possibly be formally subdivided. The base of the Hunts Cove Formation can be examined along Highway 330 and on various woods roads north and south of Bellmans Pond. Close to the Gander River Complex the basal facies is a pale green mudstone bedded on a centimetre scale which contains sporadic pale purple intervals up to a metre thick. West of Gander River the basal facies is pale grey mudstone-shale rhythmites with cm-scale beds grading from basal mudstone to darker grey shale. Both facies contain within them occasional massive sandstone beds 2 to 65 cm thick. The upper part of the formation consists of homogeneous dark grey shale, commonly intensely cleaved. Rare exposures in fold cores preserve cleavage-bedding relations, showing that beds were 5 to 20 cm thick. The distribution of the Outflow Formation, combined with cleavage-bedding relations from favorably oriented road cuts, gives the gross fold structure. Dividing the width of synclines in shale by two suggests the thickness of the Hunts Cove Formation does not excede 1000 m. It could be less because of undetected folds, but it could also be greater because the top of the formation has nowhere been observed. Assuming a thickness of 1000 m, the total thickness of the Davidsville Group is about 1300 to 1400 m.

The age of the turbiditic part of the Davidsville Group is not directly known since it is unfossiliferous. (All fossil localities date the Weirs Pond Formation or the Main Point Formation of the Hamilton Sound Group.) However its age is constrained between the Arenig obduction of the Gander River Complex (Colman-Sadd et al., 1992) and the Llandovery age of the overlying Indian Islands Group. The late Arenig-Llanvirn ages of fossils from the Weirs Pond Formation probably also date the turbidites, because both form a sedimentary cover on the Gander River Complex.

Heavily sheared, black graphitic pelite (**ODu**) of uncertain age and affinity is exposed on Highway 330 south of Weirs Brook, on the Gander River at Second Pond, and in a small quarry on the south edge of the sheet. All these occurrences are surrounded by Gander River complex, and clearly form thin smears along faults. They may be correlative to Caradocian black shale exposed at Weirs Pond east of the map area (O'Neill, 1991).

The Indian Islands Group(**SI**) forms a Silurian marine shelf assemblage found as isolated fragments along the east side of the Dog Bay Line (Williams et al., 1993). Contact with the Davidsville Group has only been observed along high-angle east-over-west faults, but these faults appear to be minor and probably conceal an unconformity. The Indian Islands Group consists of discontinuous basal limestone or limestone breccia (Seal Island formation, **SIS**) grading up into calcareous siltstone (Charles Cove Formation, **SIC**) and eventually into shale. Brecciated, vuggy, buff, *Halysites*-bearing limestone and limy shale form an horizon about 10 m thick on Salmon River (gridref 539293) and on the east side of Rocky Pond. The limestone is conformably overlain by greenish-grey calcareous siltstone (**SIC**) which contains a few discrete limestone lenses 1 to 5 cm thick and up to 50 cm long. Outcrops of this formation were formerly assigned either to the Botwood Group or to the Outflow Formation (Williams, 1964; Blackwood, 1982), but the rocks differ from the Outflow Formation by lack of grading, and uniform silty composition, and from (most of) the Wigwam Formation of the Botwood Group by lack of mica. Llandovery fossils occur in a well known locality on Salmon River and nearby Trans-Canada Highway (Williams, 1972). The thickness of the Charles Cove Formation is uncertain because folding is difficult to detect. An apparent thickness of 1200 m on the Salmon River appears to represent a single fold, suggesting a minimum thickness of about 600 m. Just south of the map area the Charles Cove Formation grades upward to a few m of grey shale with distinctive mm-scale buff siltstone beds (Horwood Formation), and eventually to red shale and siltstone of the late Silurian Ten Mile Lake Formation (**ST**) which oversteps the Dog Bay Line (Currie, 1993).

