DESCRIPTIVE NOTES

The Nippers Harbour map area in the northeast part of Baie Verte Peninsula (Newfoundland and Labrador) is one of three in a 1:50 000 scale maps in this area that are based on new and compiled bedrock geological (including geochronological and geochemical) data and detailed mineral deposit studies (Fig. 1). The Baie Verte Peninsula, the northeast tip of which is underlain by five lithotectonostratigraphic entities including: Neoproterozoic to Early Paleozoic rocks of the Laurentian continental margin (King's Bight Group); Cambrian ophiolite (Betts Cove and Pacquet complexes); Lower Ordovician ophiolite cover (Snooks Arm Group), and Upper Ordovician to Silurian continental, volcanic-plutonic rocks (Burlington plutonic suite, Confusion Bay plutonic suite and Cape St. John Group). The IUGS time scale of Cohen et al. (2013) is utilized herein.

TECTONOSTRATIGRAPHY AND SETTING

The Nippers Harbour area is situated in the northeast part of the Fleur de Lys Supergroup and correlates with the Rattling Brook Group to the west (Hibbard, 1983). It comprises pelite, semipelite, psammite, and minor metacoglomerate with small pods of mafic amphibolite and fuchsite actinolite schist. The metaclastic rocks are associated with larger panels of massive to pillowed, tholeiitic metabasalt and amphibolite, termed Petty Point schist by Hibbard (1983) and these are herein correlated with the ca. 560 Ma Blochy Complex (unit nPBm; van Staal et al., 2013). Originally described as a continental margin promontory (Hibbard, 1983), the Ming's Bight Group has since been recognized as an extensional core complex that exposes the Laurentian continental margin (Anderson et al., 2001).

The Ming's Bight Group in the Nippers Harbour area is the best preserved and most complete section of ophiolite crust on Baie Verte Peninsula (Bédard et al., 2000). (The Pacquet complex to the west comprises correlative dismembered ophiolite). A sheared serpentinite (unit Cxss) at the structural base of the Betts Cove Complex is overlain and in fault contact with intrusive rocks including layered ultramafic cumulate rocks (unit CIdnu), cumulate gabbro and pyroxenite (unit CIdn), massive gabbro (unit CIdm), late intrusive gabbro (unit CIdg) dated at 488.6 ± 1.1-1.8 Ma (location 22, Table 1), and sheeted dykes (unit CIds). The sheeted dyke complex is in fault contact with overlying pillow basalt, pillow breccia and sheeted dykes and pillowed basalt (unit CIdvbs). The Betts Head Formation (unit CIdvbs), in the lower volcanic section includes sparsely porphyritic and spherulitic bonnitite pillow lavas and breccia units that are chemically subdivided into low- and intermediate-Ti varieties (Bédard et al., 2000b, and references therein). In contrast to the stratigraphy defined by Bédard et al. (2000b), the present authors include the volcanic rocks of the Mount Misery Formation (unit CIdvm) in the Betts Cove Complex, as they are in fault contact with the Betts Cove Complex (Skulski et al., 2010). The Mount Misery Formation is composed of clinopyroxene-phyric, pillowed tholeiitic to basalt flows and breccia units that are interbedded with, and chemically equivalent to the intermediate-Ti bonnitite units.

