

# Shallow seismic Stratigraphy and Structure of the southernmost Part of the Tjörnes Fracture Zone

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## ABSTRACT

Sparker profiles show a steep contact between basaltic basement and sediments parallel to gravity contours off the coast between Gjögurtá and Flatey, northern Iceland. In the bay of Skjálfandaflói the basaltic basement rocks have been modified by glacial erosion. Modern sediments in the bay are faulted in response to movements in the Tjörnes Fracture Zone.

## INTRODUCTION

A steep gravity gradient off central northern Iceland described by Pálmason (1974) indicates a thick accumulation of sediments in the southern part of the Tjörnes Fracture Zone and a structural discontinuity between the crystalline rocks on land and lighter rocks offshore. "Crystalline rocks", in this instance, refers to flexured tholeiitic flood basalts

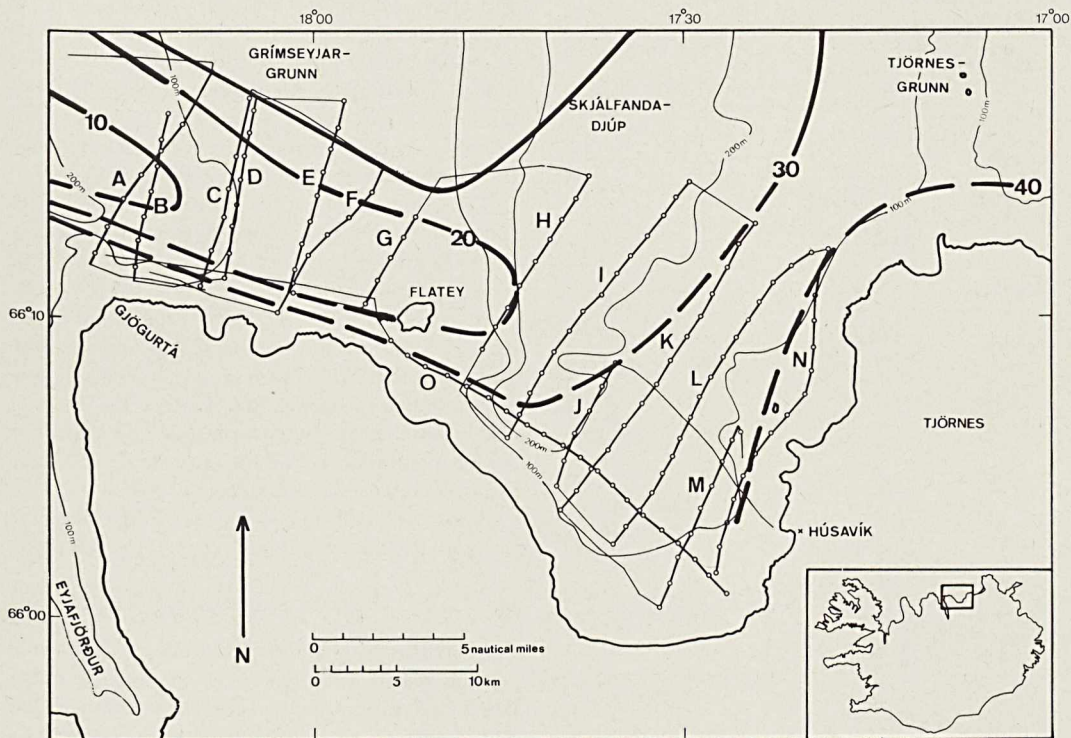


Fig. 1. Index map showing location of profiles. Heavy-lined part of profiles is illustrated in Figs. 2, 3 and 4. Free-air gravity contours after Pálmason (1974).

Mynd 2. Kort, sem sýnir mælingalínur á svæðinu frá Gjögurtá að Tjörnesi. Bókstafir auðkenna þær línur, sem sýndar eru á 2., 3. og 4. mynd. A kortið eru dregnar þyngdarlínur úr mælingum Guðmundar Pálmasonar (1974).

