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Structural setting of the Cornwallis lead-zinc district, Arctic Islands, Nunavut

Keith Dewing and Elizabeth C. Turner

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Abstract: Zinc-lead mineralization of Devonian to Carboniferous age in the Cornwallis district is spatially related to faults and folds of the Boothia Uplift. The north-south elongate Boothia Uplift, formed during Caledonian (Late Silurian–Early Devonian) compression, is characterized by west-verging, basement-rooted thrusts and related folds in cover strata. Southward compression during the Ellesmerian Orogeny (Late Devonian–Early Carboniferous), perpendicular to these older faults, reactivated them as strike-slip structures. One effect of this reactivation was the creation of transverse fracture zones where stress was transferred between basement blocks. Mineralizing fluids driven by the Ellesmerian Orogen migrated through these fracture zones and into permeable lower Paleozoic units. This style of mineralization is one of several present in the Cornwallis lead-zinc district.

Résumé : Dans le district zincifère de Cornwallis, la minéralisation de zinc-plomb du Dévonien-Carbonifère présente une association spatiale avec les failles et les plis du soulèvement de Boothia. Le soulèvement de Boothia, une structure formée au cours de la compression calédonienne (Silurien tardif–Dévonien précoce) et allongée suivant un axe nord-sud, est caractérisé par des chevauchements à vergence ouest qui s'enracinent dans le socle et par les plis associés dans les strates de la couverture. Au cours de l'orogenèse ellesmérienne (Dévonien tardif–Carbonifère précoce), la compression dirigée vers le sud s'est exercée perpendiculairement à ces failles plus anciennes et a entraîné la réactivation de celles-ci sous forme de structures de coulissage. Un effet de cette réactivation a été la création de zones de fracture transversales qui ont permis le transfert des contraintes d'un bloc de socle à l'autre. Des fluides minéralisateurs mus par l'orogenèse ellesmérienne ont migré le long de ces zones de fracture jusque dans des unités perméables du Paléozoïque inférieur. Ce style de minéralisation n'est que l'un des nombreux reconnus dans le district zincifère de Cornwallis.

INTRODUCTION

The Cornwallis lead-zinc district contains at least 25 carbonate-hosted Zn-Pb(±Cu) showings or clusters of showings on Cornwallis, Bathurst, Devon, Little Cornwallis, and Somerset islands in the Canadian high Arctic. The best known of these is the Polaris deposit and mine site (22 Mt at 14% Zn+Pb), which closed in August 2002. Although the mine started operating in 1981 and local studies have been undertaken (e.g. Randell, 1994; Randell and Anderson, 1996; Heroux et al., 2000), a coherent explanation for the formation, distribution, and attributes of showings throughout the district has not emerged. This paper presents a new interpretation of structural controls on one type of mineralization in the Cornwallis lead-zinc district, based on previous work, existing maps, and ongoing detailed mapping.

GEOLOGICAL SETTING

The Canadian Arctic Islands are dominated by sedimentary rocks deposited on a long-lived passive margin (Fig. 1; Trettin, 1991). Cambrian to Upper Silurian carbonate and evaporite strata accumulated on a broad, curving shelf in the southern and eastern parts of the high Arctic, with deeper water shale north and west of a distinct shelf margin.

The Caledonian Orogeny on east Greenland shed clastic sediment onto the Arctic Platform and created localized, basement-cored uplifts in the Silurian and Early Devonian. The most significant of these is the Boothia Uplift, a north-south elongate basement feature (Fig. 1). Southward compression during the Late Devonian to Early Carboniferous Ellesmerian Orogeny produced a fold-thrust belt north and west of the former continental margin, and ended carbonate sedimentation throughout the region. Ellesmerian structures affect mid-Fammenian (ca. 365–360 Ma) and older strata but not strata that yield late Visean (335–325 Ma) or younger fossils (Eisbacher, 1998; dates from Okulitch, 1999). Polaris Zn-Pb mineralization coincided with this orogeny: Polaris ore yielded a Late Devonian paleomagnetic age and may have been tilted by the orogeny (Symons and Sangster, 1992), and sphalerite samples from Polaris gave Rb-Sr ages of 366 ± 15 Ma (Christensen et al., 1995); ongoing analytical work from other showings has given ages of about 352 to 355 Ma (Brian Cousens, pers. comm., 2001).

The detailed structural mapping that is fundamental to understanding the structural geology of the Cornwallis lead-zinc district is hampered by poor outcrop. An intimate knowledge of the lithofacies and metre-scale stratigraphy of individual map units is critical to recognizing geological structures, especially because recognition of faults is generally based on the juxtaposition of subtly different carbonate rock units exposed only as felsenmeer.

BOOTHIA UPLIFT

The Boothia Uplift, measuring about 125 km by 1000 km and exhibiting 3 to 5 km of uplift, developed in the Late Silurian to Early Devonian (Kerr, 1977; Harrison et al., 1993; Harrison and de Freitas, 1999); surrounding areas remained below sea level (Okulitch et al., 1986). It coincides spatially with a region of north-trending structures in basement metamorphic rocks (Blackadar, 1967; Kerr and deVries, 1976, 1977; Frisch et al., 1987; Hoffman, 1989; Frisch and Sandeman, 1991), and is interpreted to be a product of intraplate stress transmitted from the distant Caledonian Orogen, the closest part of which is exposed in east Greenland (Kerr, 1977; Okulitch et al., 1986).