The Lower to Middle Ordovician Snooks Arm Group (Bédard et al., 2000b; Skulski et al., 2010) overlies the Betts Cove and Pacquet complexes. The Scrape Point Formation rests paraconformably to locally disconformably on underlying ophiolite crust. The basal Nugget Pond member (unit OSPr) comprises a local, basal sedimentary breccia overlain by clasts of pillow basalt and chert cemented by quartz and magnetite (Sangster et al., 2007), overlain by jasper iron-formation interbedded with pillowed basalt (unit OSPm). The Scrape Point Formation is overlain by the Rogers Harbour Formation (unit OSRv) and by the Lunn Point Formation (unit OSlp) and related volcaniclastic rocks (unit OSlv). The overlying Bobby Cove Formation includes a lower calc-alkaline pillow basalt and andesite (unit OBcm), overlain by a regionally distinctive marker unit (Prairie Hat member; unit OBcc) consisting of clinopyroxene-phyric to megacrystic, intermediate-, calc-alkaline crystal tuff to tuff breccia. The Prairie Hat member is overlain by a 470 ± 4 Ma (location 16, Table 1) felsic crystal tuff (unit OBst) that is interpreted to be the stratigraphic equivalent of the Little Passage Point Formation (Skulski et al., 2010). An iron-formation marker unit (unit OBcf) lies at the top of the Bobby Cove Formation and consist of banded jasper or quartz-magnetite iron-formation. The Venams Bight Formation consists of tholeiitic, pillowed basalt and related breccia (unit OVbm). The overlying Balsam Bud Cove Formation consists of black, graptolitic shale and turbiditic wacke (unit OBbs) covered by a felsic volcanic unit (unit OBst) including a 467 ± 4 Ma (location 14, Table 1) rhyolite overlying the Betts Cove Complex, and 470 ± 4 Ma (location 15, Table 1) lapilli tuff overlying the Pacquet complex. Thick-bedded, volcanic-derived conglomerate forms the upper part of the formation at Betts Cove. The Round Harbour Formation marks the top of the Snooks Arm Group and consists of basaltic to andesitic, pillowed to massive flows and breccia (unit OSlv) and felsic volcaniclastic, tholeiitic gabbro sills and dykes intrude the Snooks Arm Group (unit OSdg) and bonnitte units of the Pacquet complex.

Silurian (Llandoverian) plutonic rocks of the Burlington plutonic suite intrude the ophiolite complexes and the Snooks Arm Group cover. These include calc-alkaline, hornblende-biotite quartz diorite (unit SSqd) and biotite±hornblende granodiorite (unit SSgd) and tonalite (unit SSt). The Cape Brule Porphyry (unit SSbp) and Cape St. John Group (unit SJgp) intrudes the Burlington plutonic suite and includes pseudomorphous, biotite±muscovite tonalite-granodiorite, trondhjemite and muscovite-garnet leucogranodiorite (Epstein, 1983). The Wenlookian to Ludlovian Confusion Bay plutonic suite (Cape Brule Porphyry, Gunamagan granite, Rocktits Cove gabbro, Seal Island Bight granite, and La Scie granite) and Cape St. John Group are coeval and share common tholeiitic to alkaline parental magmas. The Cape Brule Porphyry is a composite early, subvolcanic pluton comprising tholeiitic, two feldspar-biotite-quartz-phyric monzogranite (unit SCbp) dated at 429 ± 4 Ma (location 6, Table 1), with a metamorphic, coarse-grained, granodiorite to monzogranite phase (unit SCbg) and a younger, two feldspar-biotite-quartz-phyric monzogranite (unit SCbp). The Cape Brule Porphyry has an unconformity separates the Cape St. John Group from the underlying Snooks Arm Group, Burlington plutonic suite, and Pacquet complex. A lenticular lower sedimentary sequence (Beaver Cove formation; unit SBca) comprises red-buff-weathering arkose and conglomerate. This is overlain by amygdaloidal tholeiitic basalt, alkaline basalt and hawaiite flows of the Long Pond formation (unit SLm). These are covered by welded rhyolitic tuff of the Goat Pond formation (unit SGhr) dated at 426.3 ± 1.1 Ma (location 3, Table 1). The Goat Pond formation is overlain by a thick, rhyolite to trachyte, lithic-crystal-tuff matrix of the Red Cliff Point formation (unit SRcrp) and a younger rhyolitic tuff breccia with blocks of basalt, rhyolite, and felsic tuff in a mafic, highly magnetic matrix (Goss Pond formation; unit SGrh). These are in turn overlain by fine-grained rhyolitic to comenditic tuff (Birch Pond formation; unit SBrh) and amygdaloidal basalt, alkaline basalt, hawaiite and fault-transitional basalt of the Mathis Pond formation (unit SMrm). Overlying intermediate to felsic lapilli tuff units are subdivided into the Mount Misery Formation (unit Scbd) and the Beaver Cove Formation (unit Scbv). The Mount Misery Formation (unit Scbd) and Cove formation (unit Scbv) with beige lapilli. These are overlain by a 426.1 ± 0.5 Ma (location 2, Table 1) flow-banded rhyolite that includes K-feldspar-phyric rhyolite (Welsh's Point formation; unit SWrh) that grades westward into tuff breccia, and overlying, comparatively aphyric flow-banded, high-K rhyolite of the Blanche Point formation (unit SBrh). A welded, high-K, quartz–two-feldspar-magnetite felsic tuff (Carolina Point formation; unit SCrh) is overlain by a white, high-K, K-feldspar megacrystic, flow-banded rhyolite (Aucoin Point formation; unit SAph). The Aucoin Point formation is overlain by a basaltic to amygdaloidal aphyric basalt unit (Glakes Pond formation; unit SGhm) and an upper flow-banded aphyric rhyolite (La Scie formation; unit SLsr). Younger phases of the Confusion Bay plutonic suite include the medium- to coarse-grained Dunamagon monzogranite (unit SDgr) dated at 427.2 ± 1.4 Ma (location 4, Table 1), equigranular to layered Reddits Cove gabbro (unit SRg), fine to medium-grained, Seal Island Bight syenite (unit SSsb) dated at 426.3 ± 1.1 Ma (location 3, Table 1), and Lobrie granite (unit SLb) locally with abundant mafic enclaves (unit SLblo).

