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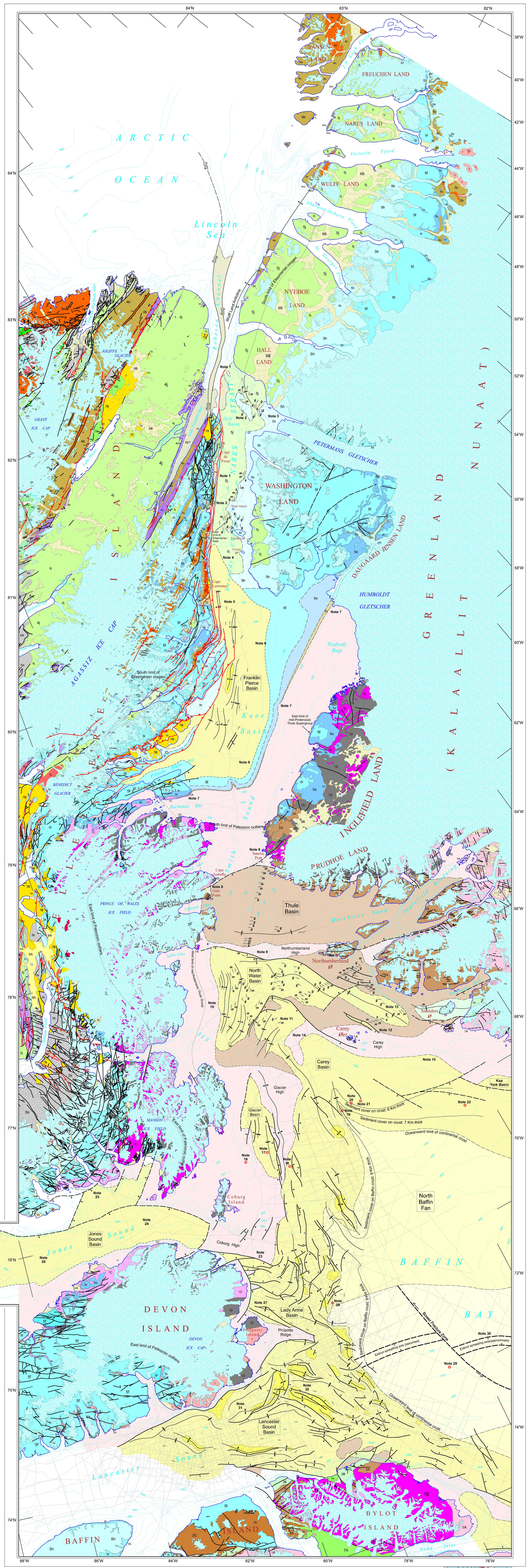

OPEN FILE 5278

BEDROCK GEOLOGY (sheet 1 of 2)

NARES STRAIT

Scale 1:1 000 000 - Échelle 1/1 000 000

kilometres 25 0 25 50 75 100 kilomètres

Polar Stereographic Projection

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Projection stéréographique polaire

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LOCATION MAP - LOCALISATION DE LA CARTE

ONSHORE GEOLOGY

FRANKLINIAN SHELF: ARCTIC PLATFORM AND CENTRAL ELLESMERE FOLD BELT

HAZEN BASIN, CLEMENTS MARKHAM ARC: NORTH GREENLAND FOLD BELT, HAZEN FOLD BELT, CLEMENTS MARKHAM FOLD BELT

PEARYA COMPOSITE TERRANE

NEOGENE
- Quaternary and Holocene — 8B — *glacial, glaciofluvial, glaciomarine and post-glacial sediments*
- Pliocene — 8A — *BEAUFORT SEQUENCE: Nonmarine sandstones, peat, wood, minor conglomerate*

LOWER CRETACEOUS TO EOCENE
- Upper Paleocene through Tupper Eocene — 7B — *EUREKA SOUND SEQUENCE: Mixed coarse and fine clastic sediments, conglomerate, coal, minor volcaniclastic sediments*
- Hauterivian through Danian — 7A — *BAFFIN SEQUENCE: Basinal marginal and basinal facies mixed coarse and fine clastic sediments, minor volcanic rocks*