Between the Dog Bay Line and Reach Fault rocks have been assigned to either the Duder Complex (**SD**) or the unconformably overlieing Ten Mile Lake Formation. The Duder Complex appears as a narrow belt along the Reach Fault and in a small area on the west side of South Pond. In map-area 2 E/7 (Currie, 1995b) the complex forms three fairly well-defined belts, namely from west to east, sheared black shale or mudstone matrix, boudined and brecciated mafic volcanic and plutonic rocks, and an east-facing section of siltstone and greywacke. This order appears to be reversed in map-area 2 E/2. Sheared siltstone-shale just west of South Pond contains a large (>100 m) inclusion of salic and mafic volcanics on the north side of the road 250 m west of South Pond. Rock types in this occurrence are reminiscent of the Klutha gold prospect to the north. Boudined and brecciated pillow basalt with interstitial carbonate and a sparse matrix of black shale and siltstone occur on Ten Mile Lake and from Fox Pond north toward Long Pond. Black chert similar to the Baytona Formation of the Exploits Group occurs east of Long Pond (gridref 632573). The most westerly exposures assigned to the Duder Complex, north of Island Pond, comprise grey feldspathic sandstone which also contains dekametre-scale boudins of both mafic and salic volcanic rocks. Near gridref 576516 this unit is conglomeratic with clasts of brecciated trondhjemite up to 40 cm across, and rests unconformably on trondhjemite. Near gridref 637543 a window in the Ten Mile Lake Formation exposes sheared siltstone containing a large (>2 m) clast of richly fossiliferous limestone resembling blocks found in the Badger Group conglomerates. The protolith(s) of the Duder Complex remain uncertain, but the presence of pillowed basalts similar to the Loon Harbour Volcanics, black chert similar to the Bytona Formation, and fossiliferous limestone blocks similar to those in the Badger Group suggest that parts of the Exploits and Badger groups are represented. Evans et al. (1992) correlated the psammite north of Island Pond with the Botwood Group.

The Duder Complex is overlain by a distinctive sequence (Ten Mile Lake Formation, **ST**) which consists mainly of of purple to crimson shale interbedded with thin pink sandstone beds, and 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 metres thick, and to unconformably overlie the Duder Complex, although no exposed contacts have been found. Significant cleavage and steep dips of bedding within the Ten Mile Lake Formation are more abundant in map-area 2 E/2 than in 2 E/7 to the north, but low dips and open folds are characteristic of a broad swath extending from Ten Mile Lake to Salmon Pond. Northeast and south of the map-area the formation oversteps the Dog Bay Line without obvious displacement, and conformably overlies the Wenlock or younger strata (Currie, 1995a).

Rocks west of the Reach Fault form a stack of north vergent thrust slices. Units of the Exploits Group (**OE**) occur in several slices. Most of the Llanvirn 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. West of Indian Arm Brook the Loon Harbour Volcanics contains amygdaloidal basalt flows with rare interstitial carbonate lenses, and grey fragmental rhyolite or dacite. The basaltic volcanics are of non-arc chemistry (K.L. Currie, unpublished data). Loon Harbour Volcanics grade up through salic volcanics to silicified salic tuff and chert.belonging to an overlying composite unit of chert and black shale (Baytona Formation, **OEB**) which can be divided into two units to the west (Strong Island Chert and Luscombe Shale, O'Brien, 1993). However in this map-area poor outcrop and blackening of chert due to hornfelsing makes it impossible to reliably distinguish these two units which 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, but east of the brook, bedded cherts are black, and rich in pyrite and pyrolusite and contain thin black shale beds in chert. At the mouth of Indian Arm Brook (just north of the map area) this unit 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). The contact between Baytona Formation and greywacke of the overlying Badger Group (**OSB**) has not been observed in this map area, but elsewhere is conformable, or almost so (Currie, 1995b). 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. Greywacke between Indian Arm Brook and Long Pond coarsens upward from homogeneous fine-grained green turbiditic siltstone and dark grey mudstone to massive greywacke with rare pebbly beds. The pebble to cobble conglomerate intervals within the greywacke become thicker and more numerous toward the top of the section, and 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 metre thick occur within the conglomerate. The character of the conglomerate is essentially identical in all three major occurrences, west of Dildo Pond, southwest of Long Pond and southwest of Dans Pond.