Basement uplift took place along discontinuous west-verging reverse faults (Fig. 2; Kerr and de Vries, 1976; Stewart and Kerr, 1984; Okulitch et al., 1986, 1991), now locally exposed on the west side of the uplift on eastern Prince of Wales Island. Westerly vergence is interpreted to be responsible for geometric asymmetry of the uplift and the composition of uplift-derived sedimentary rocks flanking the uplift. On the steep, western side of the uplift on Prince of Wales Island, reverse faults place Precambrian rocks over tightly folded to overturned Cambrian to Silurian strata that narrowly border the exposed uplift core (Christie et al., 1971; Okulitch et al., 1986). The east side is characterized by gentler west-verging folds and east-facing monoclines (Okulitch et al., 1986). The western margin of the uplift is flanked by coarse, uplift-derived, Silurian to Devonian, clastic coastal fan complexes (Miall, 1970; Miall and Gibling, 1978; Mortensen and Jones, 1986), whereas the eastern slope on Somerset Island is flanked by alluvial and tidal-flat strata (Stewart and Kerr, 1984; Stewart, 1987).

Farther north (Cornwallis and Devon islands; Fig. 2), where basement is not exposed, lower Paleozoic cover strata exhibit roughly north-trending gentle folds. Fold wavelength is similar to fault spacing in the south. Anticlines are tight and commonly slightly asymmetrical (*see* Thorsteinsson, 1986; Mayr et al., 1998; Eisbacher, 1998), whereas synclines are generally broad. The western margin of the uplift (eastern Bathurst Island) is characterized by a band of closely spaced, complexly reactivated, north-trending thrusts. Kerr (1977) and Okulitch et al. (1986) proposed that structures in the basement and cover parts of the uplift are geometrically and genetically related: anticlines are surmised to conceal blind thrusts, whose propagation forced anticlines to form in overlying strata (Henrichsen and Kennedy, 2002). A similar interpretation was invoked to explain folding in the northern part of the Boothia Uplift (Grinnell Peninsula of Devon Island; de Freitas and Mayr, 1993; Eisbacher, 1998), where west-verging thrusts break through to surface. An absence of seismic information precludes pinpointing subsurface structures. Two Ordovician evaporite formations that are known to be present in the subsurface, however, are possible intermediate décollement levels.

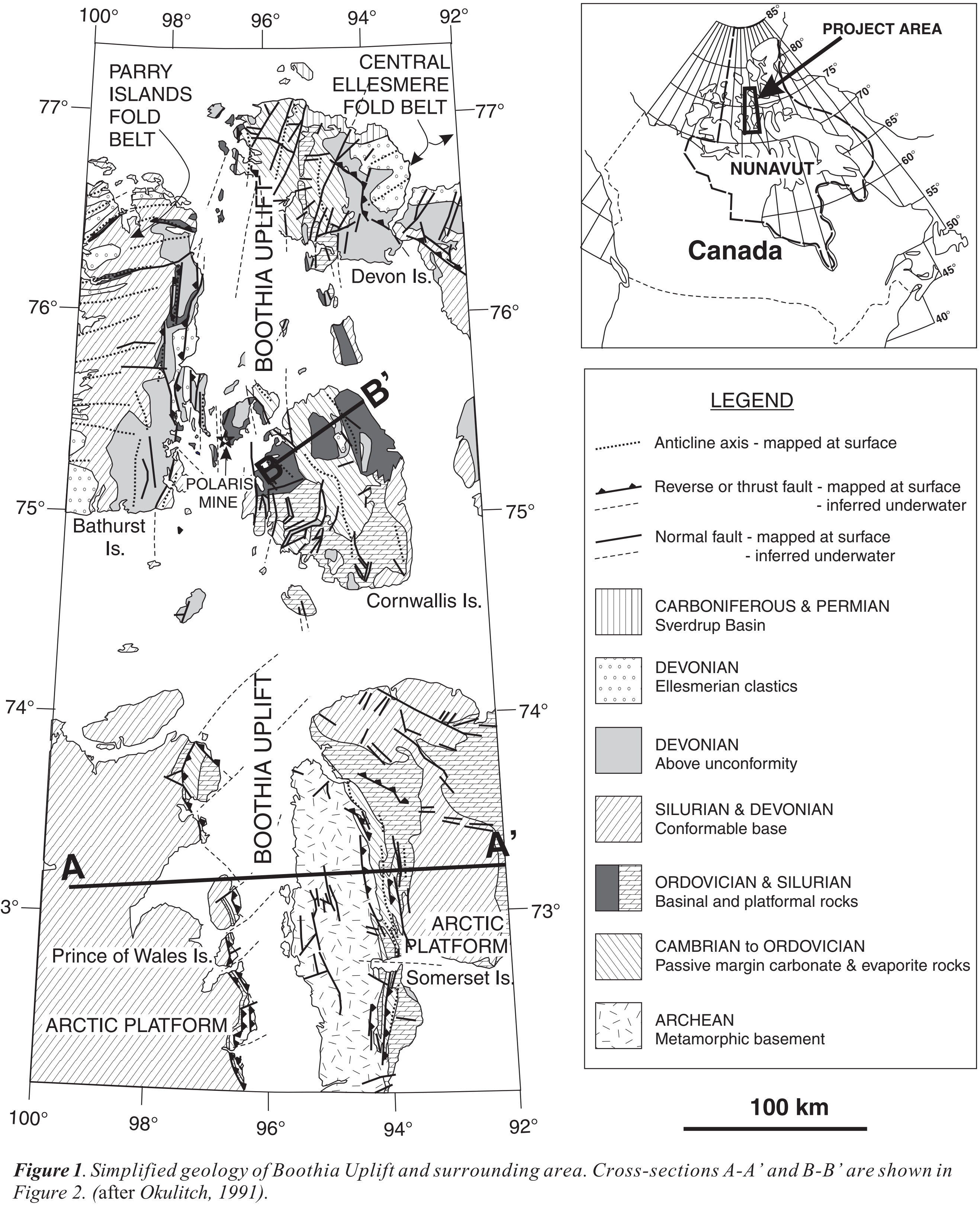

***Figure 1**. Simplified geology of Boothia Uplift and surrounding area. Cross-sections A-A' and B-B' are shown in Figure 2. (*after *Okulitch, 1991).*