Two caldera-collapse cycles are recognized in the Cape St. John Group and related Confusion Bay plutonic suite (Bédard et al., 2000b). The first cycle is defined by a thick succession of rhyolitic ignimbrite (unit SSbt) and a large, ring-fracture emplacement include prominent quartz plus two-feldspar porphyritic character in a fine-grained groundmass, presence of miarolitic cavities, reverse compositional zoning with a melanocratic core (unit SCblo) and leucocratic rim (unit SCbp), roof pendants of ophiolitic crust, dykes and plugs of intrusive felsic breccia (unit SCbx), and a half-ring dyke (unit SCbd) of granite porphyry. The extrusive equivalent of the Cape Brulé Porphyry (429 ± 4 Ma; location 6, Table 1) is the precotaige-welded tuff (unit SBrh), which is dated at 426.1 ± 0.5 Ma (location 2, Table 1). The second caldera-collapse cycle is marked by deposition of volcanic breccia units; initially with abundant ophiolitic and cover-related basement clasts (unit SHCrb) and later with cognate xenolithic (unit SGrb) culminating with caldera-fill tuff (unit SBrt). Resurgence of the caldera resulted in a ring dyke forming in a trap-door caldera uplift (unit Scbd) followed by eruption of mildly peralkaline rhyolitic tuff (unit Sbrt). A period of intracaldera resurgence involved eruption of lapilli tuff units (units SArt and SLtl), followed by eruption of flow-banded rhyolite domes (units Sbrh and SBrh) at 426.1 ± 0.5 Ma; location 2, Table 1, and SBrh). The second caldera collapse event may be distal (King's Point caldera at 427 ± 2 Ma; Coyle, 1990) and involved eruption of high-K rhyolitic tuff (unit SKtf), ash flow tuffs, eruption of high-K lapilli tuff (unit SKtl), and followed by later resurgence and eruption of rhyolite domes (unit SLtl).

ECONOMIC GEOLOGY

Three mines have operated in the Nippers Harbour map area (Sangster et al., 2007, and references therein). Copper-rich, sphalerite-hosted volcanogenic massive sulphide was mined in the Tilt Cove area, where ore lenses were hosted by the Betts Cove Complex and Snooks Arm Group. The Betts Cove deposit comprises copper-rich massive sulphide hosted by Betts Head formation bonnitte and underlying, sheeted dykes. The Nugget Pond mine is a past-producing gold mine where mineralization was hosted by quartz- albite-carbonate alteration in formation in the Nugget Pond member of the Scrape Point Formation (Snooks Arm Group).

TECTONOMETAMORPHIC EVOLUTION

At least four phases of regional deformation have affected the rocks of the eastern Baie Verte Peninsula (DeGrace et al., 1976; Hibbard, 1983; Stella, 1987; Tremblay et al., 1997; Anderson et al., 2001; Castonguay et al., 2009; Skulski et al., 2010, and references therein). In general, rocks show a general increase in strain and metamorphic grade from south to north across the map area.

