NORTH AMERICAN CONTINENT-OCEAN TRANSECTS PROGRAMME, CORRIDOR G, SOMERSET ISLAND TO CANADA BASIN

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ABSTRACT

This open file consists of two large display sheets that show a 1:500,000 geologic strip map and crustal cross-sections based on geological and geophysical interpretations across the central Arctic Islands and into the Canada Basin. An accompanying pamphlet describes the layout of display features and explains the constraints used in their derivation. Corridor G is a joint study by the Geological Survey of Canada and the Earth Physics Branch and is part of the Decade of North American Geology (DNAG) program.

PAMPHLET TO ACCOMPANY CORRIDOR G DISPLAY SHEETS

Sources of information are published and unpublished maps, cross-sections, reports and manuscripts of the Earth Physics Branch, Geological Survey of Canada and Panarctic Oils Ltd., Calgary. The display is intended to portray factual information as well as interpretation for areas such as the polar margin and lower crust where data are few. Information available to October 1982 is incorporated into the display.

CONTENTS OF DISPLAY SHEETS 1 AND 2

Title, credits and index map with tectonic elements and location of Corridor G are at the upper left of Display Sheet 1. Below these the legend columns show from left to right:

(1) tectonic event flow diagram,

(2) units of map and age-coded section,

(3) corresponding formational nomenclature (rock formation names),

(4) units of tectonic-coded section.

Display Sheets 1 and 2 show from top to bottom:

1. gravity and magnetic anomaly profiles
2. section to 48 km depth coded by tectonic kindred indicating major structures, P-wave velocity horizons and density blocks within the crust. No vertical exaggeration
3. section to 25 km depth coded by age of rock units. No vertical exaggeration

4. 1:500,000 map of Corridor G showing:

   (a) line of section,

   (b) lithology, tectonic kindred and age of map units,

   (c) major structures and facies boundaries,

   (d) borehole control (well identification at upper right on Display Sheet 2),

   (e) bathymetry offshore contoured at 100 m intervals,

   (f) assumed positions of present and Proterozoic continental boundary.

5. geophysical parameters, from left to right:

   (a) maps of seismicity (sheet 1), total magnetic field (sheet 1) and gravity anomalies (sheet 2),

   (b) crustal density model along line of section (on gravity anomaly map) normal to trend of Corridor G (sheet 2).

LEGEND

Tectonic events

The Canadian Arctic Margin developed in three major tectonic cycles since the late Precambrian. Franklinian Basin, which formed during the late Proterozoic to mid-Paleozoic cycle, was punctuated by local structural disturbances such as the Boothia Uplift. This cycle was terminated by Middle Devonian to Early Carboniferous regional compression and uplift of basin and adjacent platform rocks that were structurally and thermally altered with increasing intensity northward and eastward (Ellesmerian Orogeny). The Sverdrup Basin cycle began with superposition of a rift basin on deformed Franklinian rocks. This late Paleozoic and Mesozoic cycle was terminated by the Eurekan Orogeny, when compression, folding, uplift, and erosion of Sverdrup sequences took place from Maastrichtian to Early Miocene time. The Arctic Terrace Wedge has been superposed on Sverdrup Basin rocks during the present cycle that began with the initial stages of opening of the Canada Basin, the main pulse of which appears to have taken place during Early and mid-Cretaceous time.

Symbols for tectonic-coded section

Three tectonic zones - continental, transitional and oceanic - are recognized. The continental tectonic zone is subdivided into local tectonic elements and units of tectonic kindred (universal tectonostratigraphic units). These are cross-correlated with depositional environment. Symbols are plotted in tectonic-coded sections. Map unit designations derived from cross-correlation are plotted in age-coded section. Data are insufficient to permit subdivision of the transitional and oceanic tectonic zones.

Symbols for map and age-coded section

For the Proterozoic and Cambro-Ordovician succession, only platform rocks are exposed along corridor G (map units Hp.p, Hp.c, COp.ce and COp.c). Basinal Cambro-Ordovician rocks are known from other parts of the Arctic Islands. Together with Proterozoic basinal rocks, they are presumed to be present in the subsurface north of Grinnell Peninsula.