SVERDRUP SEQUENCE

LOWER TRIASSIC TO LOWER CRETACEOUS
- 6B — *Basin marginal and basinal facies mixed coarse and fine clastic sediments, minor limestone*

LOWER CARBONIFEROUS TO UPPER PERMIAN
- 6A — *Syn-rift and post-rift sediments*

PHANEROZOIC
- *Felsic, Intermediate and mafic plutonic rocks (Ordovician, Devonian, Cretaceous ages)*

MIDDLE AND UPPER DEVONIAN
- 5k — ***Deltaic-shallow marine clastics**: sandstone, siltstone, shale, minor conglomerate, coal, limestone*

UPPER SILURIAN AND LOWER DEVONIAN
- 5j — ***Flysch**: sedimentary gravity flows, submarine fan deposits*

UPPER SILURIAN AND LOWER DEVONIAN
- 5g — ***Continental clastics and carbonates**: Uplift-derived redbeds, conglomerate, evaporites, sandstone, shallow marine carbonates*

UPPER ORDOVICIAN TO LOWER DEVONIAN
- 5h — ***Shallow marine carbonates**: shelf carbonates, shelf edge carbonate buildups, carbonate patch reefs,*

UPPER CAMBRIAN TO UPPER ORDOVICIAN
- 5f — ***Shallow marine carbonates and evaporites,** minor quartz sandstone: Lower Ordovician-Upper Ordovician*
  ***Shallow marine carbonate,** minor quartz sandstone: Upper Cambrian-Lower Ordovician:*

LOWER CAMBRIAN AND MIDDLE CAMBRIAN
- 5e — ***Shallow marine carbonates**: minor sandstone*

UPPER ORDOVICIAN TO LOWER DEVONIAN
- 5d — ***Deeper marine shale and carbonate**: graptolitic mudrocks, slope and basin facies carbonates, olistostromal deposits, minor chert and sandstone*

LOWER CAMBRIAN
- 5b — ***Shallow marine clastics:** inner to outer shelf and slope facies siliciclastic rocks and slaty mudrocks (may include highest Neoproterozoic strata)*

NEOPROTEROZOIC
- 5a — ***Clastics and shallow marine carbonates:** shales and deeper marine carbonates overlain by shallow marine carbonates; local diamictites at the base in North Greenland*

UPPER SILURIAN
- 4j — ***Flysch**: sedimentary gravity flows, submarine fan deposits*
- 4h — ***Carbonates and fine clastics**: Shallow marine carbonates, subtidal carbonates, chert, spiculitic mudrock, pebble conglomerate*

LOWER CAMBRIAN TO SILURIAN
- 4d — ***Deeper marine shale and carbonate**: trilobitic and graptolitic mudrocks, chert, slope and deep water carbonates, breccia*

MIDDLE ORDOVICIAN
- 4c — ***Arc-related volcanic rocks**: andesite, trachyandesite and rhyodacite flows, tuff, minor sediments, local ultramafic rocks*

LOWER CAMBRIAN
- 4b — ***Deeper marine clastics**: Outer shelf, slope and turbiditic basin-fill facies sandstone, pebble conglomerate, schist, phyllite, slaty mudrocks (may include highest Neoproterozoic strata)*

NEOPROTEROZOIC
- 4a — ***Deeper marine clastics and carbonates.** Slope carbonates, conglomerate, mudrock, sandstone, overlain by shelf carbonates*

LOWER SILURIAN
- 3j — ***Flysch**: Sedimentary gravity flows, submarine fan deposits*

UPPER ORDOVICIAN AND SILURIAN
- 3h — ***Shallow marine carbonates**: shelf carbonates*

UPPER ORDOVICIAN
- 3g — ***Clastics and carbonates**: redbeds, carbonates, sandstone, conglomerate*

MIDDLE ORDOVICIAN TO UPPER ORDOVICIAN
- 3c — ***Volcanics:** andesitic volcanic flows and tuff*