Structures related to D_1 (D_0 of Hibbard, 1983) are weakly developed or poorly preserved. In the Betts Cove Complex, a northeast-directed reverse fault, interpreted as a D_1 obduction-related structure (Tremblay et al., 1997; Bédard et al., 2000b), juxtaposes the Betts Head and Mount Misery formations against cumulate peridotite, sheeted dykes, and serpentinite. The D_1 phase is interpreted as related to obduction of ophiolitic rocks, arc collision of the Baie Verte Oceanic Tract, and attempted subduction of the autochthonous margin during the Taconic Orogeny (Waldron et al., 1998; van Staal et al., 2009; Zagorevski et al., 2010). The Burlington Peninsula Fault (Tremblay et al., 1997; Bédard et al., 2000b; Skulski et al., 2010) is the main moat of the contact between the Betts Cove Complex and the Cape St. John Group, and southwards between the talc-serpentine schist and the Snooks Arm Group or Cape Brulé Porphyry.

Penetrative D_2 deformation (D_1 of Hibbard (1983); D_1 of Anderson et al. (2001)) is accompanied by greenschist-facies metamorphism. In the southern part of the peninsula, S_2 is a steep to moderately northeast- to northwest-dipping spaced cleavage (mesoscopic F_2 folds are rare) developed in the Cape St. John Group and Cape Brulé Porphyry. Stretching lineations suggest that the oncoplur F_2 folds plunge moderately to the northeast and, locally, subvertically. D_2 is related to a series of major cross-south- to southeast-directed shear zones, such as the fault that juxtaposes the Cape St. John Group and Cape Brulé Porphyry against the Betts Cove Complex (Tremblay et al., 1997; Bédard et al., 2000b). The D_2 deformation is characterized by open, upright F_2 cross folds that vary in style and fold plunge depending on the orientation of earlier structures. These north-trending folds are locally associated with a subvertical axial-planar cleavage. The D_2 and D_3 structural phases are interpreted to form part of a progressive deformation associated with the Salinic Orogeny (Skulski et al., 2010) that led to the development of a regional, northeast-trending, upright to overturned to the west, F_3 fold pair. The timing of peak metamorphism are locally constrained to be less than 425 Ma (location 2, Table 1; age of D_2 deformed upper Cape St. John Group) and as young as 417 Ma (location 41 and 103, Table 1. "$^{40}Ar/^{39}Ar$ hornblende and biotite ages). The later age (417 Ma) constrains the age of metamorphism of the ca. 440 Ma phase of the Burlington plutonic suite (units Sdgd and Sdqd), insofar as it is a depositional basement to the ca. 427 Ma King's Point volcanic complex in southeastern Baie Verte Peninsula.

The fourth deformation phase (D_3 of Hibbard (1983); D_{1-2} of Anderson et al. (2001)) is recognized in the northern part of the map area. It is characterized by shallowly inclined to recumbent, open to tight F_3 folds that are interpreted as coeval with the development of the Burlington Peninsula Fault (Tremblay et al., 1997). The Burlington Peninsula Fault is formed by transposition of S_{1-2} dips shallowly to the southeast. D_3 is locally the dominant structure in the Ming's Bight Group, where it is associated with an amphibolite-facies metamorphic overprint (with $^{40}Ar/^{39}Ar$ hornblende ages from 405 Ma (location 85, Table 1) to 359 Ma (location 59, Table 1); 385 Ma titanite (Location 30, Table 1), and $^{40}Ar/^{39}Ar$ muscovite from 365 Ma (location 82, Table 1) to 358 Ma (location 84, Table 1); Anderson et al., 2001), which has also affected the Cape St. John Group (Bédard et al., 2000b; Skulski et al., 2010). The Burlington Peninsula Fault is interpreted to be a north-dipping ductile-brittle normal faults overprint contacts of the Ming's Bight Group. The D_3 phase is interpreted to have initiated progressive extensional unroofing of the Ming's Bight Group during an overall dextral strike-slip (transpressional to transtensional) regime (Waldron et al., 1998; Anderson et al., 2001). Several northeast-trending faults occur in the southwestern part of the map area. They affect the Silurian intrusions with systematic apparent dextral offsets and are probably related to Green Bay Fault, running offshore Notre Dame Bay (Hibbard, 1983).

