# PERMIAN STRATIGRAPHY AT PIPER PASS, NORTHERN ELLESMERE ISLAND, DISTRICT OF FRANKLIN

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## Introduction

For two days in June, 1977 the writer studied the Permian rocks exposed at the southern end of Piper Pass (Fig. 1) as a contribution toward the regional mapping project led by H.P. Trettin and U. Mayr (Mayr, 1976).

These rocks were included originally in map-unit 13 of Christie (1964) as "Permian to Jura-Cretaceous". Mapping during 1977 indicated that map-unit 13 occurs in three areas:

1. North of the main Hazen Thrust Fault, Permian strata rest unconformably on the Grant Land Formation (Cambrian and/or Ordovician, according to Trettin, 1971) and are the youngest rocks present in the area.
2. A second thrust fault has been mapped south of the main Hazen Thrust. Between the two faults is an area 1 to 8 km wide underlain by a steeply dipping to overturned Permian to Lower Cretaceous section, including the unit described in this report (also including map-unit 10G of Christie, 1964).
3. South of the two faults map-unit 13 includes an area of Mesozoic outcrop, not shown on Figure 1.

The detailed structural geology of the thrust belt in this area will be reported on elsewhere.

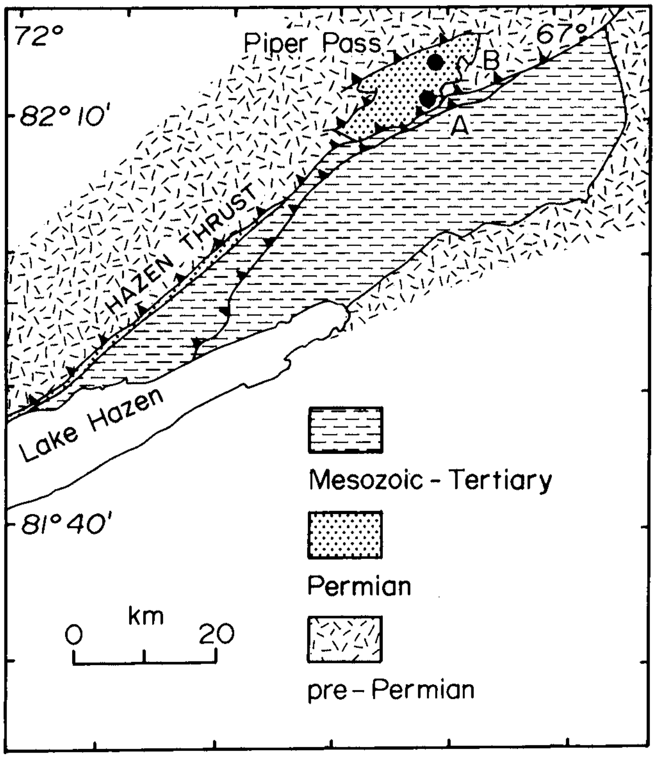

Figure 1. Report-area, showing location of stratigraphic sections A and B.