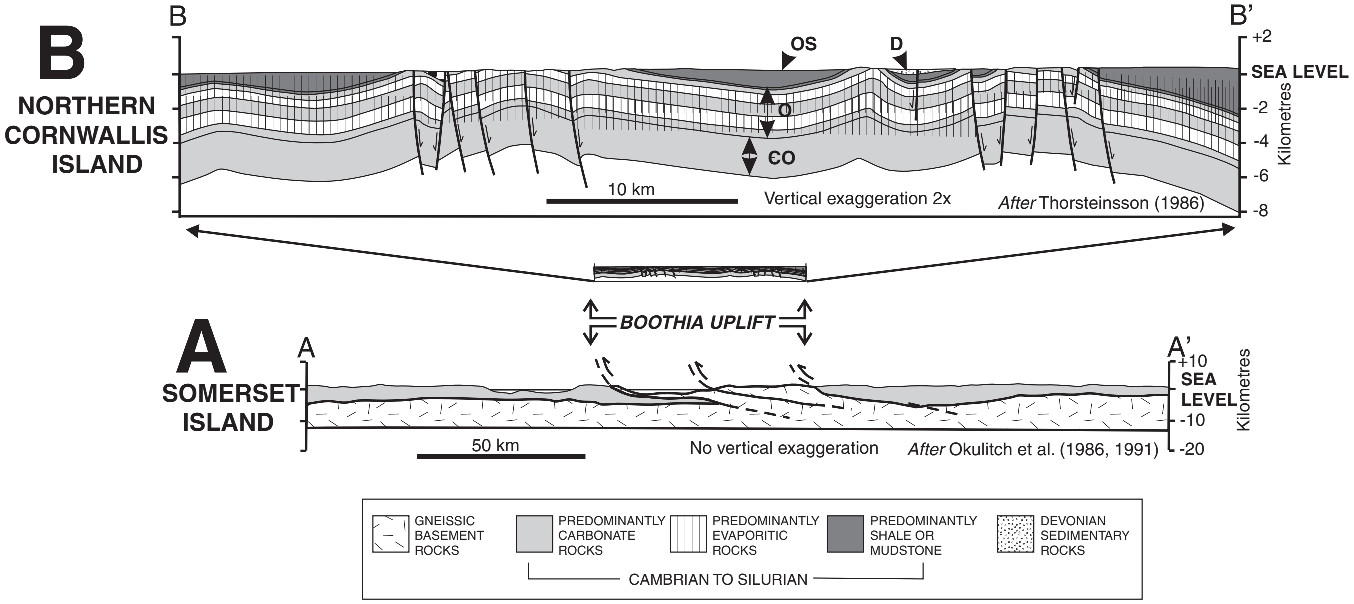

Figure 2. *Cross-sections through Boothia Uplift (*see *Fig. 1 for location):* ***A)*** *southern part of uplift, where faulted basement rock is exposed at surface (*after *Okulitch et al., 1986, 1991);* ***B)*** *northern part of uplift, where folded lower Paleozoic strata are at surface (*after *Thorsteinsson, 1986). Thrust faults probably detach in the evaporites, although dips are arbitrarily shown as vertical due to lack of information at depth. Abbreviations: C-O, Cass Fjord Formation to Christian Elv Formation; O, Baumann Fiord Formation to Thumb Mountain Formation; OS, Cape Phillips Formation; D, Disappointment Bay, Blue Fiord, and Bird Fiord formations.*

Uplift was accompanied by erosional bevelling of folded strata. Carbonate sedimentation resumed above the unconformity over the northern part of the uplift in the Early Devonian (Emsian; de Freitas and Mayr, 1998). Caledonian-age folds in Cambrian-Silurian cover strata can be visualized, in the absence of complicating later structural events and sedimentation, by mapping the stratigraphic position of the sub-Devonian unconformity (Fig. 3). Each of the major syncline-anticline pairs depicted on this peneplaned post-Caledonian landscape would be linked to a thrusted basement block or a thrust ramp. The approximate locations of exposed (south) and inferred (north) blind thrusts can then be depicted on a map, somewhere between the axis of the anticline and the axis of the syncline immediately to the west (Fig. 4).

Basement thrusts exposed on Prince of Wales and nearby islands are complexly segmented (Fig. 3). A similar geometry for buried thrust sheets in the northern domain is suggested by abrupt changes in orientation and location of anticline axes in folded Paleozoic rocks on Cornwallis and Devon islands (Fig. 3).

ELLESMERIAN OROGENY AND ITS EFFECT ON OLDER STRUCTURES

Ellesmerian compression (roughly southward in present-day co-ordinates) was active from the latest Devonian to the Early Carboniferous. Outside the area of the Boothia Uplift, structural shortening took the form of an arcuate, westerly-trending fold-thrust belt on Bathurst, Devon, and southern Ellesmere islands (Parry Islands and Central Ellesmere fold belts), the southern limit of which is part-way down the length of the Boothia Uplift (Fig. 4). The Boothia Uplift itself, however, formed a structural buttress (Kerr, 1977) around the northern end of which the fold belt wrapped: it does not exhibit the same degree of shortening as is evident elsewhere. Shortening within the Parry Islands and Central Ellesmere fold belts was decoupled from the rigid Boothia Uplift by north-south faults along the margins of the northern part of the Boothia Uplift: dextral displacement along the Icefield and Grinnell Range faults on eastern Devon Island and sinistral displacement along the Southeast Bathurst fault zone on Bathurst Island (Temple, 1965; Kerr, 1974, 1977; Harrison et al., 1993; Mayr et al., 1998). Although subtle, westerly-trending Ellesmerian folds are locally evident on the northern Boothia Uplift, the most important effect of the Ellesmerian Orogeny within the area underlain by the Boothia Uplift is brittle faulting. Extensive brittle faulting in the Carboniferous (opening of the Sverdrup Basin) and Cenozoic (rifting of Greenland) also affected the central Arctic Islands, so distinguishing younger faulting from Devonian faulting is difficult.