Abstract

Northeastern Baie Verte Peninsula (Newfoundland and Labrador; NTS 2-E/13 and parts of NTS 2-E/12, 2-E/14, 2-E/12) is underlain by the Neoproterozoic to Ordovician Ming's Bight Group, Cambrian ophiolite of the Betts Cove Complex, submarine Ordovician ophiolite cover of the Snooks Arm Group, and a continental overlap assemblage including Ordovician-Silurian Burlington plutonic suite, Stocking Harbour suite, Confusion Bay plutonic suite, Cape Brule Porphyry suite and Cape St. John Group. Three mines have operated in this area including two Cu volcanogenic massive-sulphide deposits in the Betts Cove Complex (Tilt Cove and Betts Cove mines), and gold in iron-formation in the Snooks Arm Group (Nugget Pond mine). Four phases of regional deformation affected this area. D_1, regional, obduction-related, northeast-reverse fault in the Betts Cove Complex related to ophiolite obduction; D_2, regional, penetrative deformation accompanied by greenschist metamorphism; D_3 related to open upright cross folds; and D_4 in the north, related to recumbent folding coeval with extensional faults, accompanied by an amphibolite metamorphic overprint.

Résumé

Le sous-sol de la partie nord-est de la péninsule Baie Verte (Terre-Neuve-et-Labrador; SNRC 2-E/13 et parties de SNRC 13-I/4, 2-E/14 et 2-E/12) est constitué du Groupe de Ming's Bight du Néoprotérozoïque à l'Ordovicien, des ophiolites du Complexe de Betts Cove du Cambrien, de la succession sous-marine de couverture des ophiolites du Groupe de Snooks Arm de l'Ordovicien, ainsi que d'un assemblage de chevauchement continental comprenant la suite plutonique de Burlington de l'Ordovicien-Silurien, la suite intrusive de Stocking Harbour, la suite plutonique de Confusion Bay et le Groupe de Cape St. John, tous du Silurien. Trois mines ont été exploitées dans cette région dont deux gisements de sulfures massifs volcanogènes riches en cuivre, dans le Complexe de Betts Cove (mines Tilt Cove et Betts Cove), et de l'or dans une formation de fer des formations de fer, dans le Groupe de Snooks Arm (mine Nugget Pond). Quatre phases de déformation régionales ont touché la région, dont D_1, limitée à une faille inverse à vergence nord-ouest dans le Complexe de Betts Cove et reliée à l'obduction des ophiolites; D_2, une déformation pénétrative régionale accompagnée d'un métamorphisme au faciès des schistes verts; D_3, reliée à des plis transversaux, ouverts et droits; et D_4, dans la partie nord, associée à des plis couchés et à des failles d'extension contemporaines et accompagnée d'une surimpression métamorphique du faciès des amphibolites.

National Topographic System reference and index to adjoining published Geological Survey of Canada maps

