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THE PARRY ISLANDS FOLDED BELT IN THE CANADIAN ARCTIC ARCHIPELAGO*

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ABSTRACT. A preliminary description is given of the Parry Islands folded belt in the Canadian Arctic Archipelago. The problems of determining the time of orogeny of this belt and of its relation to folded strata on Ellesmere Island are discussed, and other possible major structural features of the islands are mentioned. It appears that the geological history of the major part of the Archipelago north of latitude 75° N has been more eventful than mere deposition of strata in epicontinental seas over a stable shield.

THE larger part of the Canadian Arctic Archipelago has long been considered as made of sedimentary strata deposited on a stable shield. Haughton's compilation (1857, 1859) of data gathered during the search for Franklin and by earlier explorers has supplied the main basis for such a conclusion. The sequence of exposed formations has been summarily described by many, and lately by Armstrong (1947), as successively younger from southeast to northwest. Folded strata have been known to occur on Ellesmere Island, notably through the observations of Fielden and De Rance (1878), Schei (1903, 1904), and Bentham (1936, 1941). The time of their folding and their southern extension are two problems of interest for students of Arctic geology.

Troelsen, who has been investigating the geology of Ellesmere Island for some time, recently (1950) presented some results of his observations, together with the latest summary of the geology of Ellesmere and adjacent regions. He concludes that marked diastrophism appears to have affected the area at least twice since Precambrian time, and that those periods include close folding at the end of the Silurian or, more likely, some time during the Devonian period (Caledonian-Acadian revolution), and weak folding with local, small-scale overthrusting between Early Jurassic (?) and the time of deposition of Cretaceous or Cenozoic limnic beds. Troelsen thus gives support to those who have believed in the extension to Ellesmere Island, through Spitsbergen and northwest Greenland, of the Caledonian system

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of mountains of northwest Europe. This is in opposition to some geologists who have believed that repeated orogeny in Ellesmere Island had not been proven; or again, in contrast with a third group who think there is some evidence for two periods of orogeny, one in Mesozoic time, but that definite dating of an earlier, pre-Pennsylvanian orogeny must await further investigation.

Folded rocks of Ordovician and Silurian age have been observed on Ellesmere Island as far south as Vendome Fjord and the north coast of Baumann Fjord, where folds trend southwesterly. On the south coast of Baumann Fjord, Bentham (1941) suggests that the folded Ordovician and Silurian strata are buried under flat-lying Devonian and Carboniferous strata. Schei (1904) has measured in the very southwest part of Ellesmere Island some 9000 to 10,000 feet of conformable Ordovician, Silurian, and Devonian strata, gently inclined to the northwest but not folded. He observed undisturbed Carboniferous (Permian ?) beds north of the area of Devonian, but with a gap in outcrop.

Eardley (1948, 1951) has suggested that the folded belt of Ellesmere Island extends through Bathurst and Melville Islands by a westward curving. His arguments are the "substantial thickness" of 3850 feet of Carboniferous (Permian ?) sandstone and shale occurring on the south coast of Melville Island with high dips averaging 65 degrees south, as mentioned by Armstrong (1947), and the coincidence of strike of these with the general contact of the Carboniferous rocks and older strata. This contact, according to the Geological Map of the Dominion of Canada (1945), lies south of Melville and Bathurst Islands, thence trends northeasterly towards southwest Ellesmere Island.

Studies by the Geological Survey of Canada since 1949 show that the group of islands extending from Cornwallis Island westward, through Bathurst and Melville Islands, to Prince Patrick Island, are traversed by a belt of folded rocks, to which the authors refer as the "Parry Islands folded belt." The data have been obtained through the study of air photographs, a flight over the region, field work, and the scanning of earlier explorers' reports. Part of the data have been already incorporated in the Tectonic Map of Canada (1950). The sketch map (fig. 1) of the Canadian Archipelago shows the occurrence