HYPOTHESIS FOR DISTRIBUTION OF MINERALIZATION

Kerr (1977) and Kerr and deVries (1977) proposed that exposed and blind, north-south, Caledonian-age reverse and thrust faults were reactivated as strike-slip faults during

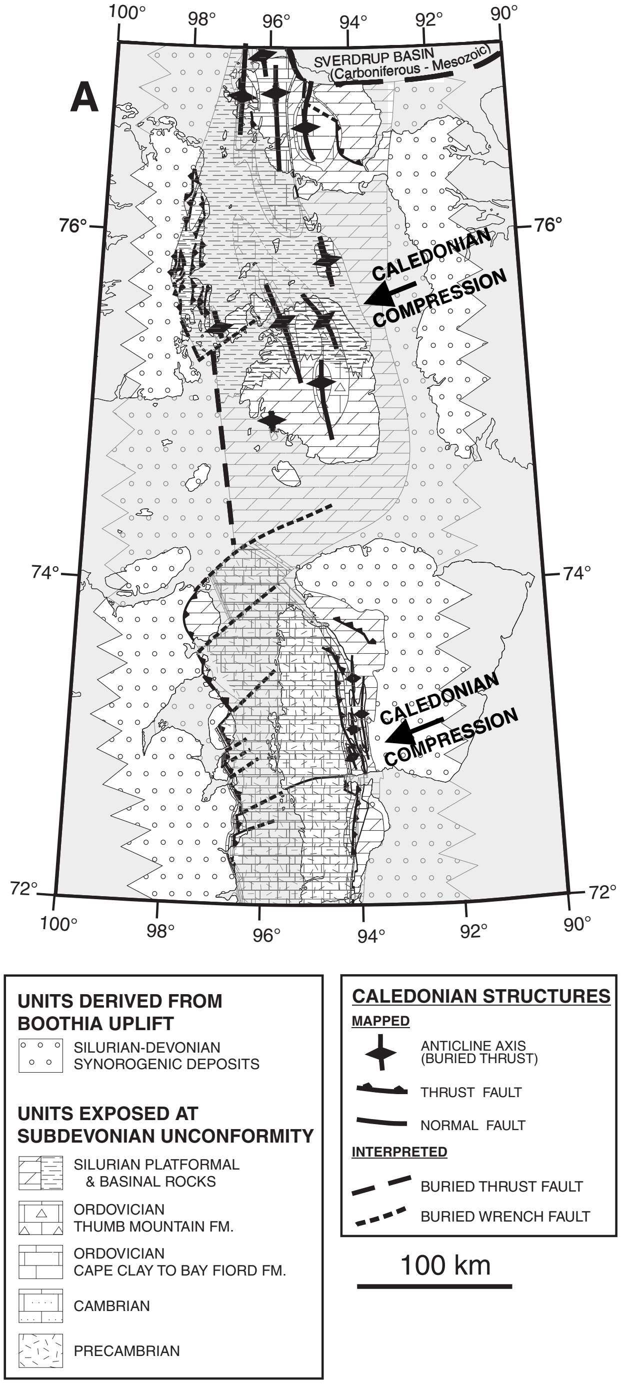

Figure 3. *Caledonian-age structures of Boothia Uplift. Distribution of stratigraphic units at sub-Devonian unconformity reveals location of major Caledonian-age anticlines. Sub-sea geology after Okulitch (1991). Conglomerate symbol shows the approximate limit of sediments shed off the Boothia Uplift. The serrated margin implies uncertainty in the limits of these sediments.*

Ellesmerian compression. Because the thrust faults are discontinuous and their disposition is oblique to Ellesmerian compression, strike-slip stress was transferred among the basement-cored blocks, and, where a thrust sheet ends, from one thrust sheet to another. Strain was accommodated by several means. Differential translation or slight rotational motion of basement blocks resulted from displacement-transfer along block margins oblique to the principal stress direction, forming transverse wrench faults or reactivating transverse tear faults on Boothia thrust slices (de Freitas and Mayr, 1993). Cross faults at thrust termini might have formed when strike-slip motion along a reactivated, Caledonian-age thrust reached the end of that thrust sheet, and motion was transferred onto the adjacent thrust sheet.

Cross faults could have acted to focus fluids via vertical fractures, at local dilational zones that form zones of low fluid pressure (Connolly and Cosgrove, 1999), or by creating local vertical impediments to horizontal fluid flow that would have channelled fluids upwards (Caine et al., 1996). Increased permeability is also plausible along reactivated structures bordering uplift blocks that were slightly rotated by oblique transpression. Permeability produced in any of these settings could have acted as conduits for mineralizing fluids driven up-dip from the Ellesmerian orogen to the north and into permeable carbonate strata, according to the tectonically driven Mississippi Valley–type (MVT) fluid-flow model (Garven and Freeze, 1984a, b).

Detailed mapping of Little Cornwallis Island has revealed subtle extensional structures of possible Ellesmerian age (Fig. 5). These normal faults trend northeast, perpendicular to the trend of the Boothia structures. Vertical offsets are between 50 and 85 m, creating a graben with a total down-drop of about 175 m. These faults locally have veins of sparry dolomite, pyrite, and barite, indicating a probable association with the Polaris fluid event.