CAMBRIAN-?ORDOVICIAN
- 3b — ***Clastics**: quartzite and phyllite*

NEOPROTEROZOIC
- 3a — ***Clastics and carbonates**: phyllite, sandstone, minor carbonate, tuff, diamictite*

MESO- AND NEOPROTEROZOIC
- 3S1 — ***Crystalline rocks**: Lower amphibolite facies hornblende, garnet and biotite gneiss, augen gneiss, cataclasite, metasediments; granitoid intrusions*

THULE BASIN AND BORDEN BASIN

MESOPROTEROZOIC
- 2C — *Upper clastic and mudrock dominated units (Borden Basin only)*
- 2B — *Carbonate dominated units*
- 2A — *Lower clastic and mudrock dominated units, minor basalt*

HIGH GRADE METAMORPHIC ROCKS OF THE CANADA-GREENLAND SHIELD

INGLEFIELD MOBILE BELT

PALEOPROTEROZOIC
- 1F — *Retrograde granitoid rocks and gneisses of Inglefield mobile belt*
- 1E — *Granulite facies plutonic gneisses of Inglefield mobile belt (intrusive into Etah Gp supracrustal rocks)*
- 1D — *Supracrustal rocks of Inglefield mobile belt (ie. Etah Group, Prudhoe Land Group)*
- 1C — *Undifferentiated gneisses of Inglefield mobile belt*

COMMITTEE OROGEN

NEOARCHEAN
- 1B — *Supracrustal rocks of Committee Orogen (Mary River, Lauge Koch groups)*
- 1A — *Gneisses of Committee Orogen >2700 Ma (basement to Mary River, Lauge Koch groups)*

ARCHEAN AND PALEOPROTEROZOIC
- 1 — *Undivided*

OFFSHORE GEOLOGY

Tertiary

Eocene and younger — *Basins and thick sediment cover developed on refraction serpentinitic crust of Baffin Bay*

Upper Paleocene and younger — *Basins and thick sediment cover developed on refraction serpentinitic crust of Baffin Bay*

Paleocene — *Aeromagnetically anomalous rock units correlated with magnetically susceptible Paleocene volcaniclastic sediments on Judge Daly Promontory and elsewhere on northeastern Ellesmere Island*

Cretaceous and Tertiary

Lower Cretaceous and younger — *Mapped extent of structural culminations developed in Cretaceous, Paleogene and younger strata*

Basins and thick sediment cover developed on continental crust of North America and Greenland

Silurian — ***Flysch**: Siliciclastic submarine fan deposits, carbonate mudrocks and forereef carbonate apron material*

Ordovician to Devonian

Upper Ordovician through Lower Devonian — ***Shallow marine carbonates**: Shelf carbonates, shelf edge carbonate build ups, carbonate patch reefs.*

Cambrian and Ordovician

Upper Cambrian through Upper Ordovician — ***Shallow marine carbonates and evaporites**; minor sandstone*

Cambrian

Lower Cambrian and Middle Cambrian — ***Shallow marine carbonates**; minor sandstone*

Lower Cambrian — ***Shallow marine clastics***

Cambrian to Silurian

Lower Cambrian to Lower Silurian — ***Deeper marine shale and carbonate**: trilobitic and graptolitic mudrocks, chert, slope and deep water carbonates, breccia*

Neoproterozoic — ***Clastics and shallow marine carbonates***

Mesoproterozoic

BYLOT AND THULE SEQUENCES

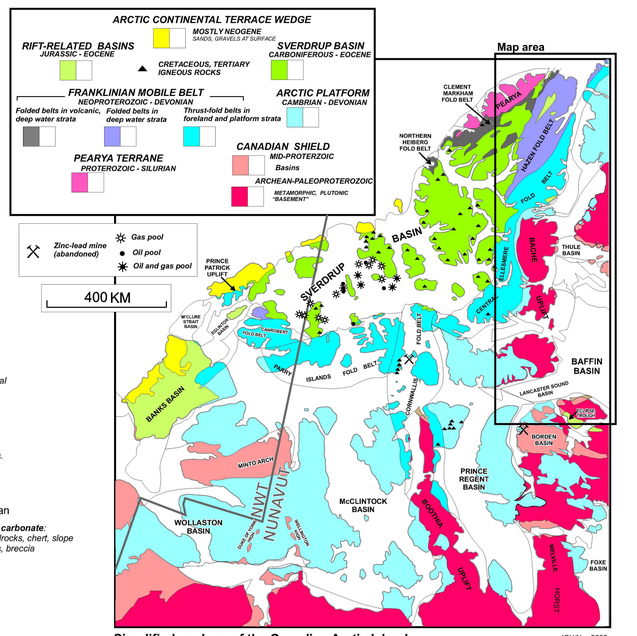
Carbonate-dominated strata correlated with the upper Thule and medial Bylot sequences