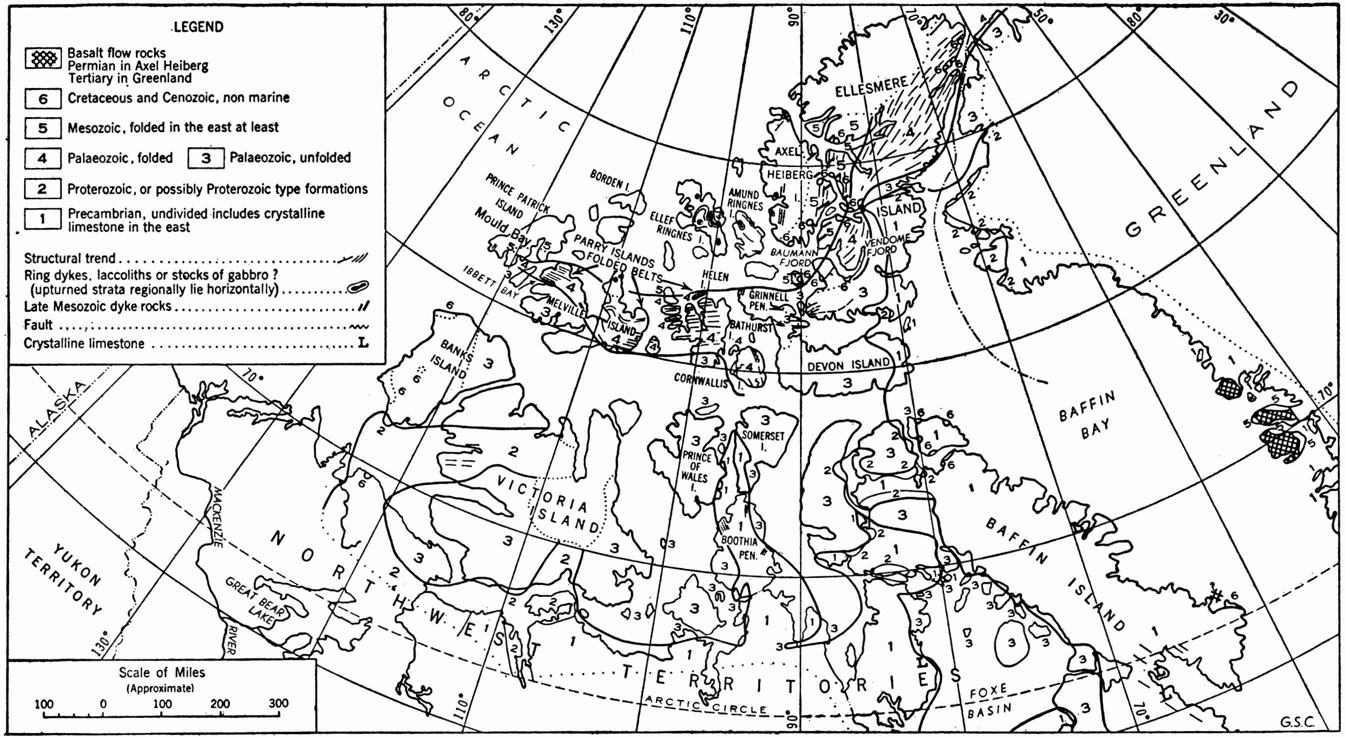

Fig. 1. Geological sketch map of Arctic Canada, showing the position of the Parry Islands folded belt.

of the Parry Islands folded belt. The map and this report must be considered preliminary pending further investigation.

In 1949, Major Ivor Bowen showed to the senior author some air photographs of Bathurst Island, clearly exhibiting folded rocks; he suggested that a geosyncline must have occupied those parts. Further examination of air photographs revealed that the folds on Bathurst Island (plate 1, fig. 1), where they are best displayed within the belt, are open, canoe-shaped structures, apparently without overturning, of Appalachian type. The island has been estimated to have a maximum elevation of some 1500 feet above sea level. In part it has low relief; in other parts it has low rock ridges separated by narrow flat areas and such topographic features are related to the folded structures. This is in contrast with the high relief and the great dissection of the folded belt on Ellesmere Island (plate 1, fig. 2), where the land is 5000 to 6000 feet above sea level in many places (even over 10,000 feet in the northern part), and where crested ridges, with roughly concordant summits, are an expression of the folded strata.