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CANADIAN GEOSCIENCE MAP 160

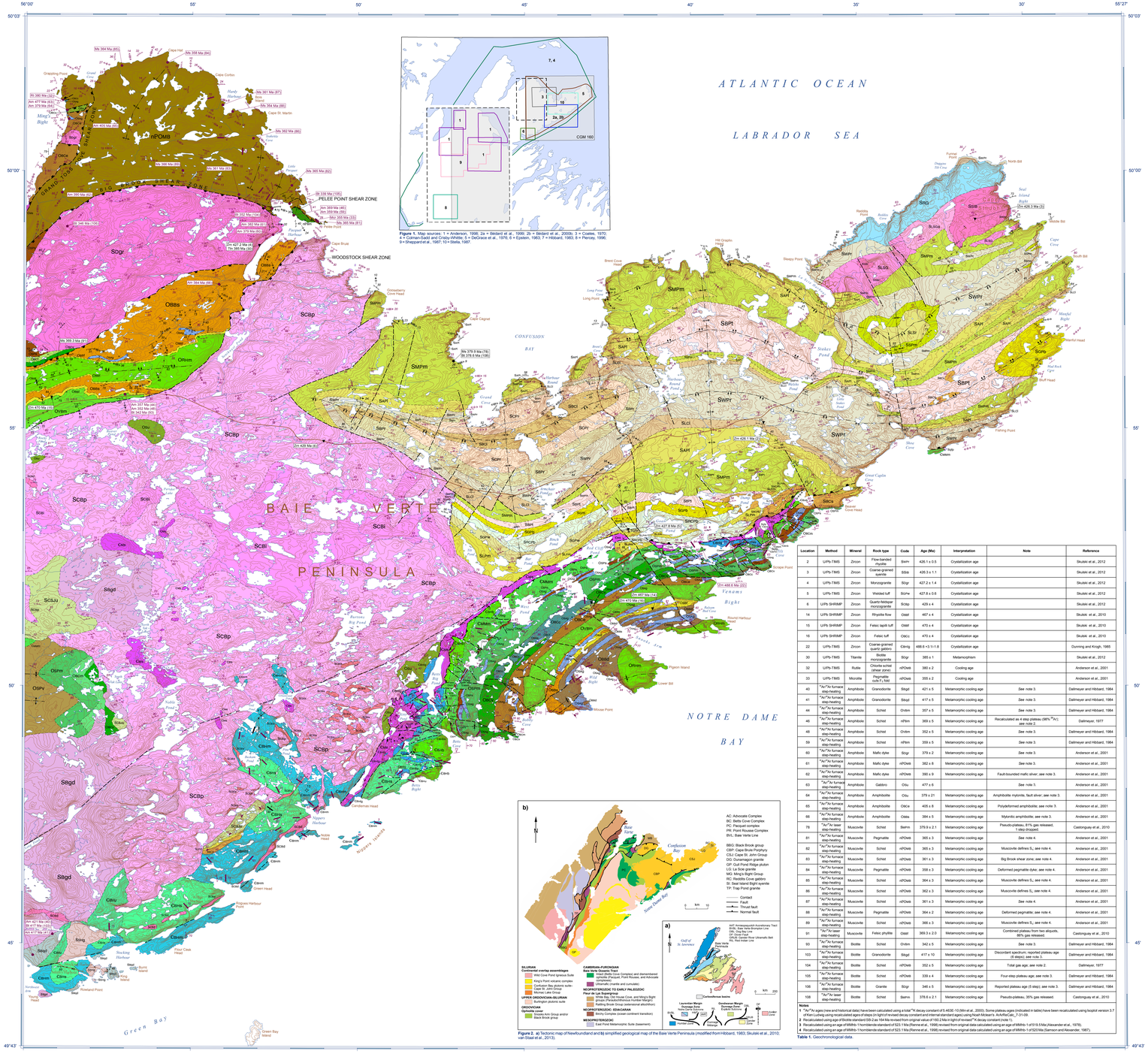
GEOLOGY

NIPPERS HARBOUR AND PARTS OF HORSE ISLANDS, CAPE ST. JOHN, AND LITTLE BAY ISLAND

Newfoundland and Labrador

NTS 2-E/13 and parts of NTS 2-E/12, NTS 2-E/14, and NTS 2-L/4

1:50 000


ATLANTIC OCEAN
LABRADOR SEA
NOTRE DAME BAY
BAIE VERTE PENINSULA
WOODSTOCK SHEAR ZONE
PELEE POINT SHEAR ZONE
CONFUSION BAY
Nippers Harbour
Rogers Harbour
Round Harbour
Lunn Point
Aucoin Point
Cape Brule
Cape St. John
Seal Island
Green Bay
Green Bay Island
Pigeon Island
Mouse Point
Little Passage Point
Four Cleft Head
Stocking Harbour
Burlington Peninsula
Cape Rouge
Cape Cormorant
Cape Ste. Marie
Cape Martin
Cape Freels
Cape Charles
Cape Anguille
Cape Ray
Cape Race
Cape Pine
Cape Spear
Cape Chidley
Cape Harrison
Cape Porcupine
Cape Bauld
Cape Norman
Cape Bonavista
Cape Bonavista
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