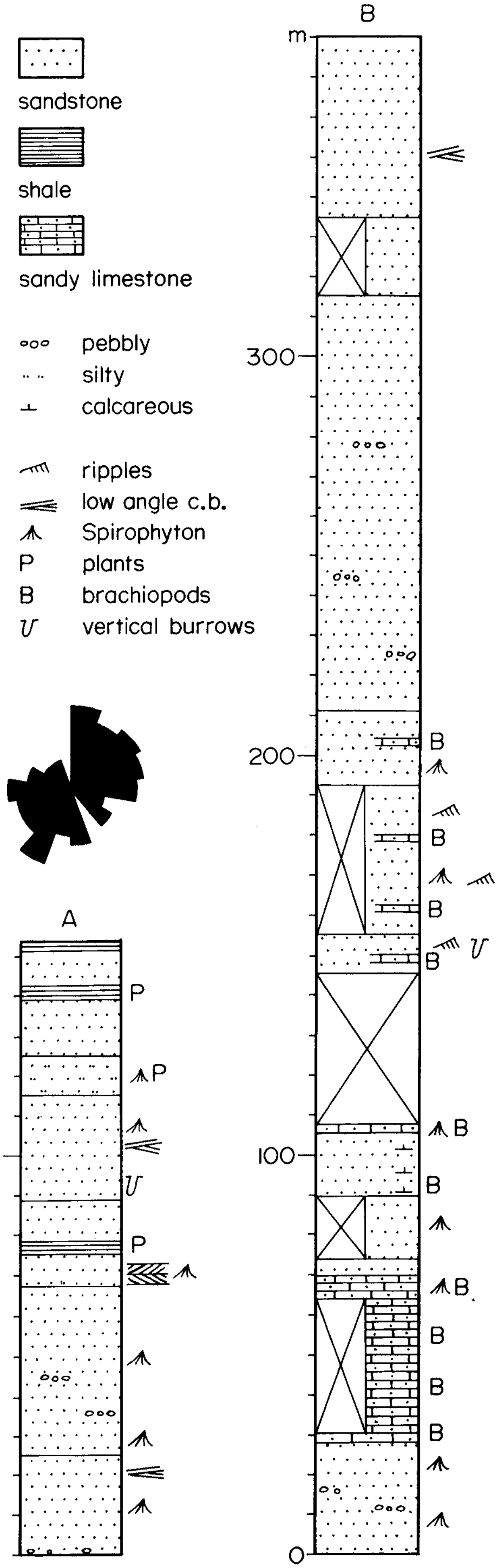

Figure 2. (right) Stratigraphic sections A and B through the Permian rocks at Piper Pass. Both sections commence at the base of the Permian. The rose diagram at left-centre represents 55 cross-bed orientation measurements made on herringbone cross-stratification in the 67-75 m interval of section A.

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### Thickness and Lithology

Two sections through the Permian rocks exposed north of the main Hazen Thrust were described and measured in detail (Fig. 2). Both sections commenced at the unconformable contact of the Permian with the Grant Land Formation. The thicker of the two sections totals 380 m, with an estimated 100 m of poorly exposed section present, but not measured, above the highest stratigraphic level reached.

The dominant lithology throughout is sandstone, which generally is fine to medium grained, white to pale grey, cream to pale buff or brown weathering. Small pyrite nodules and small pebbles of white vein quartz and black chert are common locally. Spirophyton traces are abundant, and some units contain numerous trace fossils (Fig. 3). Trace fossil types include simple vertical tubes up to 18 cm long (Asterosoma-type), "knobbly"-walled tubes (Ophiomorpha-type) and meniscus-filled burrows (Diplocraterion-type). Most of the sandstone is massive, bedding being very faint. However, in section A the interval between 67 and 75 m contains abundant high-angle herringbone cross-stratification (Fig. 4). Low-angle (<5°) cross-bed sets rarely are present elsewhere in this section, and ripple marks and small trough sets were recorded at a few levels in section B.

In section B brachiopod debris is common, in some places forming a sandy brachiopod coquina. Several intervals of dark grey fissile claystone containing coaly plant fragments are present in section A.

### Correlation

Lithologically these rocks are similar both to the Sabine Bay Formation (Lower Permian) and to the Trold Fiord Formation (Upper Permian). Regional mapping indicates that they probably should be assigned to the Trold Fiord, but formal designation must await a detailed examination of the brachiopod collection. Differences between the Piper Pass rocks and the type Trold Fiord described by Thorsteinsson (1974) include a much greater thickness in the report-area and an absence of the distinctive green weathering common in areas farther south.

### Depositional Environment and Paleogeography

The presence of abundant brachiopods in section B and of herringbone and low-angle cross-bedding in section A indicate a marine origin for the Piper Pass rocks. Herringbone cross-bedding is found in areas characterized by bimodal or polymodal current directions such as those influenced by waves or tides. There are various causes of low-angle cross-bedding, but a common one is the slow progradation of beach surfaces under the influence of waves in a foreshore or inner shoreface environment (intertidal to shallow subtidal). Trace fossils of the type shown in Figure 3 are common in marine (intertidal toshallow subtidal) environments. Coquina deposits are typically shallow subtidal in origin.