Siliciclastic and mudrock-dominated strata correlated with the lower and medial Thule sequence and lower Bylot sequence; common diabase sills, some mafic volcanic flows in the lower part

Archean and Paleoproterozoic — ***Crystalline basement complex**: upper amphibolite and granulite facies plutonic gneisses and supracrustal rocks (undivided)*

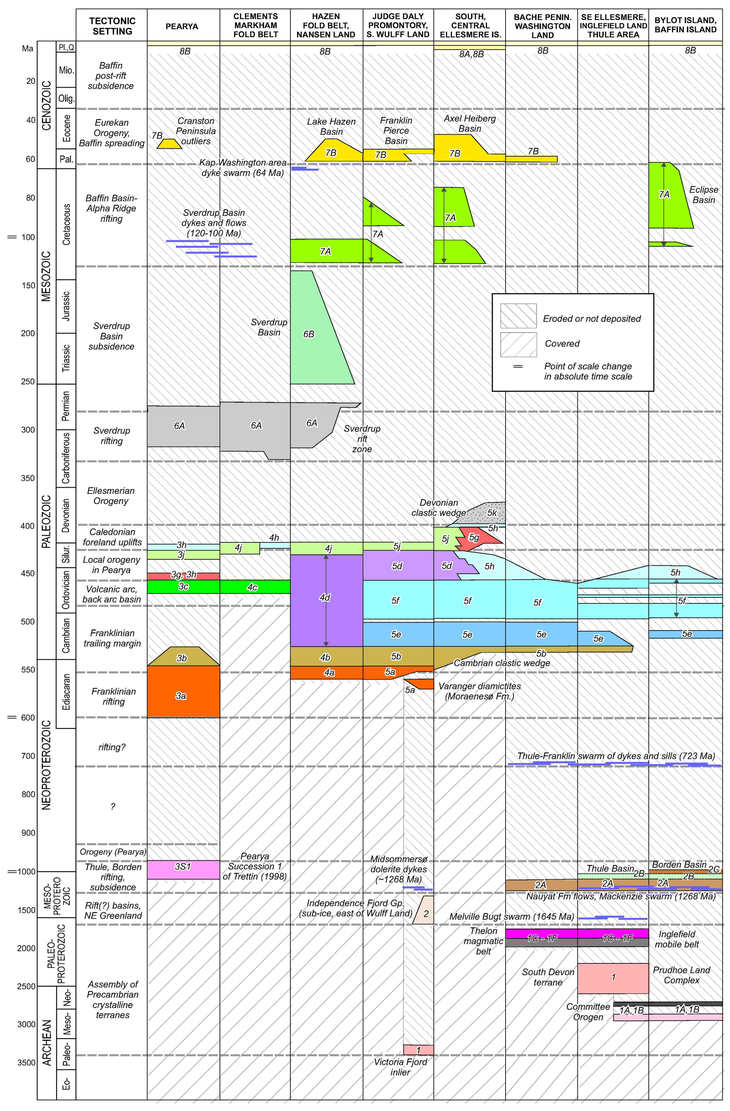
STRUCTURAL ELEMENTS (and other features)