A contact between the Badger Group and overlying Botwood Group (**SB**) is exposed north of the map-area near Port Albert (Williams, 1993), where a weak cleavage in the Badger Group may be truncated at the contact. 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. Ignimbrites occur within the Lawrenceton Formation to the west (O'Brien, 1993) but none were observed in this map-area. The Wigwam Formation (**SBW**), homogeneous pale green to buff micaceous sandstone, commonly rather thin-bedded and well ripple-marked, occurs in fault slices around Confederation Pond and Lake O'Brien. The Botwood Group is known from other map areas to be of Llandovery to early Wenlock age (Williams, 1972).

Igneous rocks of late Silurian to Devonian age cut all older rocks throughout Gander River map-area. Uralitised and saussuritised north to northeast-trending gabbro dykes from 1 to 350 metres wide (**SDm**) cut the Duder Complex, Ten Mile Lake Formation and Charles Cove Formation, and hence are of late Silurian or younger age. The northeast portion of the Mount Peyton igneous suite in the southwest corner of the map area consists of poorly exposed medium to coarse-grained two-pyroxene gabbro in which intersertal texture with plagioclase lathes surrounding pyroxene is well preserved but both plagioclase and pyroxenes are partly to totally altered. To the west and south this unit has been radiometrically dated at about 425 Ma (see Dickson, 1994 for summary). No outcrops of granitic rocks were observed in the Mount Peyton igneous suite within the map-area, but there are large numbers of boulders of grey leucocratic biotite granite, and an outcrop of similar rocks occurs on the Trans Canada Highway just west of the map area. The Mount Peyton igneous suite is surrounded by a hornfels aureole 100-200 m wide which in the Duder Complex locally contains andalusite spots. Two minor intrusions of grey to buff biotite granite (**SDg**) occur 15 km north of the Mount Peyton igneous suite, and are thought to be correlative with the granitoid portion of the suite. East of the Dog Bay Line feldspar porphyries charged with rounded fragments of Outflow Formation occur at Bellmans Pond. These rocks were previously mapped as conglomerate (Blackwood, 1982), but the matrix is feldspar-porphyritic dacite or rhyolite. The youngest rock in the map-area is pegmatitic biotite-titanaugite gabbro believed to be of Jurassic age (Strong and Harris, 1974) exposed at Dildo Pond.

The structure of areas to the north and west of Gander River map area has been examined in detail (Karlstrom et al., 1982; Elliot et al., 1989; Lafrance and P.F.Williams, 1992; O'Brien, 1993), who concluded that all or most deformation was of Llandovery and younger age. Gently west-dipping cleavage axial planar to sheath-like folds occur in the Gander Group, and possibly also in the Gander River Complex. These features may be related to Arenig or older eastward obduction of the Gander River Complex (Colman-Sadd et al., 1992), but this has not been demonstrated, and the structures have certainly been modified by post-Caradoc events as noted below. West of the Gander River Complex the earliest deformation (D_1 of Lafrance and Williams, 1992) comprises small scale thrust ramps and flats in the Badger and Davidsville Groups, together with associated intrafolial folds. Relatively steep ramps and flats are also abundant in the western part of the Gander River complex where they overprint older flat structures. 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 may be 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 in the Davidsville Group, small dextral folds, and abundant dextral movement indicators closely associated with faults. Upright, tight to isoclinal, gently doubly-plunging, kilometre-scale folds can be defined in the Davidsville Group by lithology distribution cleavage-bedding relations. Small folds of similar style occur in the Indian Islands Group. West of the Reach Fault the regional cleavage dips southeast, and the folds are overturned toward the northwest. 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 prospect near Big Pond. The orientation of these folds commonly suggests a small element of southeast-over-northwest motion. Small, post-folding, high-angle, east-over-west reverse dextral faults are common in the Outflow Formation where they have modified all contacts between the Outflow Formation and Indian Islands Group. The Dog Bay Line is marked by zones of phyllonite with shallowly plunging lineations, sparse mylonitised quartz veins, and some brittle shattering, particularly in the Indian Islands Group. It appears to be a late D_2 structure. D_2 structures affect the Llandovery-Wenlock Botwood and Indian Islands Groups, but are truncated by the late Silurian Mount Peyton igneous suite. Deformation is therefore of mid-to late Silurian age. Youngest deformation (D_3) in the map area is witnessed by a set of north-northeast trending sinistral brittle faults, notably the Reach Fault, which are themselves offset by small east-northeast trending dextral faults. All of these faults appear to be truncated by the Mount Peyton igneous suite, which certainly does not exhibit the 15 km of sinistral motion estimated for the Reach Fault to the north (Williams et al., 1993). If the report of offset of a Jurassic? lamprophyre dyke in the Bay of Exploits (Elliot et al., 1991) is correct, these faults must have been locally reactivated during Mesozoic time.