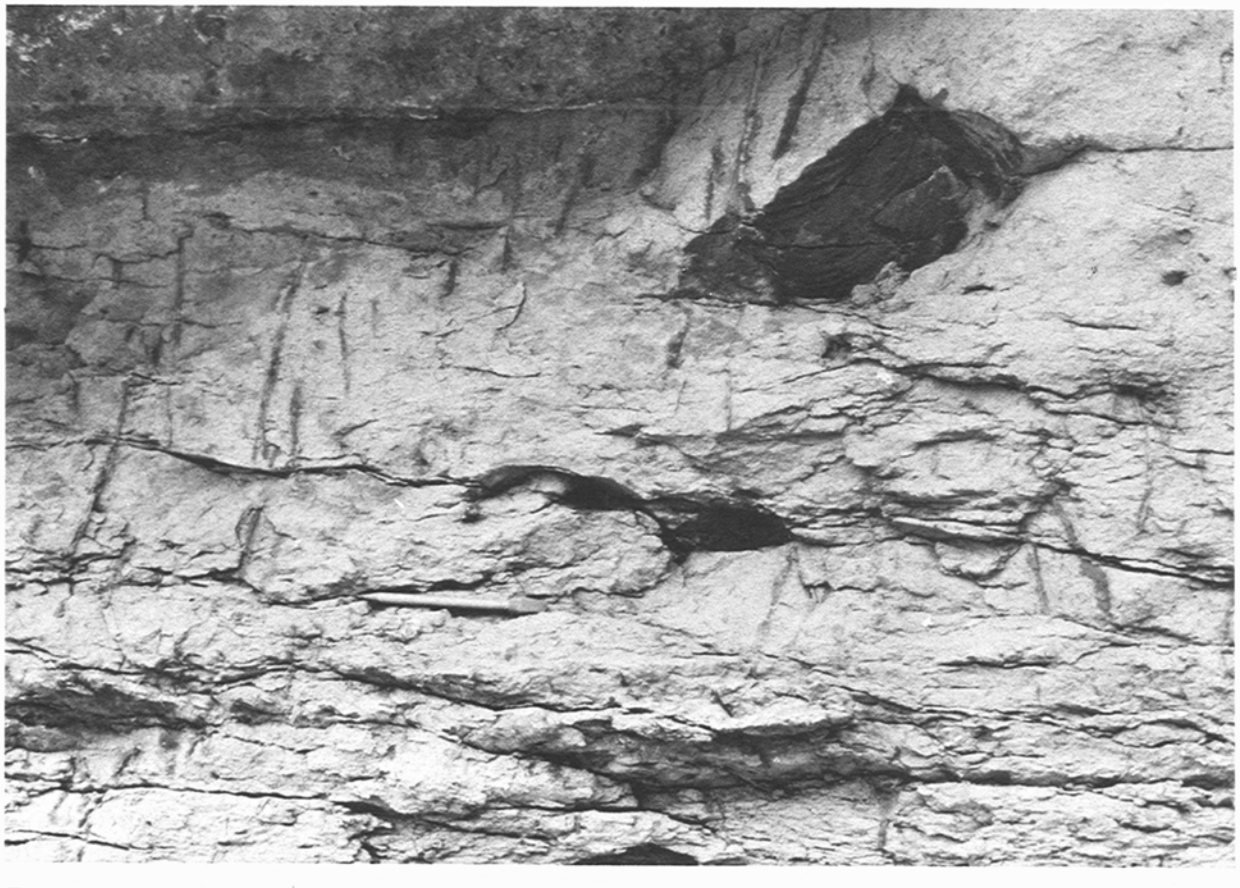

Figure 3. Trace fossils, 146-156 m interval of section B. Visible are **Spirophyton** and numerous vertical tubes. Note pencil for scale. GSC 199326.

