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## VOLCANIC BRECCIAS IN THE ISACHSEN FORMATION NEAR STRAND FIORD, AXEL HEIBERG ISLAND, DISTRICT OF FRANKLIN

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### **Abstract**

*An 80 m thick sequence of volcanic breccia occurs in the upper Isachsen Formation at the northeast end of Strand Fiord. Most of the sequence consists of nonstratified, angular, nonsorted basalt breccia. These massive breccias originated when rising magma reacted with meteoric water at very shallow burial depths, and were subsequently extruded as breccia onto the Isachsen delta plain. A different origin is envisaged for the crudely stratified and matrix-supported breccias that occur in the upper few metres of the sequence. They are probably lahars that reworked the extruded breccia and small amounts of included bedrock.*

### **Résumé**

*Dans la partie supérieure de la formation d'Isachsen, à l'extrémité nord-est du fjord Strand, on rencontre une épaisse séquence (80 m) de brèches volcaniques. La majeure partie de cette séquence est constituée de brèches basaltiques non stratifiées, à éléments anguleux, non triés. Ces brèches massives se sont formées lorsque le magma ascendant a réagi avec les eaux météoriques à très faible profondeur, et s'est déversé ensuite sous forme de brèches sur la plaine deltaïque d'Isachsen. On a envisagé une origine différente pour les brèches grossièrement stratifiées et englobées dans une matrice, que l'on rencontre dans les premiers mètres supérieurs de la séquence. Il s'agit probablement de coulées de boue (lahars) qui ont remanié les brèches extrudées, et de petits volumes de roche de fond incluse.*

**Stratigraphic setting**

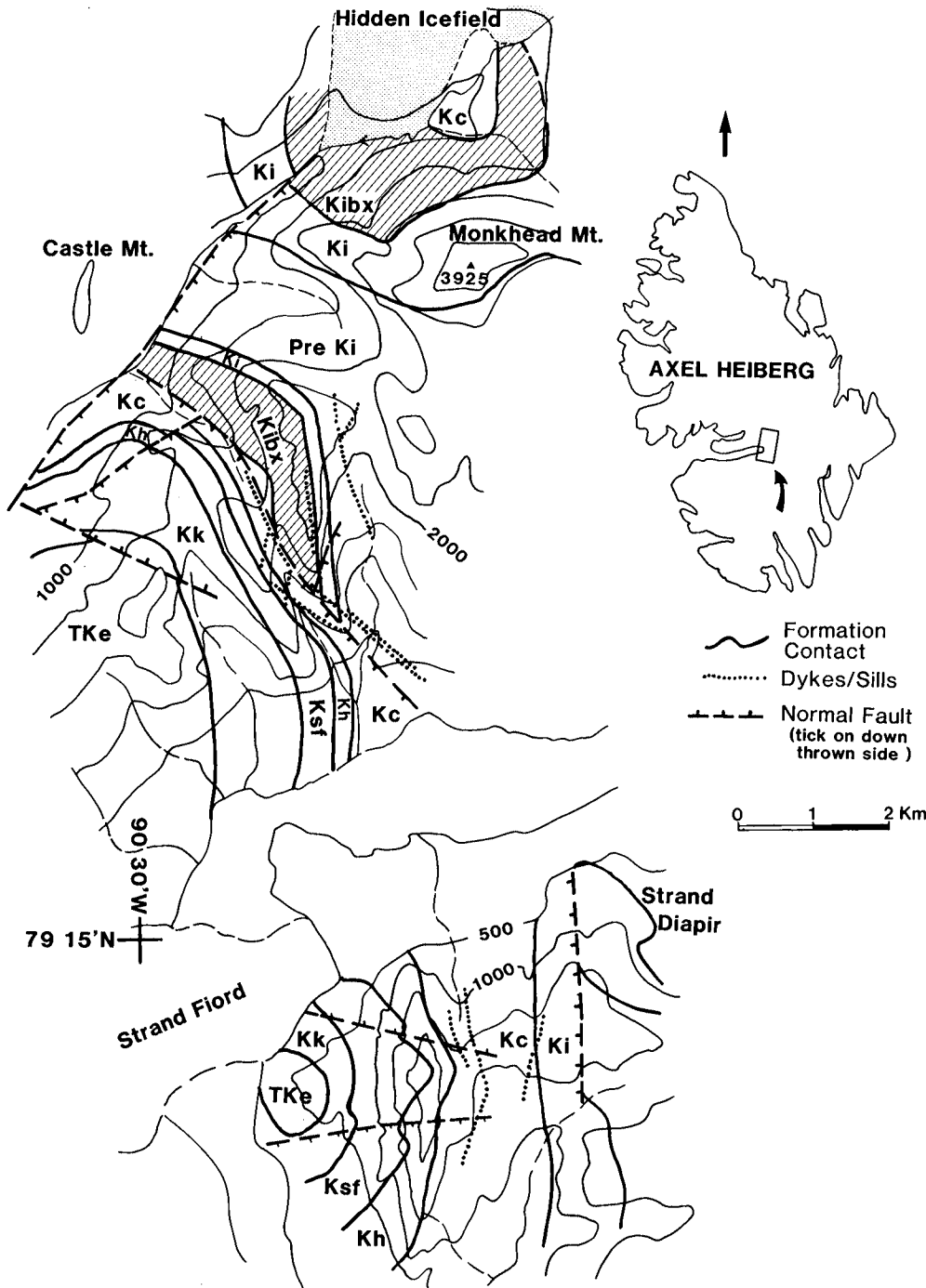
During field studies on western Axel Heiberg Island in 1983, some unusual volcanic breccias occurring in the Isachsen Formation were examined. The breccias, first described by Souther (1963), are exposed in two dip-slopes; one that forms a prominent ridge at the northeast end of Strand Fiord, and the other between Monkhead Mountain and a small glacial lobe of Hidden Icefield (Fig. 72.1). Stratigraphically, the breccias occur in the upper part of the Isachsen Formation, and therefore are probably Barremian-Aptian in age (A.F. Embry, personal communication, 1984).