A speculative synthesis of the structure of this region assumes the Davidsville Group 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 west of the Reach Fault represent filling of a basin formed by rifting of a mid-Ordovician (post-obduction) west-facing volcanic arc (compare Swinden et al., 1990). The Loon Harbour Volcanics and Baytona Formation are back-arc basin deposits in this model while 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. This event shortened strata to the southeast sufficiently to imbricate the Gander River Complex with its sedimentary cover. Subsequent shortening was accomodated by early Silurian westward subduction of the floor of the basin, eventually leaving the Botwood Group, accumulated on the western (active) margin of the closing basin, and the Indian Islands Group, accumulated on the eastern (passive) margin, separated only by the Duder Complex. Such westward subduction could be responsible for the ubiquitous early north-over-south thrusts deduced by Lafrance and Williams (1992), while the subsequent dextral transpressive regime followed continent-continent collision in Wenlock or Ludlow time and created the Dog Bay Line approximately along the line of collision. 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 Ten Mile Lake Formation was deposited in the brief interval between collision and climactic plutonic activity in late Silurian time. Latest sinistral/dextral transcurrent faulting which created the Reach Fault and parallel faults is compatible with further northwest-southeast compression prior to pluton emplacement. .

Gold mineralisation occurs associated with both the GRUB and Dog Bay Lines. The Jonathans Pond prospect (Blackwood, 1982, gridref 777401), northwest of Jonathans Third Pond, is hosted by fine to medium-grained gabbro of the Gander River Comnplex. Gold mineralisation occurs in quartz-pyrite-arsenopyrite veins controlled by extensional shears. Grades as high as 0.28 oz Au per ton over 2 m have been reported (Evans, 1994). Anomalous Au values due to grains in till have been reported from a substantial area around Jonathans Third Pond (Evans, 1994). The source of these Au grains is unknown. Along the Dog Bay Line, the Big Pond prospect (gridref 577413) southwest of Big Pond occurs in altered, deformed gabbro which either intrudes the Ten Mile Lake Formation or forms a block within the Duder Complex. Gold occurs in a sheet-like set of quartz veins within the gabbro which assayed up to 441 g/t Au. Occurrences of chromite, magnesite, chalcopyrite and asbestos in the Gander River complex have been reported by Blackwood (1982), as noted on the map.

REFERENCES

Blackwood, R.F.
1982: Geology of the Gander Lake (2 D/15 and Gander River (2 E/2) area. Newfoundland Mineral Development Division Report 82-4, 56 p.

Colman-Sadd, S.R., Dunning, G.R. and Dec, T.
1992: Dunnage-Gander reltionships and Ordovician orogeny in central Newfoundland: a sediment provenance and U/Pb age study. American Journal of Science 292, 317-355

Currie, K.L.
1992: A new look at Gander-Dunnage relations in Carmanville map-area, Newfoundland. Geological Survey of Canada Paper 92-1D, 27-33

Currie, K.L.
1995a: A tale of shale - stratigraphic problems in the Gander River map-area (2 E/2) Newfoundland. Geological Survey of Canada Current Research 1995-D (in press)
1995b: Geology, Comfort Cove-Newstead map-area (2 E/7), Newfoundland. Geological Survey of Canada Open File (in press)

Currie, K.L., Pajari, G.E. and Pickerill, R.K.
1980: Carmanville map-area, Newfoundland (2 E/8). Geological Survey of Canada Open File 776

Currie, K.L., Pickerill, R.E. and Pajari, G.E.
1979: Tectono-stratigraphic problems in the Carmanville area, northeastern Newfoundland. Geological Survey of Canada Paper 79-1A, p.71- 76