The dearth of evidence for cross faults on existing maps is probably because 1) the 1:250 000 scale of existing maps is insufficient to depict complex structures of limited lateral extent; 2) such faults commonly run through areas where the thick Cape Phillips shale is at surface, making it difficult to recognize lithological changes; 3) some such faults have minimal vertical displacement, making them difficult to recognize using stratigraphic markers, particularly in a terrain of little outcrop; and 4) Cenozoic brittle faulting related to the separation of Greenland and Canada has created a host of brittle faults that are difficult to distinguish from older, Ellesmerian faults.

DISTRIBUTION OF ZN-PB MINERALIZATION

The spatial abundance of known showings is high in the northern part of the district, low on northern Somerset Island, and decreases southward to zero at the centre of Somerset Island (Fig. 4). This concurs with southward attenuation of Ellesmerian deformation and increasing distance from the orogen. Superimposing the distribution of known Zn-Pb showings on the map of known and interpreted faults reveals three structural settings for mineralization in the Cornwallis lead-zinc district (Fig. 4): 1) along linear trends that mimic the independently interpreted, buried, north-south Boothia faults; 2) along the strike-slip faults that decouple the Boothia Uplift from adjacent fold belts (Bathurst and Devon islands); and 3) in fracture zones where strike-slip motion steps from one basement block to another.

Showings that parallel Boothia structures (type a) are generally not precisely located over the main interpreted north-south subsurface structures, but are some distance from them along west-east cross structures and local extensional structures that are not visible at the scale of Figures 3 and 4 but are mappable at a local scale (e.g. Turner, 2001; Turner and Dewing, 2002). Showings along the margins of the Boothia

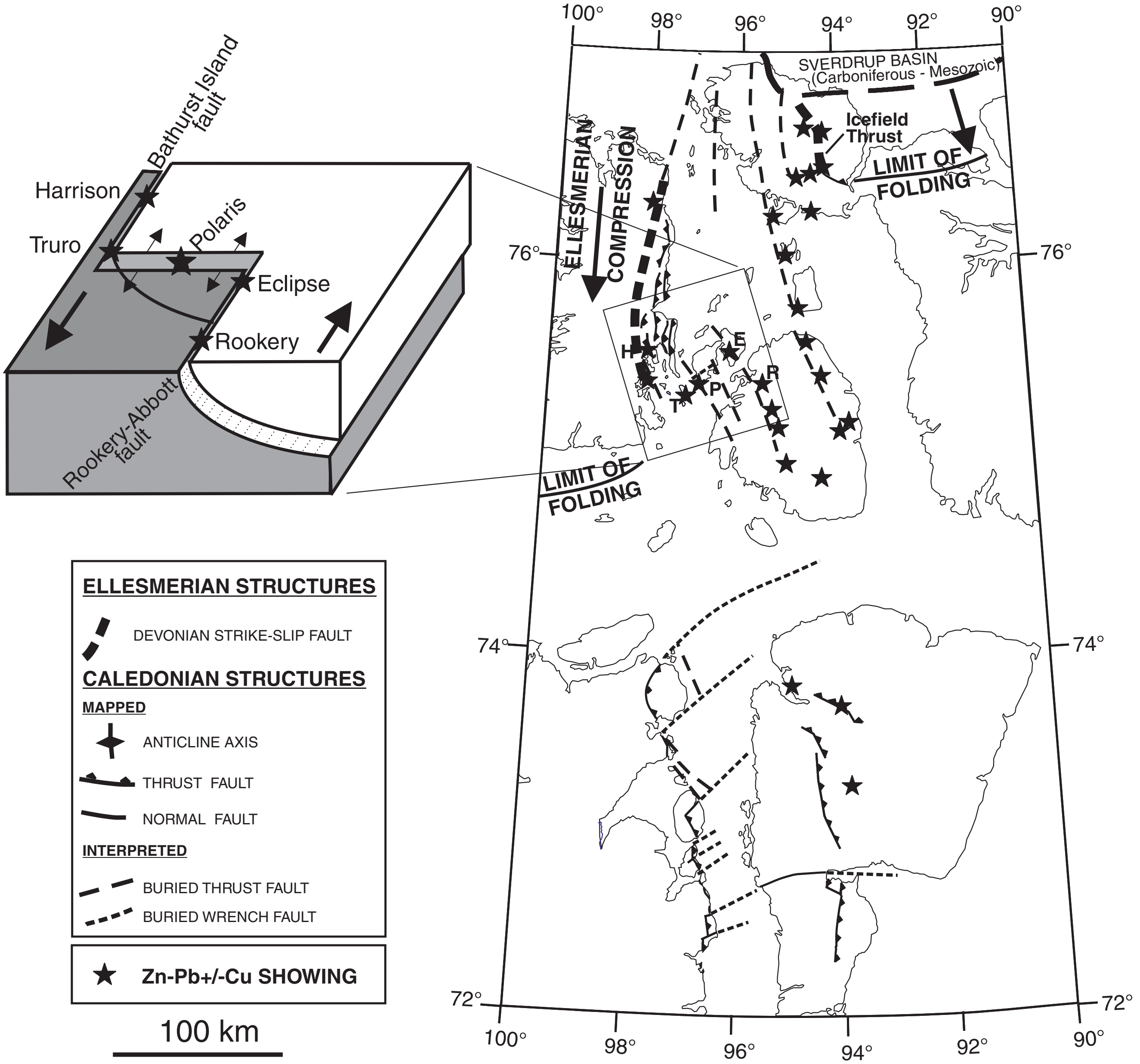

Figure 4. Mapped (south) and interpreted (north and underwater) locations of basement-rooted thrusts and cross faults of Boothia Uplift; faults under ocean water are speculative and therefore generalized compared to onshore examples. Distribution of known Zn-Pb(+/-Cu) mineralization follows these structures. A schematic of the three mineralization types is shown on the side: 'Harrison' showing occurs on a strike-slip fault that decouples the Boothia Uplift from adjacent fold belt; Rookery, Truro, and Eclipse showings are on local dilational zones caused by rotation or translation of Caledonian-age thrust blocks due to oblique compression; and Polaris deposit is adjacent to a fracture zone where strike-slip motion was transferred between basement blocks. Abbreviations: P, Polaris deposit; H, Harrison showing; R, Rookery showing; T, Truro showing; E, Eclipse showing.