The strata are not markedly folded on the southern part of Bathurst Island, but the folds are well displayed on air photographs on other parts of the island and as far north as Helen Island on latitude 76°40′ N. McMillan (1910, p. 415) reports strata dipping up to 25 degrees southeasterly and northwesterly at Cape Hotspur, well north on the west coast of Bathurst Island, and further south, along the same coast, at Schomberg Point, he observed a syncline one mile in width. Haughton (1857) shows on his map some coal seams trending northeasterly on Bathurst, Melville, and Banks Islands. It now appears possible to us that Haughton may have extended to Melville and Banks Islands southwesterly trends observed only on Bathurst Island coal seams, in an attempt to link reported coal occurrences. The strata on the northeastern part of Banks Island are now known to be horizontal and some of the coal occurrences reported there as well as on the southeastern part of Melville Island may not have been found in situ.

On Melville Island the folds, westerly to southwesterly trending on the east coast, swing to northwesterly in the central part of the island, according to data obtained from air photographs. McMillan's sketch map (1910, p. 449) shows a structural trend north of west in the area of Cape Bounty and Bridport Inlet on the south coast of the island. His text mentions both northerly and southerly dipping strata, although the section he measured as 3845 feet thick has southerly dipping strata at an estimated average of 65 degrees. McMillan concluded in his summary of structural features that the structure in southern Melville Island was a series of monoclines resulting from block faulting, and that if any folding had taken place it was not apparent. This type of deformation may well have taken place at the edge of the folded belt. McMillan recognized folds on western Bathurst Island but their implication seems to have escaped him, since he failed to mention the role of folding in the general structure of the western islands. In the northwest part of Melville, the folds (plate 2) trend westerly. From air photographs the folds appear closer than on Bathurst, with steeper dipping limbs, narrower crests and sharper noses. No overturning has been detected. The southern boundary of the folded belt is apparently in the vicinity of parallel 75 N in southeastern Melville, and at Ibbett Bay (fig. 1) on the western part of the island. South of this bay, M'Clintock (1855) observed dips up to 5 degrees only. During a flight over the island, the authors observed, within the belt of folded rocks, large areas with strata of gentle inclinations, that may represent younger, unfolded rocks, unconformably overlying older folded beds. The island varies in relief from plains but a few hundred feet above sea level to a western plateau, more than 2000 feet above sea level.

Folded rocks occur on Prince Patrick Island, as observed by the writers both from aircraft and air photographs. However, the areas of distinctly folded rocks are restricted in extent, and there are large tracts of horizontally lying beds that, as on Melville, may represent an unconformable cover of younger strata. The trend of the folded rocks appears to be southerly, suggesting further arching of the folded belt, as on Melville Island. However, air photographs of Borden Island show folds at one locality. Metamorphic rocks have been collected on the northwest coast of Ellesmere Island and there has been speculation as to the western extension of the zone of deformation to which these metamorphic rocks belong. Schei (1904) observed that the folding on Ellesmere Island in latitude 80 degrees north dwindled out westward. He reported volcanic rocks from northernmost Axel Heiberg Island and found similar (p. 462) specimens collected on Ringnes Land. Specimens of basalt from the western part of Ellef Ringnes have been identified by Fortier, and the writers, while on a flight over the same locality, have observed features suggesting the occurrence of basic igneous rocks. Air photographs indicate similar dark rocks on parts of Prince Patrick. There is much conjecture in all this; nevertheless further investigation may eventually establish the above localities to be within a belt of disturbance, along the very northwest edge of the Canadian Archipelago that is in part covered unconformably by younger, unfolded strata, and joins the Parry Island folded belt on Prince Patrick Island.