Dickson, W.L.
1994: Geology of the southern portion of the Botwood map-area (NTS 2 E/3), north central Newfoundland. Newfoundland Geological Survey Branch Report 94-1, 101-116

Elliot, C.G., Dunning, G.R. and Williams, P.F.,
1991: New U/Pb zircon age constraints on the timing of deformation in north-central Newfoundland and implications for early Paleozoic Appalachian orogenesis. Geological Society of America Bulletin 103, 125-135

Evans, D.T.W.
1993: Epigenetic gold occurrences, eastern Dunnage Zone. unpublished contract report to the Geological Survey of Canada

Evans , D.T.W., Hayes, J.P. and Blackwood, R.F.
1992: Gander River. Newfoundland Geological Surveys Branch Map 92-21

Karlstrom, K.E., van der Pluijm, B.A. and Williams, P.F.
1982: Structural interpretation of the eastern Notre Dame Bay area, Newfoundland: regional post-Middle Silurian thrusting and asymmetrical folding. Canadian Journal of Earth Sciences 19, 2325-2341

Kennedy, M.J. and McGonigal, M.H.
1972: The Gander and Davidsville groups of northeastern Newfoundland; new data and geotectonic implications. Canadian Journal of Earth Sciences 9, p.452-459

Lafrance, B., and Williams, P.F.
1992: Silurian deformation in eastern Notre Dame Bay, Newfoundland. Canadian Journal of Earth Sciences 29, 1899-1914

McKerrow, W.S. and Cocks, L.R.M.
1977: The location of the Iapetus Ocean suture in Newfoundland. Canadian Journal of Earth Sciences 14, 488-495

O'Brien, B.H.
1993: A mapper's guide to Notre Dame Bay's folded thrust faults; evolution and regional development. Newfoundland Department of Mines and Energy Report 93-1, 279-291

O'Neill, P.P.
1991: Geology of the Weirs Pond area, Newfoundland (NTS 2 E/1). Newfoundland Department of Mines and Energy Geological Surveys Branch Report 91-3, 144 p.

O'Neill, P.P. and Blackwood, R.F.
1989: A proposal for revised stratigraphic nomenclature of the Gander and Davidsville groups and the Gander River ultrabasic belt of northeastern Newfoundland. Newfoundland Department of Mines and Energy Mineral Development Division Report 89-1, pp.127-130

Srong, D.F. and Harris, A.
1974: The petrology of Mesozoic alkaline intrusives of central Newfoundland. Canadian Journal of Earth Sciences 11, 1208-1219

Swinden, H.S., Jenner, G.A., Fryer, B.J., Hertogen, J. and Roddick, J.C.
1990: Petrogenesis and paleo-tectonic history of the Wild Bight Group, an Ordovician rifted island arc in central Newfoundland. Contributions to Mineralogy and Petrology 105, p.219-241