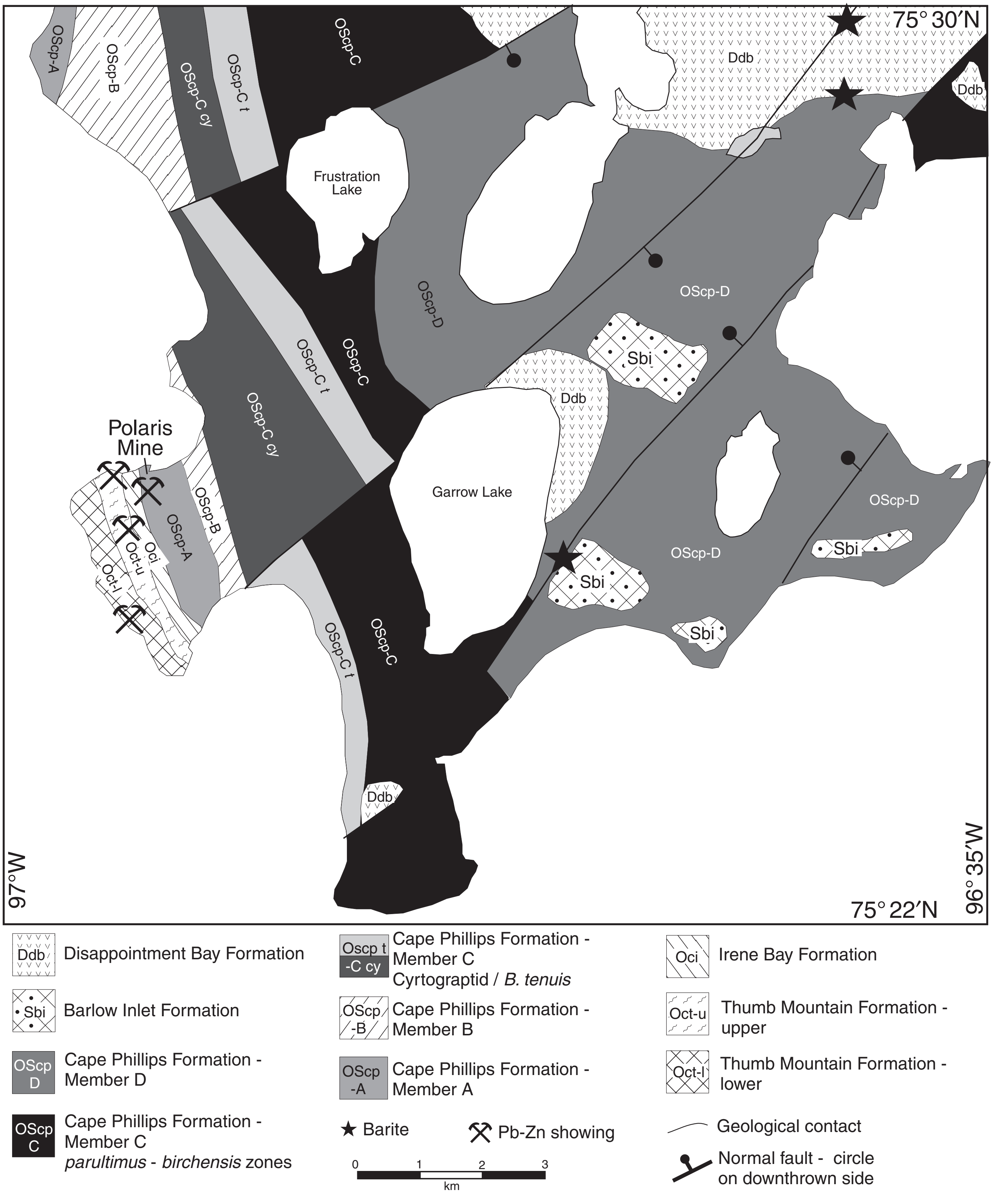

Figure 5. *Geology of southwestern Little Cornwallis Island, showing normal faults that are perpendicular to the trend of the Boothia Uplift. These faults are locally mineralized with barite and pyrite.*

Uplift on Bathurst and Devon islands (type b) are closely associated with the major north-south faults that separate Ellesmerian fold belts from the Boothia Uplift (Harrison and de Freitas, 1996). The largest and most important showing (type c, Polaris; Fig. 4) appears to have developed along a significant fracture zone between two major basement blocks. The large fracture zones of type c appear to have been most conducive to high fluid flux that could bring large volumes of metal to the site of deposition. Types a and b locally contain significant metal content (e.g. Eclipse, Truro), but are order(s) of magnitude smaller than the Polaris deposit.

Undiscovered mineralization could be present along hitherto unknown or unexplored cross structures within the Boothia Uplift area. The most obvious analogous structure to the Polaris cross faults is on Grinnell Peninsula, where the Icefield Thrust that decouples the Boothia Uplift from Ellesmerian folding terminates (Fig. 4). The termination of the Icefield Thrust on the east side of the Boothia Uplift forms roughly the mirror image of the Polaris graben. North-south displacement caused by Ellesmerian compression to the east of the Icefield Thrust appears to have transferred between Boothia basement blocks using a pre-existing Boothia tear fault (de Freitas and Mayr, 1993). This zone of fracturing perpendicular to the Boothia trend may be suitable for type c deposits.. Outside the Cornwallis lead-zinc district are other possibly prospective areas, such as the Bache Uplift on Ellesmere Island (Trettin, 1978; Smith and Okulitch, 1987), which have similar structural histories to the Boothia Uplift and in which zinc exploration has been minimal or nonexistent.