- *Geological contacts: defined and approximate; assumed*
- *Fault: circle on downthrown side; defined and approximate; assumed*
- *Thrust and reverse fault: defined and approximate; assumed*
- *Sinistral strike slip fault: defined and approximate; assumed*
- *Dextral strike slip fault: defined and approximate; assumed*
- *Synclinal fold hinge; trough axis of basin (offshore only)*
- *Anticlinal fold hinge; axis of high (offshore only)*
- *Isobath; bathymetric contour (100 m contour interval)*
- *Seismic track line*
- *Attitude of stratification from reflection seismic profiles (offshore only):*
  - *g: gentle dip*
  - *m: moderate dip*
  - *s: steep dip*
  - *dip angle not determined*
- *position of detailed Note*
- *Mapped extent of structural culminations developed in Cretaceous, Paleogene and younger strata*
- *Glaciers, Gletschers*



Simplified geology of the Canadian Arctic Islands
(Modified from Wheeler et al., 1996)

JCH/Nov.2003



Simplified correlation chart for map units of Nares Strait region

Notes keyed to offshore geological features

1. Offshore map units in Hall Basin, Robeson Channel and south of Cape de Fosse adjacent to coastal Judge Daly Promontory in western Kennedy Channel (identified as "aeromagnetically anomalous" in the map legend), coincide with identical onshore aeromagnetic anomalies illustrated by Damaske and Oakey (in press) that are underlain by undegraded volcaniclastic sediments of the upper Paleocene Pavy Formation on the maps of Mayr et al., (in press) and Harrison et al. (in press). These highly susceptible volcanic sediments contain rounded detrital grains of alkali basalt, nephelinite, and phonolite and occasional magnetite paleoplacer layers.

2. The extent of Silurian carbonate buildups and bank edges, located in eastern Hall Basin and around Hans and Franklin islands, is based on reflection seismic evidence acquired by BGR and GSC in 2001. These features include internal reflection-free character, upward convex and shallow, erosionally resistant bathymetric expression, and lateral limits defined by recessive and discontinuous outward-dipping downward convergent bedrock reflection segments in assumed submarine fan deposits of the Silurian Danish River Formation and Peary land Group.

3. BGR-GSC seismic profiles in eastern Hall Basin commonly feature seismic channel-fill deposits (not shown on the map) assumed to represent Quaternary and Holocene outwash from the Petermann Gletscher.

4. Seismic profiles acquired by BGR and GSC west of the carbonate banks of Hans and Franklin islands feature shallow westward-dipping bedrock reflectors beneath folded and tectonically disturbed reflectors in seismically-defined Silurian fan deposits of the Danish River Formation and Peary Land Group. Onshore evidence from northern Judge Daly Promontory and western Hall Land suggests that this deformation is associated with chevron style folding and cleavage development during the end-Devonian Ellesmerian Orogeny. Seismic data indicate that the basal detachment below the folds occurs either within or above the underlying Ordovician to lowest Silurian carbonate shelf succession.

5. Structure contours on basement drawn by Rendell and Craig (1974) indicate that the thickness of low velocity (ca. 3.0 km/s) strata may exceed 2 seconds (3000 m) in the vicinity of Cape Lawrence of northern Franklin Pierce Basin. Northerly-trending folds in this package have a west-facing asymmetry and are interpreted to include hanging wall anticlines above easterly-transported thrusts that rise from lower Paleozoic "basement". Correlative strata exposed at Cape Lawrence and north of Princess Marie Bay are dominated by upper Paleocene carbonate breccias and syn-orogenic carbonate clast orthoconglomerates of the Cape Lawrence Formation. The latter unit ranges to 1000 m in preserved thickness and, in coastal cliffs north of Cape Lawrence, is observed to overlie Ordovician shelf carbonate formations with profound angular unconformity.

6. The base of seismically-defined low velocity strata on the top-basement structure contour map of Rendell and Craig (1974) rises to a depth of 1200 ms at the southeast end of seismic profiles in the north and to less than 700 ms at the southeast end of profiles in the south. The position of the southeastern limit of the basin is extrapolated to surface from the Rendell and Craig map and appears to coincide with several northerly-trending bathymetric valleys. It is possible that the southeastern edge of the basin is fault bounded.