Both upper and lower contacts appear to be conformable. Where breccias overlie typical Isachsen lithologies of interbedded sandstone, grey shale and thin coal seams, the lower bounding surface is abrupt. Diabase sills, some with prominent jointing, intrude the lower breccias and clastic Isachsen strata. In addition, Souther (1963, p. 439) also noted the presence of tuff beds near this contact.

The upper contact of the breccias is in most places faulted against dark grey shale of the Christopher Formation. However, a stratigraphic contact is exposed in a small saddle 5 km due north of the head of Strand Fiord. Here, the breccias are overlain by a 3 m interval of thin quartz arenites and interbedded shale (Fig. 72.2); the lowermost sandstone beds contain fine basalt pebbles and granules. This interval in turn is overlain by Christopher shale.

The maximum thickness of breccia exposed at these localities is about 80 m. In adjacent areas, the breccia appears to have pinched out completely. Upper Isachsen strata that outcrop near Strand Diapir contain only isolated

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**Figure 72.1**

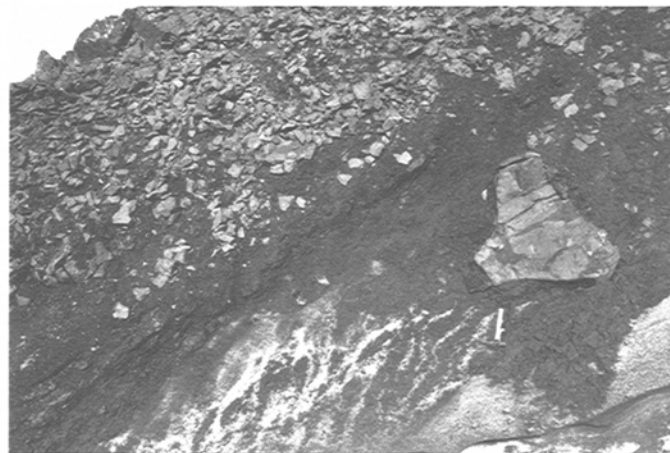
Locality map of the Isachsen breccias, western Axel Heiberg Island. Area of exposure is delineated by the diagonal pattern (Kibx). Other stratigraphic units are:

- (oldest) Pre-Ki = pre-Isachsen strata;
- Ki = Isachsen;
- Kc = Christopher Fm;
- Kh = Hassel Fm;
- Ksf = Strand Fiord Fm;
- Kk = Kanguk Fm;
- TKe = Eureka Sound Fm.

Geology modified after Thorsteinsson (1971a).