SUMMARY

The geological events most important to Zn-Pb mineralization in the Cornwallis district are as follows.

1. Development of a carbonate-dominated passive margin (Cambrian through Devonian)
2. Development of Boothia Uplift during the Caledonian Orogeny, which caused faulting in metamorphic basement, faulting and folding in cover strata, and erosion of the uplifted area (Late Silurian–Early Devonian), and was followed by deposition of additional marine strata (Middle Devonian)
3. Southward compression from the Ellesmerian Orogeny (Late Devonian to Early Carboniferous), which caused development of a fold-thrust belt outside the Boothia area and both strike-slip reactivation of Caledonian-age thrusts and creation of cross faults within the Boothia area
4. Mineralizing fluids migrated southward from the orogen into transverse structures and adjacent permeable strata in three structural settings: a) along local dilational zones caused by rotation or translation of Caledonian-age thrust blocks due to oblique compression; b) along strike-slip faults that decouple the Boothia Uplift from adjacent fold belts; and c) along fracture zones where strike-slip motion was transferred between basement blocks

REFERENCES

Blackadar, R.G.
1967: Precambrian geology of Boothia Peninsula, Somerset Island, and Prince of Wales Island, District of Franklin; Geological Survey of Canada, Bulletin 151, 62 p.

Caine, J.S., Evans, J.P., and Forster, C.B.
1996: Fault zone architecture and permeability structure; Geology, v. 24, p. 1025–1028.

Christensen, J.N., Halliday, A.N., Leigh, K.E., Randell, R.N., and Kesler, S.E.
1995: Direct dating of sulphides by Rb-Sr: a critical test using the Polaris Mississippi-Valley–type Zn-Pb deposit; Geochimica et Cosmochimica Acta, v. 59, p. 5191–5197.

Christie, R.L., Thorsteinsson, R., and Kerr, J.W.
1971: Geology, Prince of Wales and adjacent small islands, District of Franklin, maps; Geological Survey of Canada, Open File 66, 6 unedited maps at 1:250 000 scale.

Connolly, P. and Cosgrove, J.
1999: Prediction of fracture-induced permeability and fluid flow in the crust using experimental stress data; American Association of Petroleum Geologists Bulletin, v. 83, p. 757–777.

de Freitas, T.A. and Mayr, U.
1993: Middle Paleozoic tear faulting, basin development, and basin uplift, central Canadian Arctic; Canadian Journal of Earth Sciences, v. 30, p. 603–620.
1998: Upper Ordovician to Lower Devonian (Richmondian to Emsian) carbonate platforms and the Boothia Uplift synorogenic succession; Chapter 4 *in* The Geology of Devon Island north of 76°, Canadian Arctic Archipelago, (ed.) U. Mayr, T. de Freitas, B. Beauchamp, and G. Eisbacher; Geological Survey of Canada, Bulletin 526, p. 57–154.

Eisbacher, G.H.
1998: Structural geology; Chapter 8 *in* The geology of Devon Island north of 76°, Canadian Arctic Archipelago, (ed.) U. Mayr, T. de Freitas, B. Beauchamp, and G. Eisbacher; Geological Survey of Canada, Bulletin 526, p. 237–250.

Frisch, T. and Sandeman, H.A.I.
1991: Reconnaissance geology of the Precambrian Shield of the Boothia Uplift, northwestern Somerset Island and eastern Prince of Wales Island, District of Franklin; *in* Current Research, Part C; Geological Survey of Canada, Paper 91-1C, p. 173–178.

Frisch T., Digel, M.R., and Williams, E.J.
1987: Precambrian Shield of the Boothia Uplift, southern Somerset Island and northern Boothia Peninsula, District of Franklin; *in* Current Research, Part A; Geological Survey of Canada, Paper 87-1A, p. 429–434.

Garven, G. and Freeze, R.A.
1984a: Theoretical analysis of the role of groundwater in the genesis of stratabound ore deposits: I: mathematical and numerical model; American Journal of Science, v. 284, p. 1084–1124.
1984b: Theoretical analysis of the role of groundwater in the genesis of stratabound ore deposits: II: quantitative results; American Journal of Science, v. 284, p. 1125–1174.

Harrison, J.C. and de Freitas, T.
1996: New showings and new geological settings for mineral exploration in the Arctic Islands; *in* Current Research 1996-B; Geological Survey of Canada, p. 81–91.
1999: Overview of bedrock geology; *in* Mineral and Energy Resource Assessment of Bathurst Island Area, Nunavut, (ed.) C.D. Anglin and J.C. Harrison; Geological Survey of Canada, Open File 3714, p. B1–B40.

Harrison, J.C., de Freitas, T., and Thorsteinsson, R.
1993: New field observations on the geology of Bathurst Island, Arctic Canada: Part B, structure and tectonic history; in Current Research, Part B; Geological Survey of Canada, Paper 93-1B p. 11–21.

Henrichsen, M. and Kennedy, L.
2002: Structural geology of the Stanley Head region, western Cornwallis Island, Nunavut; Geological Survey of Canada, Current Research 2002-B1, 9 p.

Héroux, Y., Chagnon, A., Dewing, K., and Rose, H.R.
2000: The carbonate-hosted base-metal sulphide Polaris deposit in the Canadian Arctic: organic matter alteration and clay diagenesis; *in* Organic Matter and Mineralisation: Thermal Alteration, Hydrocarbon Generation and Role in Metallogenesis, (ed.) M. Glikson and M. Mastalerz; Kluwer Academic Publishers, Dordrecht, The Netherlands, p. 260–295.

Hoffman, P.F.