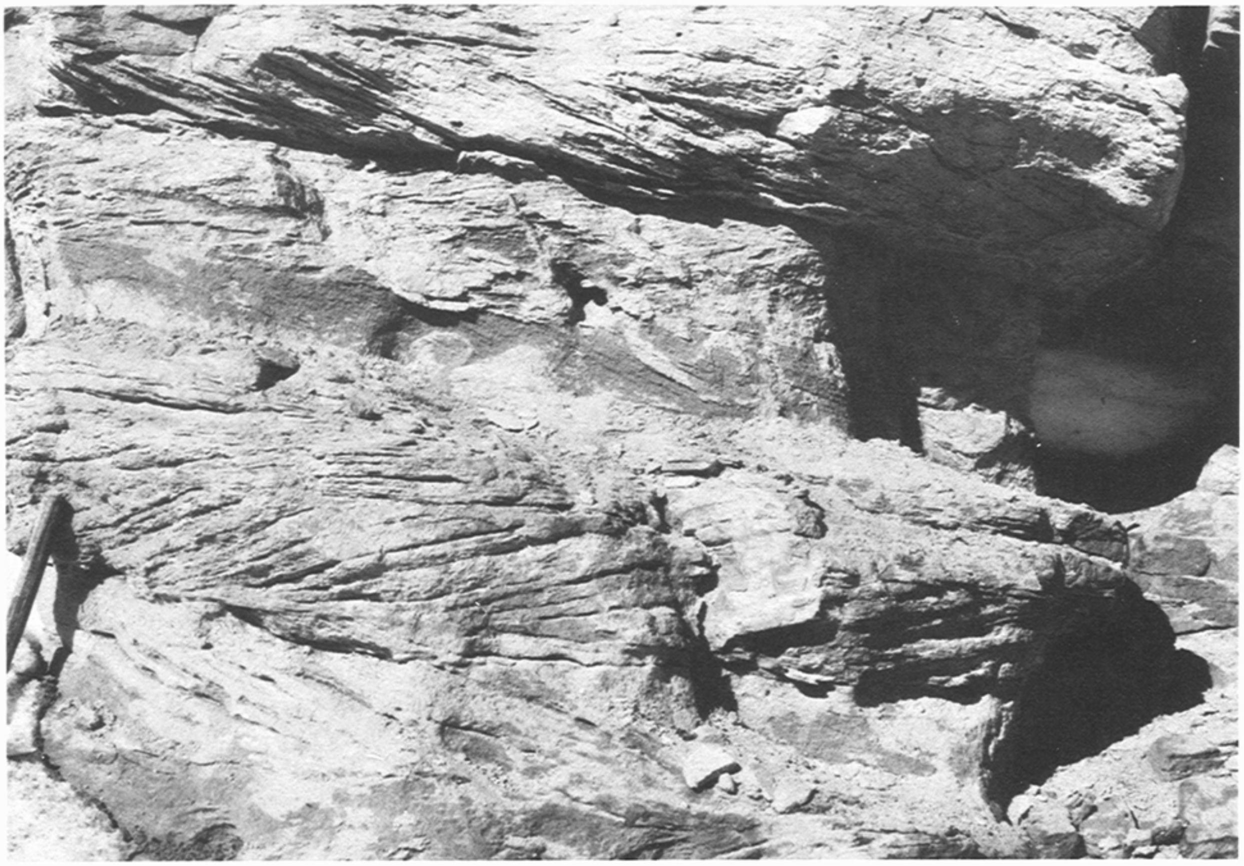

Figure 4. Herringbone cross-stratification, 67-75 m interval of section A. Five sets are present, showing alternate southwesterly and northeasterly orientations (set next to top of hammer handle is 20 cm thick). GSC 199325.

Detailed environmental interpretations are hindered by the lack of obvious cyclicity or repeated facies associations in these rocks, and by the marked contrast between the sequences present in the two sections. There are general similarities with the shallow shelf sandstone deposits described by Goldring and Bridges (1973) and Brenner and Davies (1974). Shoreline and barrier environments commonly generate coarsening-upward sequences (Davies et al., 1971), and these are absent in Piper Pass, with the possible exception of the 75 to 115 m interval in section A. In this interpretation the thin shale unit at 75 to 77 m would be interpreted as an offshore deposit, containing transported plant material. However, it could represent a lagoonal deposit originally formed landward from a coastal barrier island. The underlying sandstone unit contains abundant herringbone cross-stratification which could represent a foreshore, inner shoreface, or tidal delta environment within a barrier system.

Fifty-five cross-bed orientation measurements were made on the herringbone cross-stratification (Fig. 2). The distribution of readings is strongly bimodal about a northeast-southwest axis, which is parallel to the present-day structural grain, and also parallels the interpreted axis of the Sverdrup Basin during Carboniferous-Permian time (Throsteinsson, 1974). Two possible interpretations of the data are offered:

1. The cross-bedded sandstone represents the deposits of a tidal delta formed during ebb and flood through an inlet in a barrier system. In this case the current modes likely would be oriented perpendicular to the local coastline. In view of regional paleogeographic considerations, this interpretation does not seem very plausible.

2. Cross-bed orientations were caused by strong, offshore, reversing tidal currents such as occur at the present day in narrow seaways, for example the English Channel and the Malacca Strait. The relatively narrow (less than 100 km) outcrop belt of the Carboniferous-Permian rocks that extends northeastward through northern Ellesmere Island may reflect an original paleogeography consisting of a narrow linear seaway, in which case evidence of strong reversing tidal currents might well be expected. Based on this hypothesis, the lithologic contrasts between sections A and B could reflect narrow facies belts parallel to a shoreline that deepened toward the northwest (sandier in shallow coastal environments and more calcareous in the open sea).

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