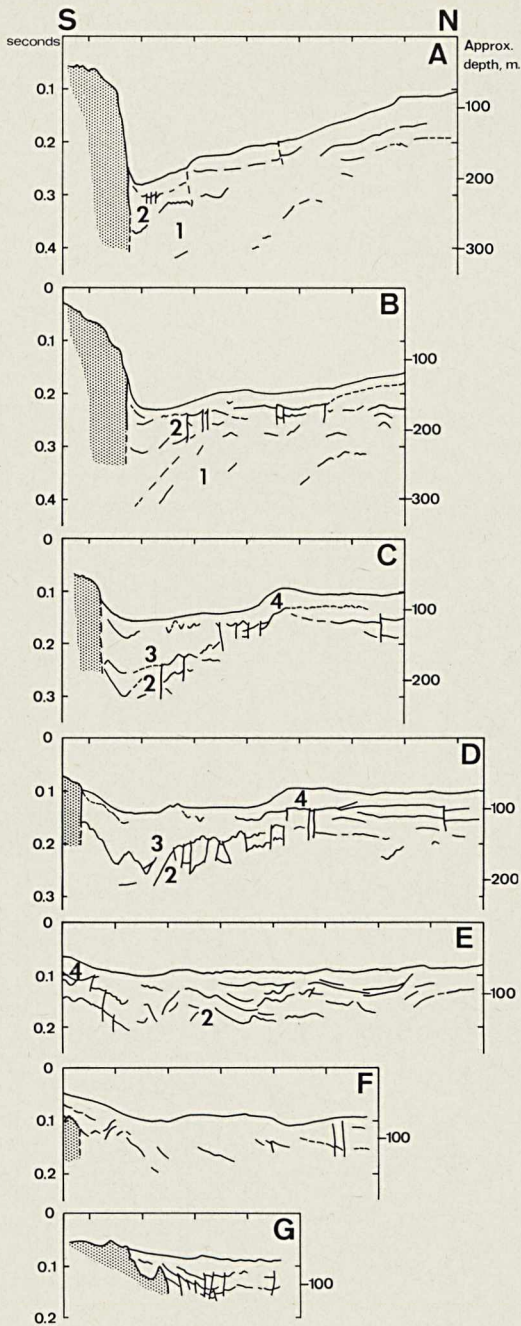


Fig. 2. Seismic profiles to the west of Flatey showing the steep contact between basement rocks (shaded) and sediments. Shading on profile G indicates submarine extension of Flatey volcanics. Vertical scale in seconds of two-way travel (left).

and basaltic-rhyolitic rocks of the Flateyjardalur central volcano. The age of the sequence on land ranges from 12 to less than 7 million years (Aronson and Sæmundsson 1975).

Sparker measurements were made in the area between Eyjafjörður and Tjörnes in order to map this basement/sediment contact. The profiles (Fig. 1) were positioned so as to cross the gravity contours. The survey was carried out on vessels belonging to the Marine Research Institute, Reykjavík.

Navigation was based on radar and Loran C. Some of the profiles overlap lines surveyed by McMaster *et al.* (1977).

## RESULTS

### *The Flatey fault*

Several profiles measured to the west of Flatey island (profiles A-F, Figure 2) cross the boundary between crystalline rocks and sediments. This boundary is found 2 nautical miles off Gjöfurtá and appears to merge with the coast near Flatey. The profiles show the contact to be near vertical and its straightness and orientation suggest that this is indeed a fault in direct continuation of the Húsavík faults, as predicted by Sæmundsson (1974) and McMaster *et al.* (1977). This feature will be referred to as the Flatey fault in the following discussion.

The Flatey fault is very strongly reflected in the topography: the sea-floor is seen in profile A to drop from 60 milliseconds (44 meters) to 280 ms (204 meters) across the fault. Reflectors in the sediments were recorded at 420 ms depth (minimum of 310 meters) and these are not thought to represent basaltic basement. The coastline in this area is mountainous and rises steeply from sea-level to elevations above 800 meters. These figures give an indication of the magnitude of the discontinuity, i.e. a minimum vertical fault component of 1100 m.

A narrow platform has been cut in the basement between the Flatey fault and shore. The edge of this

Approximate scale in metres also shown. Horizontal scale indicated with divisions of one nautical mile.