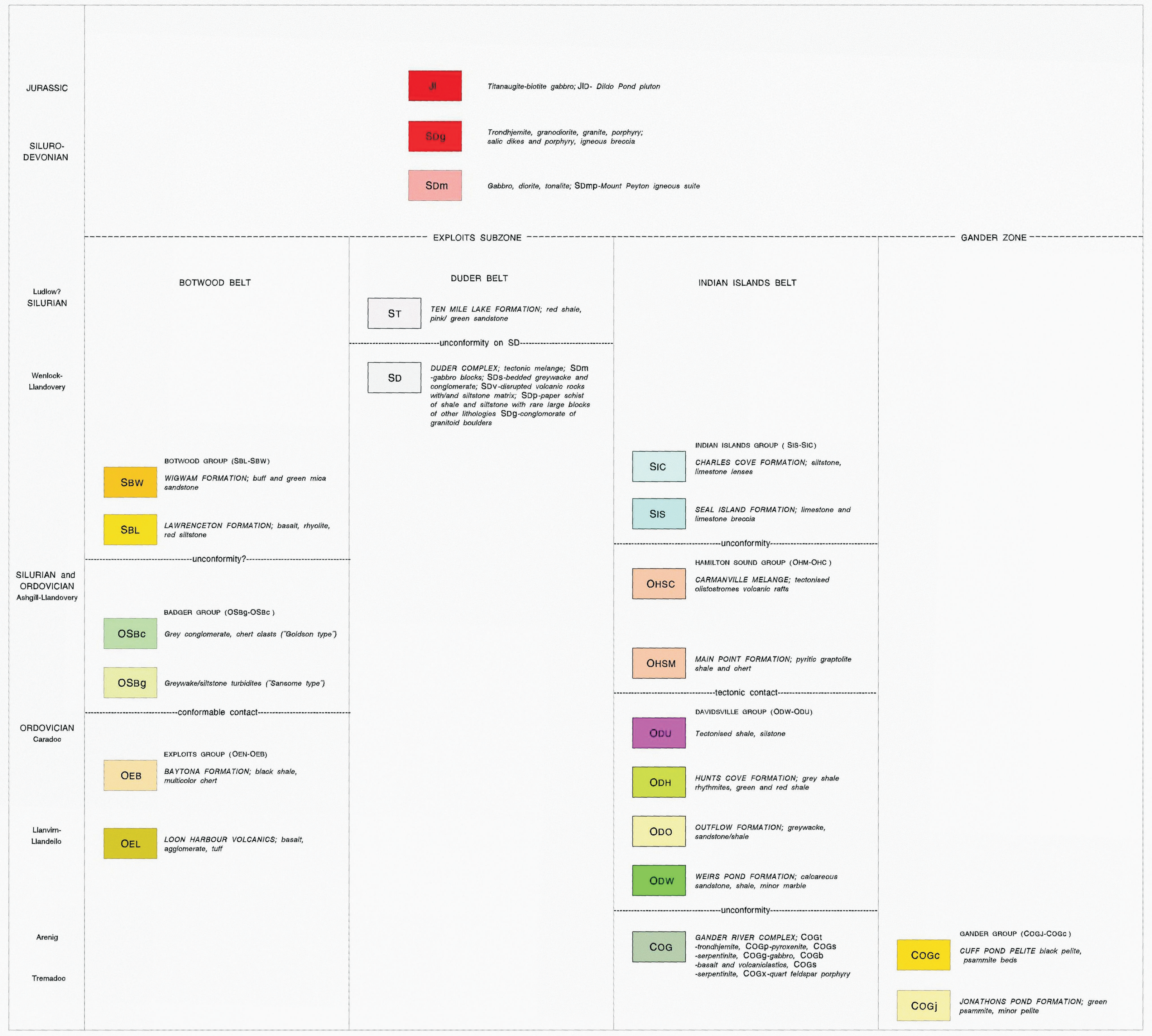
Williams, H.
1964: Botwood, Newfoundland. Geological Survey of Canada Map 60-1963
1972: Stratigraphy of Botwood map-area, northeastern Newfoundland. Geological Survey of Canada Open File 113.

Williams, H., Colman-Sadd, S.P. and Swinden, H.S.
1988: Tectonic stratigraphic subdivisions of central Newfoundland. Geological Survey of Canada Paper 88-1B, p.91- 99

Williams, H, Currie, K.L. and Piasecki, M.A.J.
1993: The Dog Bay Line: a major Silurian tectonic boundary in northeast Newfoundland. Canadaina Journal of Earth Sciences 30, 2481-2494

Williams, S.H..
1993: More Ordovician and Silurian graptolites from the Exploits Zone, Newfoundland. Newfoundland Department of Mines and Enegy Report 93-1, 311-316

Wonderly, P.R. and Neuman, R.B.
1984: The Indian Bay formation: fossiliferous early Ordovician volcanogenic rocks in the northern Gander Terrane, Newfoundland and their regional significance. Canadian Journal of Earth Sciences 21, 525-532



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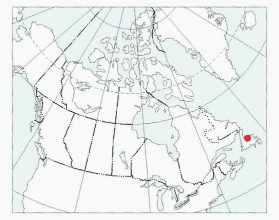

LOCATION MAP

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GEOLOGY

GANDER RIVER

NEWFOUNDLAND

Scale 1:50 000 - Échelle 1/50 000

Kilometres 1 0 1 2 3 4 Kilomètres

Projection transverse de Mercator
MC 54°45', facteur d'échelle 1
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