During late Ordovician time the basin expanded. Slope and starved basin sediments were deposited on Grinnell Peninsula and southward (map units SDb.s and DSb.st) as the platform area (map units SDp.c and SDp.ce) was reduced. An early Devonian unnamed orogeny, pronounced on northern Ellesmere Island, is expressed in corridor G by minor folds of the Cornwallis Foldbelt and uplift and erosion of the Boothia Uplift (detritus indicated by map unit SDp.b). The folded rocks were covered unconformably by Devonian platform carbonates (map unit Dp.c) and coeval basinal rocks (upper part of map unit SDb.st) that in turn were gradually overlapped by non-marine clastics (map units Dp.p and Df.d) derived from the north during the early phases of the Ellesmerian Orogeny.

Sverdrup Basin stratigraphy is known from reconnaissance surface mapping, petroleum industry drillholes, and reflection seismic data. Stratigraphic units currently in use represent thick and widespread lithologies commonly bounded at the basin margins by unconformities. Initial basin rocks were syn-rift clastics and evaporites laid down in Carboniferous time (map units Cs.b and Cb.e). Until Late Triassic, the basin was characterized by a rapidly subsiding axial zone that received pelites (map units Cpb.st, $TRb.st_1$ and $TRb.st_2$), and moderately subsiding marginal zones that received carbonates and sandstones (map units CPs.c, Ps.p, TRs.d and TRs.p). Moderate rates of subsidence prevailed during Jurassic and Cretaceous clastic deposition, with phases of accelerated subsidence in Late Jurassic and early Late Cretaceous. Map units $Kp.d_1$ to $Kp.d_3$, preserved in grabens on the Arctic Platform and in the Cornwallis Foldbelt, are remnants of a Cretaceous transgression that over-stepped Sverdrup Basin rocks and extended to the south and west over the craton. The Sverdrup Basin subsidence cycle was terminated by Late Cretaceous - middle Tertiary compression (Eurekan Orogeny).

The Arctic Terrace Wedge (map units Jw.b to $Tw.d_2$) began to form in Late Jurassic/Early Cretaceous time. The wedge consists of unconformity-bounded clastic sequences lying on Mesozoic and older rifted rocks along the continental margin. Oceanward these sequences presumably grade into deep water sediments (map unit TKu) but little is known about the sedimentary column in the Canada Basin.

CRUSTAL CROSS-SECTION

Gravity and magnetic profiles

Gravity (Earth Physics Branch) and magnetic (Geological Survey of Canada) anomalies along the line of section (given on the 1:500,000 map) are shown. Gaps in the magnetic profile indicate an absence of data. Straight line segments join discrete gravity measurements (dots) which are reduced at a density of 2.67 g/cm^3 to Bouguer anomalies over land (including inter-island waterways) and free-air anomalies seaward from the north shore of Ellef Ringnes Island. Approximating the observed field, the calculated gravity effect is shown for a set of densities assigned to crustal blocks in the tectonic kindred depth-section (described below).

Section coded by tectonic kindred

This profile extends to the Moho, up to 48 km deep along the line of section, and shows tectonic zones and elements. Near-surface crustal boundaries are controlled by geological mapping, borehole logs and seismic reflection data. Deeper horizons are constrained by refraction data and crustal density modeling of the observed gravity profile. The

Rock densities used in the crustal profile to calculate a fit to the observed gravity field are compiled from surface samples, drill cuttings and borehole cores and density logs. Zones of extensive mafic igneous intrusion (chiefly dikes and sills) within the Sverdrup Basin are modeled as more dense by 0.10 to 0.20 g/cm^3 than the adjacent stratigraphy. The gravity low over the large diapir (mainly halite) on Ellef Ringnes Island is best fit with a model density of 2.31 g/cm^3 for the evaporites. This density is used also for evaporite deposits elsewhere in the cross-section.

Lower crust and upper mantle densities are assumed at 3.00 and 3.40 g/cm^3 respectively beneath the continent. This assumption produces a mantle anticline below the continent-ocean transition zone and generates excessive Moho depths beneath the Canada Basin. Reducing the mantle density to 3.25 g/cm^3 seaward of the outer continental shelf eliminates the mantle anticline and yields a more realistic Moho depth below the ocean basin. This presumed change in mantle density is arbitrary but within reasonable limits in both location and magnitude. A more satisfactory representation must await further constraints.