Most of Ellef Ringnes is underlain by flat-lying strata, as is presently known from the study of air photographs and a flight over the area. However, the strata have been locally upwarped to form circular structures as described by Brown (1951). From air photographs, such structures (fig. 1) are known to extend from the west coast of Axel Heiberg, through Amund and Effel Ringnes, to Sabine Peninsula, on northern Melville Island. They are presently being investigated in the field by W. W. Heywood. Whether these structures turn out to be due to igneous intrusions or salt doming, they do appear to be another major structural element on what was formerly described by Suess as the horizontally stratified northern border of the shield.

The Parry Islands folded belt may extend beneath the Beaufort Sea to the northeasterly trending Paleozoic beds in the Tanana-Yukon region of Alaska, as suggested by Eardley (1951). However, the northeastern part of Banks Island and the southwestern part of Melville Island do not appear to be within the folded belt. Scrutiny of air photographs has failed to identify folded rocks in that region, which is a plateau of horizontal strata, in part deeply dissected. Porsild (1951) collected Devonian fossils in the northeastern part of Banks Island and did not observe folded strata.

It is interesting to re-examine Haughton's map (1857), which has been, at least up to 1945, the basis for geological maps compiled of parts of the Canadian Arctic. On the Parry Islands, it shows a contact between sandstone on the south and limestone on the north that is parallel, in its major trend, to that of the folded belt as outlined here. A line based on available stratigraphic information, and referred to by Eardley (1951, p. 528), has been sketched on our map (fig. 1). It links

PLATE 1

Fig. 1

Fig. 2

PLATE 2

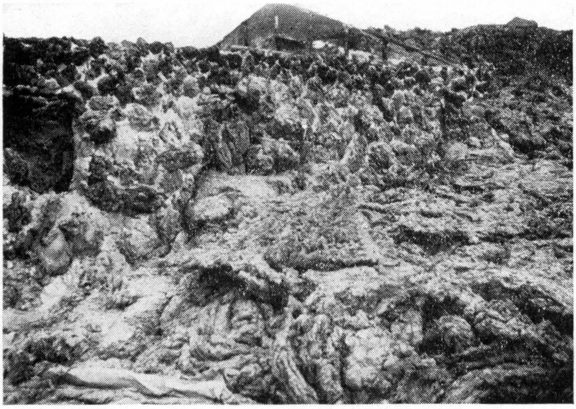

Fig. 1

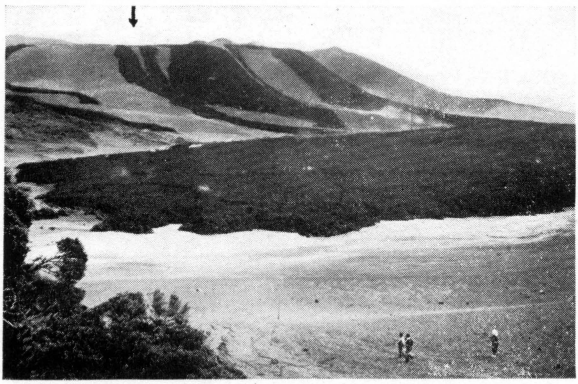

Fig. 2

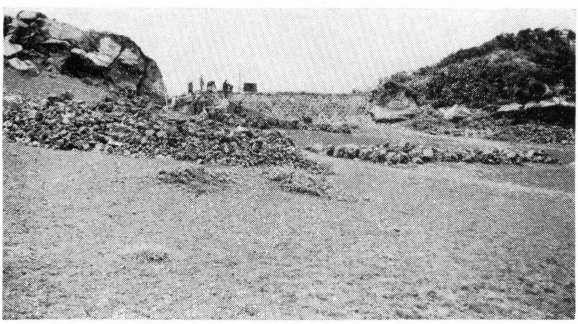

Fig. 3

the easternmost exposures of Mesozoic rocks, as reported from Ellesmere Island, with the southernmost exposures of these rocks, as reported from the Parry Islands, that is, on Graham, Table, and Exmouth islands, on a separate island formerly thought to be the northwest corner of Bathurst Island, and on the east coast of Prince Patrick. Although Mesozoic strata are known to be folded on western Ellesmere, those of Graham and Table Islands are apparently flat lying. At present the only significance of the above line is that it represents a linear feature parallel with the major trend of folds on Ellesmere and on the Parry Islands.