1989: Precambrian geology and tectonic history of North America; *in* The Geology of North America: An Overview, (ed.) A.W. Bally and A.R. Palmer; Geological Survey of Canada, Geology of Canada, no. 3, p. 447–512 (*also* Geological Society of America, The Geology of North America v. A).

Kerr, J.W.

1974: Geology of Bathurst Island Group and Byam Markham Island, Arctic Canada; Geological Survey of Canada, Memoir 378, 152 p.

1977: Cornwallis Fold Belt and the mechanism of basement uplift; Canadian Journal of Earth Sciences, v. 14, p. 1374-1401.

Kerr, J.W. and deVries, C.D.S.

1976: Structural geology of Somerset Island, District of Franklin; *in* Report of Activities, Part A; Geological Survey of Canada, Paper 76-1A, p. 493–494.

1977: Structural geology of Somerset Island and Boothia Peninsula, District of Franklin; *in* Report of Activities, Part A; Geological Survey of Canada Paper 77-1A, p. 107–111.

Mayr, U., de Freitas, T., Eisbacher, G.H., and Kerr, J.W.

1998: Geology, Prince Alfred Bay–Cardigan Strait and parts of adjacent sheets, Northwest Territories; Geological Survey of Canada, Map 1924A, scale 1:250 000.

Miall, A.D.

1970: Continental marine transition in the Devonian of Prince of Wales Island, Northwest Territories; Canadian Journal of Earth Sciences, v. 7, p. 125–144.

Miall, A.D. and Gibling, M.R.

1978: The Siluro-Devonian clastic wedge of Somerset Island, Arctic Canada, and some regional paleogeographic implications; Sedimentary Geology, v. 21, p. 85–127.

Mortensen, P.S. and Jones, B.

1986: The role of contemporaneous faulting on Late Silurian sedimentation in the eastern M'Clintock Basin, Prince of Wales Island, Arctic Canada; Canadian Journal of Earth Sciences, v. 23, p. 1401–1411.

Okulitch, A.V. (comp.)

1991: Geology of the Canadian archipelago and north Greenland; Figure 2 *in* Geology of the Innuitian Orogen and Arctic Platform of Canada and Greenland, (ed.) H.P. Trettin; Geological Survey of Canada, Geology of Canada, no. 3, 1:2 000 000 scale map (*also* Geological Society of America, The Geology of North America, v. E).

Okulitch, A.V.

1999: Geological time chart (revised); Geological Survey of Canada, Open File 3040, 1 sheet.

Okulitch, A.V., Packard, J.J., and Zolnai, A.I.

1986: Evolution of the Boothia Uplift, Arctic Canada; Canadian Journal of Earth Sciences, v. 23, p. 350-358.

1991: Late Silurian–Early Devonian deformation of the Boothia Uplift; *in* Geology of the Innuitian Orogen and Arctic Platform of Canada and Greenland, (ed.) H.P. Trettin; Geological Survey of Canada, Geology of Canada, no. 3 , p. 302-307 (*also* Geological Society of America, Geology of North America, v. E).

Randell, R.N.

1994: Geology of the Polaris Zn-Pb Mississippi Valley–type deposit, Canadian Arctic archipelago; Ph.D. thesis, University of Toronto, Toronto, Ontario.

Randell, R.N. and Anderson, G.M.

1996: Geology of the Polaris Zn-Pb deposit and surrounding area, Canadian Arctic archipelago; *in* Carbonate-Hosted Lead-Zinc Deposits, (ed.) D. Sangster; Society of Economic Geologists, Special Publication 4, p. 307–319.

Smith, G.P. and Okulitch, A.V.

1987: The Inglefield Uplift: a Devonian tectonic element, Ellesmere Island, Arctic Canada; Bulletin of Canadian Petroleum Geology, v.35, p.75–78.

Stewart, W.D.

1987: Late Proterozoic to early Tertiary stratigraphy of Somerset Island and northern Boothia Peninsula, District of Franklin, N.W.T. Geological Survey of Canada, Paper 83-26, 78 p.

Stewart, W.D. and Kerr, J.W.

1984: Geology of Somerset Island north, Somerset Island south, Boothia Peninsula north, and central Boothia Peninsula; Geological Survey of Canada, Maps 1595A, 1596A, 1597A, and 1598A, scale 1:250 000.

Symons, D.T.A. and Sangster, D.F.

1992: Late Devonian paleomagnetic age for the Polaris Mississippi Valley–type Zn-Pb deposit, Canadian Arctic archipelago; Canadian Journal of Earth Sciences, v. 29, p. 15–25.

Temple, P.G.

1965: Geology of Bathurst Island Group, District of Franklin, Northwest Territories; Ph.D. thesis, Princeton University, Princeton, New Jersey, 146 p.

Thorsteinsson, R.

1986: Geology of Cornwallis Island and neighbouring smaller islands, Canadian Arctic archipelago; Geological Survey of Canada, Map 1626A, scale 1:250 000.

Trettin, H.P.

1978: Devonian stratigraphy, west-central Ellesmere Island, Arctic archipelago; Geological Survey of Canada, Bulletin 302, 119 p.

Trettin, H.P. (ed.)

1991: Geology of the Innuitian Orogen and Arctic Platform of Canada and Greenland; Geological Survey of Canada, Geology of Canada, no. 3, 569 p. (*also* Geological Society of America, Geology of North America v. E).

Turner, E.C.

2001: Investigation of zinc-lead mineralization on eastern Cornwallis Island, Arctic archipelago, Nunavut; Geological Survey of Canada, Current Research 2001-B2, 8 p.

Turner, E.C. and Dewing, K.

2002: The geology of Rookery Creek Zn-Pb showings, Cornwallis Island, Nunavut (NTS 58 G/6); Geological Survey of Canada, Current Research 2002-B2, 15 p.

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