The gravity high over the continent-ocean transition is generated mainly by an isostatically uncompensated sediment load modeled to be up to 3 km thick over the polar margin. This load downflexes the underlying lithosphere which produces gravity lows on the flanks of the positive anomaly. Low gravity is observed landward of the margin high but seaward there are no data available.

Section coded by lithologic age

This profile extends to a depth of 25 km and shows age of rock units. Crustal boundaries are identical to those shown on the tectonic kindred

Section coded by lithologic age

This profile extends to a depth of 25 km and shows age of rock units. Crustal boundaries are identical to those shown on the tectonic kindred cross-section. Archean rocks are presumed to underlie all other lithologies within continental crust. The thickness of Proterozoic rocks beneath the Arctic Platform is taken from exposures on Somerset Island. Crustal horizons and total depth below Cornwallis Island is estimated from industry reflection and published refraction seismic data. Below the Sverdrup Basin, Proterozoic and Franklinian lithologies are shown undivided. Their combined thickness is deduced from published refraction seismic data. Franklinian rocks are presumed to exist beneath the Sverdrup Basin because, one, they are present to both the south (exposed) and the north (borehole cuttings) of the basin and, two, the P-wave velocity of rocks immediately below the basin is similar to that associated with Franklinian rocks elsewhere.

The continuation of Arctic Terrace Wedge units over the outer shelf and slope is assumed. The thickness of wedge deposits is known from published refraction seismic data below the inner shelf only.

GEOPHYSICAL PARAMETER MAPS

Seismicity

Seismicity in the central Arctic Islands for the period 1908 to 1982 is shown. Epicentral accuracy for most events is within 50 to 100 km. The threshold for complete detection of seismic events in this region is magnitude 4.5 to 5.0 below the Arctic Ocean and magnitude 4.0 to 5.0 within the archipelago. Seismicity along the polar margin is

Ringnes islands. Most seismic events take place within the crust. Focal mechanisms for earthquakes near Melville Island indicate that the direction of maximum deviatoric tensional stress for the region is about normal to the polar margin.

Total magnetic field

Shown are contoured aeromagnetic data flown at line spacings of 20 km or more at altitudes of 3.5 to 5.0 km. From Amund Ringnes Island northward flight altitude is about 300 m along lines 2 to 3 km apart. Positional accuracy for these surveys is ± 5 km. Over continental zones the total magnetic field is relatively flat. Anomaly amplitudes are generally less than 200 nT. Over Ellef Ringnes Island short wavelength slightly more intense positive anomalies are associated with extrusive and intrusive mafic igneous rocks. Northeast-trending linear magnetic anomalies in this region are associated with a swarm of diabase dikes of Early and Mid-Cretaceous age. A weak magnetic low lies over the polar margin and leads seaward to a zone of moderately intense (greater than 400 nT) short wavelength broadly irregular anomalies in Canada Basin.

Gravity and crustal density model

Shown are contoured regional gravity measurements collected at 10 to 15 km intervals together with gravity profiles having 1 km station spacing over parts of Ellef Ringnes Island, offshore along its east coast and along DD'. Positional accuracy for these data is ± 200 m. The accuracy of gravity anomaly values is estimated at ± 2 mGal. Low amplitude anomaly values (-20 to +20 mGal) characterize the gravity field between Somerset and Devon islands. Anomaly amplitudes decline northwestward to about -40 mGal over Sverdrup Basin rocks, then rise to about +30 mGal over mafic igneous rocks exposed on northern Ellef Ringnes Island. The gravity field declines sharply northwest of the island then rises and falls steeply over the continent-ocean transition zone where it achieves an amplitude greater than 100 mGal.

The crustal density model along DD' is constrained by closely-spaced gravity measurements (1 km interval) and by detailed crustal refraction data (shot points every 8 km). Crustal horizons are taken from seismic control. Densities are taken from surface samples, drill cuttings, borehole logs and P-wave velocity-versus-density tables. Zones of anomalous density within Phanerozoic stratigraphy are based on borehole data and, for evaporite distribution, borehole control plus P-wave velocity returns indicating shallower than expected horizons within a given region.