Paleontological data from Melville and Bathurst Islands are scant; it is not always clear whether specimens were collected in situ or as float; some identifications are of doubtful nature; and the stratigraphic positions of some identified forms are questionable. Although the above islands are shown on the Geological Map of Canada (1945), as underlain by Carboniferous strata, there is doubt whether the presence of Carboniferous strata has been definitely demonstrated (Armstrong, 1947; Washburn, 1947). The literature contains suggestions that, besides Mesozoic strata, the Permian, Silurian, and even Ordovician are represented on those islands. Thus far, there is no basis to determine the time of orogeny of the Parry Islands folded belt.

The Geological Survey of Canada commenced field investigation of the belt in 1950, when the authors, together with T. Harwood, explored the geology of Cornwallis Island by canoe journey around its coasts. Thorsteinsson is presently engaged in a third field season in those parts.

The coastal region of Cornwallis Island is mainly underlain by limestones and dolomites of Ordovician and Silurian age. A limited area of Devonian occurs along the east coast of the island. One Silurian formation, approximately in the northern half of the island, is more than 5000 feet thick; its graptolitic content is presently the object of study by Thorsteinsson. This formation is in stratigraphic continuity with a shelly limestone to the south. An intercalation of reefy limestone between the two facies has been located along the east coast of Cornwallis Island. The thickness of the Silurian formation so far outlined amounts to some 15,000 feet, and the disposition of the facies suggests a deepening of Silurian sea to the north.

The Silurian facies discussed above can be separated approximately along a line trending somewhat south of westerly. However, the strata are folded, more intensively near faults, in a north-northwest and northwest direction, and appear to link by curving with the easterly trending folds on the mid-latitude east coast of Bathurst Island. The Devonian strata of Cornwallis Island are in conformity with the Silurian strata, and have partaken in the same deformation, so that folding on Cornwallis is as young as Devonian. The observed Devonian strata are made, in their upper part, of coarse clastic sediments, which is somewhat in simile with the Devonian rocks of southwestern Ellesmere Island, where Schei observed these strata to pass upward into a thick sandstone series, but to be unfolded.

Examination of air photographs of northwestern Devon Island, especially Grinnell Peninsula, has brought no light on the relation of the Parry Islands folded belt and the folded rocks of Ellesmere Island. In the eastern part of the peninsula the strata, except for local steepening to some 25 degrees, form a monocline gently dipping to the north. The monocline, which extends to North Kent Island, appears to be the western extension of the monocline of regional extent as observed by Schei (1904) in Ordovician, Silurian and Devonian strata in southwestern Ellesmere. At the northwest tip of Grinnell Peninsula, some inclined strata trend northerly. It is possible that, whereas Cornwallis Island represents a southeastern branch of the Parry Islands folded belt, a northerly branch of the belt escapes detection on air photographs because it is hidden under younger strata in northwesternmost Devon Island, and also in western Ellesmere according to Bentham's (1941) suggestion. This would place the date of orogeny in those parts sometime in the Devonian according to Bentham's observations on Baumann Fjord and those of the writers on Cornwallis Island. It would further imply, if the Parry Islands folded belt as outlined here represent one orogeny, that the Carboniferous and/or Permian fossils collected on those islands were from strata unconformably resting on older folded beds.

Indeed, this communication does not present a solution to already known problems of structural geology in the Canadian Arctic Archipelago. It rather points to further problems and seeks to dispel the former notion of strata laid in epicontinental seas on a shield stable to northwesternmost Arctic lands.

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