7. The southern erosional limit of mid-Proterozoic, Cambrian and Lower Ordovician strata is marked by a 300 m high escarpment on southern Bache Peninsula above peneplained low-standing Paleoproterozoic gneisses exposed to the south and that underlie islands and marine areas of Buchanan Bay. This escarpment and the bounding submarine valley form continuous bathymetric features that extend eastward from Bache Peninsula and northeastward across Kane Basin to the northern margin of Peabody Bugt and the tidewater outlet of Humboldt Gletscher south of Daugaard Jensen Land in northwest Greenland. Lower Cambrian sandstones of the Dallas Bugt Formation exposed near the base of the escarpment on Bache Peninsula are assumed to be continuous with Lower Cambrian sandstones of the Humboldt Formation exposed above the inland ice in southern Daugaard Jensen Land.

8. Thule Supergroup outliers near Sunrise Pynt in western Inglefield Land are locally downfaulted against Paleoproterozoic marbles and other granulite facies gneisses to the north. This west southwest striking fault may be continuous with a probable fault that underlies Holocene gravels near Gale Point on the east Ellesmere coast west of Smith Sound. Thule Supergroup strata exposed at Gale Point are presumed to be downfaulted against granulite facies rocks including significant marble layers exposed at Cape Isabella. These lines of evidence considered together suggest that the faulted northern margin of the Thule Basin and the granulite-facies marbles exposed at Sunrise Pynt are continuous across northern Smith Sound without significant offset (Dawes and Frisch, 1982).

9. Extreme sea floor relief on a portion of BGR-GSC profile 2001-26 is interpreted to represent acoustic basement at the sea floor (Neben et al, 2003). Acoustic basement is correlated with Archean gneisses exposed below Thule Supergroup sediments near sea level on the north coast of Northumberland Ø. To the west the "Northumberland High" may be partly buried by a thin cover of either Thule Supergroup or Cretaceous to Neogene strata near the southwestern end of GSC-BGR profile 2001-04.

10. Industry seismic profiles present a poor definition of structural relationships in shallow water areas throughout offshore southeastern Ellesmere Island. The western margin of North Water Basin may be defined by a basement-rooted reverse fault that places Paleoproterozoic gneisses in compressive tectonic contact with folded Cretaceous to Neogene footwall rocks.

11. Seismic profiles in the southern part of North Water Basin reveal a profound angular unconformity between stratified units assumed to be mid-Proterozoic Thule Supergroup and stratified low velocity cover. Complex depositional relationships, including basement onlap, sequence overstep and downlap seismic patterns, are typical of the assumed Cretaceous to Neogene cover succession (Neben et al, 2003).

12. The fault-bounded sliver of Cretaceous to Neogene strata located east of the Carey Øer is demonstrated on both refraction and reflection profiles acquired by GSC-BGR in 2001 (Funck et al., in press; Neben et al, 2003). Maximum thickness is up to 200 ms or 300 m at 2.9 km/s.

13. The base of the Cretaceous to Neogene basin between the Carey Øer and Saunders Ø is outlined on BGR-GSC refraction profile 1 and coincides with a low angle unconformity at a maximum depth of 900 ms near SP1480 on GSC-BGR reflection profile 2001-30 (Funck et al., in press).

14. Thin and discontinuous Cretaceous to Neogene cover and or Quaternary channel fill deposits are well defined on seismic reflection profiles above stratified units assigned to the Thule Supergroup west of the Carey Øer (BGR-GSC profile 2001-01). These features define the structural high that separates North Water Basin from Carey Basin to the south.

15. The preserved limit of Cretaceous to Neogene strata above continental basement rocks on the continental shelf southwest of Saunders Island is provided by summarized reflection seismic mapping by Whittaker et al (1997) and by refraction profile 3 of Reid and Jackson (1997). Position of this line differs by about 10 km between the two sources.

16. The continental shelf between Glacier Basin and the southeast coast of Ellesmere Island may be locally or even continuously underlain by Thule Supergroup strata.

17. Indicated maximum thickness of strata above acoustic basement in southern Glacier Basin is about 1900 ms on the structure contour map of Alexander (1974). The shape and extent of the basin coincides with a bathymetric depression that provides a reasonable interpretation of the northern limit of the basin where reflection profiles are either unavailable or have not been acquired.