**Figure 72.2.** Stratigraphic contact between the crudely stratified breccia and interbedded sandstone and shale at the top of the Isachsen Formation. Located approximately 5 km due north of Strand Fiord. (ISPG 2045-382)



**Figure 72.3.** Matrix supported breccia containing large basalt blocks. The lower part of this unit is ice covered. Hammer is 33 cm long. Same locality as Figure 72.2. (ISPG 2045-383)

diabase sills, the breccias having disappeared over a distance of less than 5 km. Similarly, Fricker (1963) noted the presence of sills and a few basalt flows in the Isachsen Formation near Wolf Mountain some 12 km to the northwest, but no breccias. Thus, distribution of the breccias seems to be restricted to an area having a radius of 10 to 15 km about Monkhead Mountain.

Many of the diabase and gabbro dykes and sills that intrude the breccias also intrude overlying Christopher shale and Hassel sandstone, and are probably associated with the Upper Cretaceous extrusive event represented by the Strand Fiord volcanics.

#### Internal organization of the breccias

Crude sedimentary layering occurs at the top of the breccia sequence, and bedding, although vague, can be discerned by grain size contrasts. In contrast, breccia in the middle and lower part of the sequence is more massive. Two types of breccia are recognized:

- a. Crudely bedded, poorly sorted pebble and cobble breccia layers in the upper few metres of the sequence, having a matrix-supported framework consisting mostly of basalt (90%) and subordinate clasts of shale, rare pebbles of andesite and dacite, and reworked lapillistone breccia. Clast size averages 20 cm. Some of the clasts show a moderate degree of rounding. The matrix is composed of shale, fine sand-sized basalt, and some rounded epiclastic quartz grains with abraided quartz overgrowths. One bed near the top of the sequence contains blocks of basalt that appear to float in a matrix of dark grey shale (Fig. 72.3).
- b. Nonstratified and nonsorted breccias, some of which contain matrix-supported and others clast-supported frameworks (Fig. 72.4). Here, blocks consist almost exclusively of basalt that ranges from aphanitic to coarse grained, and up to 15% (by volume) amygdules. All fragments are extremely angular and range in size up to 2 m, averaging 50 cm. Occasional fragments show evidence of multiple brecciation.

#### Interpretation

A nonstratified and nonsorted breccia that bears some resemblance to the Isachsen breccia at Strand Fiord is found in the upper Cretaceous Hassel Formation on Amund Ringnes



**Figure 72.4.** Massive, nonstratified breccia composed of a chaotic jumble of basalt blocks. Hammer is 33 cm long. (ISPG 2045-385)

Island (Balkwill, 1983). Balkwill was able to trace the brecciated flows laterally to nonbrecciated, aphanitic basalt flows. The Hassel breccia was interpreted to be the product of phreatomagmatic fracturing of magma that had been intruded into water-saturated sediment at shallow depths, and subsequently extruded as breccia.

The Isachsen breccia however, is different from the Hassel example in a number of ways:

- crude stratification is present in the upper few metres of the Isachsen breccia;
- matrix and clast-supported frameworks occur, the matrix-supported varieties containing reworked shale and sandstone;
- no massive (nonbrecciated) lava flows occur in the eastern Strand Fiord area.

In regional stratigraphic considerations (Balkwill, 1978), the Isachsen Formation represents a major stage of delta construction in Sverdrup Basin. Isachsen strata immediately underlying the breccia at Strand Fiord are thin bedded sandstone, shale and coal, suggesting a delta plain setting, upon which the breccias accumulated.

A mechanism involving autobrecciation of massive lava flows cannot be completely dismissed, although one might expect to see at least some relics of massive lava preserved. The mechanism of brecciation suggested by Balkwill is considered feasible here, but with some modification. The Isachsen breccias probably originated in two ways. In the first case, rising magma reacted with meteoric water at very shallow depths beneath the delta plain, and was subsequently extruded as breccia. Some autobrecciation may also have occurred. Once a significant pile of breccia had accumulated on the delta plain (producing the bulk of the breccia sequence) reworking of basalt debris and included fragments of bedrock took place as a result of lahars that flowed down the flanks of the breccia pile, giving rise to the upper, stratified part of the sequence.

The Isachsen breccias are part of an intermittent but locally significant period of Lower Cretaceous volcanism in central and eastern Sverdrup Basin, represented by minor basic flows and volcanoclastics at Li Fiord (Fortier, 1963, p. 514) and the southwest shore of Strand Fiord (Tozer, 1963, p. 453), and felsic tuffs on Amund Ringnes (Balkwill, 1983). Map unit Kv, at the top of the Isachsen south of Hare Fiord, contains basalt flows (Thorsteinsson, 1971b).

#### Acknowledgments

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