18. The northerly-trending basement high ("Glacier High") located between Glacier Basin and Carey Basin to the east is overlain by up to 600 ms of low velocity cover (Alexander, 1974).

19. The northern limit of oceanic/serpentinitic crust in northern Baffin Bay has been imaged near receiver I on Profile 2 of Reid and Jackson (1997). Thickness of low velocity sediment cover in this area ranges to 11 km.

20. The western limit of attenuated Greenland continental crust is located between receivers I and J on Profile 2 of Reid and Jackson (1997) and coincides with an apparent down-to-the-west fault that extends down section into oceanic/serpentinitic crust.

21. Refraction modelling indicates that attenuated continental crust is approximately 16 km thick between receivers J and L on Profile 2 of Reid and Jackson (1997).

22. Low velocity sediment cover on the basement high west of Kap York Basin ranges to 7 km in thickness near receiver N on Profile 3 of Reid and Jackson (1997).

23. Industry and government reflection and refraction profiles all indicate that acoustic basement lies on or near the sea floor throughout the mouth of Jones Sound (Keen and Barrett, 1973; Alexander, 1974; MacLean et al., 1984). Structure of this general region, here referred to as the "Coburg High", is poorly understood and may include southeasterly-transported reverse faults rooted in basement granulite.

24. Internal geometry of Jones Sound Basin remains poorly understood. Key observations are provided by a regional reflection profile in Keen and Barrett (1973), and chevron-style short wavelength folds in shallow low velocity bedrock materials illustrated on sparker surveys of MacLean et al (1984).

25. Existence of Cretaceous to Neogene strata in the Craig Harbour area of northeastern Jones Sound is provided by geophysical surveys presented by Keen and Barrett (1973) and by MacLean et al., (1984). The northern limit of the basin appears to coincide with the eastward continuation of the South Cape Fault Zone. This is a major southerly dipping low angle detachment fault that is rooted in Ordovician evaporites (and in Paleoproterozoic basement gneiss?) and which has been traced across the peninsulas of southern Ellesmere throughout much of the length of Jones Sound (Mayr and Okulitch, 1994a,b).

26. Continuation of Cretaceous to Neogene sediments into western Jones Sound is provided by reconnaissance reflection surveys and sonobuoy results acquired by industry. The northern margin of the basin appears to coincide with a profound bathymetric escarpment. Nature of the southern basin margin is unknown.

27. Indicated maximum thickness of the stratified low velocity succession in Lady Anne Basin locally exceeds 4000ms on the structure contour map of Baffin Bay Petroleum (1974).

28. The boundary between continental crust and refraction oceanic/serpentinitic crust of Baffin Bay is located mid way between receivers D and I on profile 4 of Reid and Jackson (1997). Indicated thickness of low velocity sediment on oceanic crust is 9 km in this area and coincides with the 6000ms contour on the top-basement structure contour map of Baffin Bay Petroleum (1974).

29. Indicated thickness of low velocity sediment cover on oceanic/serpentinitic crust of northwestern Baffin Bay ranges to 12 km near receiver L on profile 4 of Reid and Jackson (1997).

30. Two parallel lines on the map coincide with the approximate location of a west northwest-trending gravity high that can be traced across the centre of northwestern Baffin Bay (Miles, 2000). This feature has been interpreted by Chalmers and Pulvertaft (2001) as geophysical evidence of a buried spreading ridge. Position of the spreading ridge and extent of Eocene and younger oceanic crust and cover is based on Figure 11 of Oakey and Chalmers (2005).

31. Indicated maximum thickness of the stratified succession in Lancaster Sound Basin locally exceeds 4800 ms on the structure contour map of Baffin Bay Petroleum (1974). However, this may include both Cretaceous-Tertiary and stratified mid-Proterozoic sequences.

32. Contact between Cretaceous to Neogene strata and Mesoproterozoic sediments of the Borden Basin succession remains uncertain within Lancaster Sound Basin. Structural culminations may feature unroofed Mesoproterozoic strata on the sea floor.

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