*Mynd 2. Endurvarpssnið vestan Flateyjar, sem sýna skil milli berggrunnis úr storkubergi og settlaga. Á sniði G kemur fram storkuberg tengt hraunlögum í Flatey. Lóðréttur kvarði er sýndur sem endurvarpstími í sekúndum, en einnig er sýnt dýpi í metrum (ónákvæmt). Láréttur kvarði táknður með strikum á einnar sjómílu bili.*

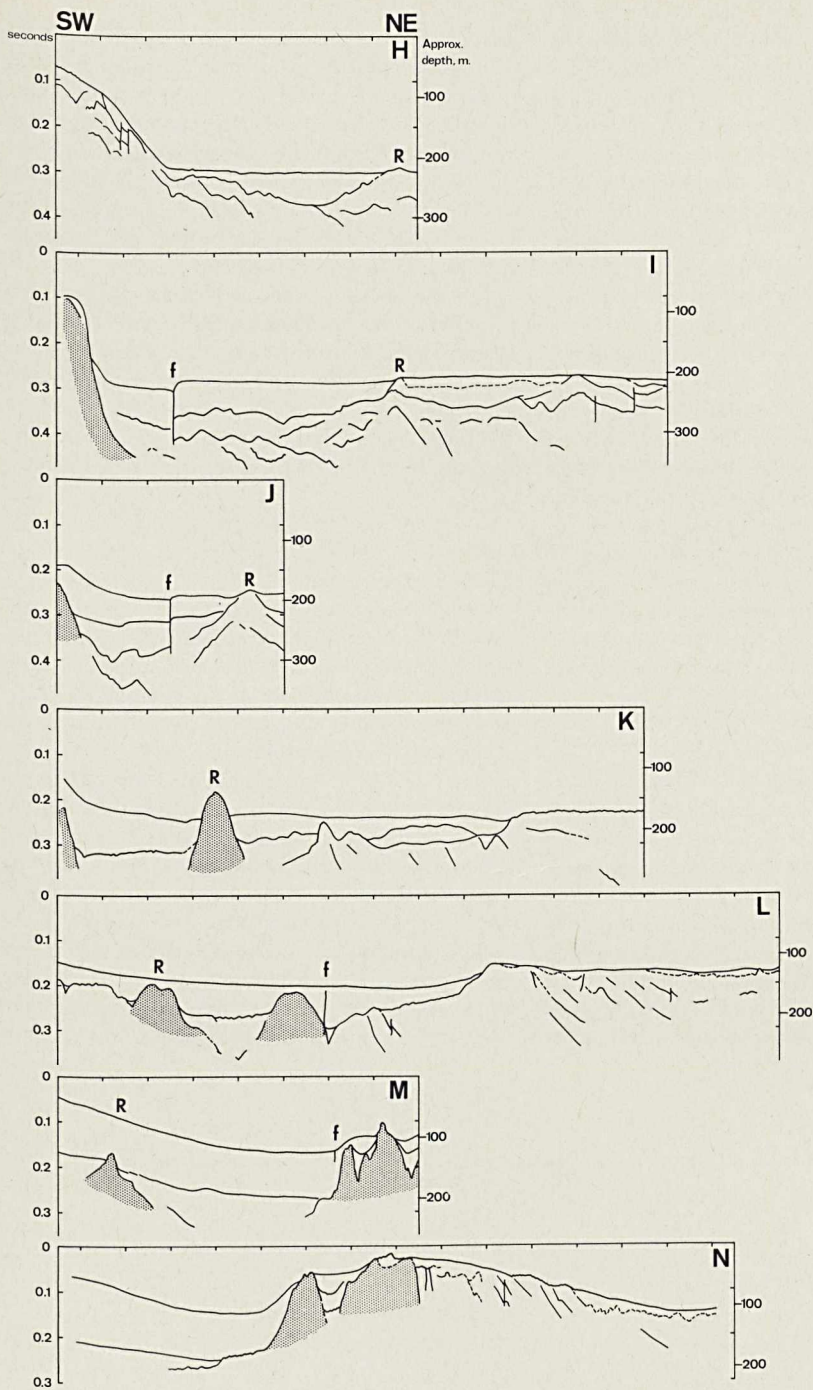


Fig. 3. Profiles from Skjálfandaflói and Skjálfandadjúp showing basement escarpment (left hand side of profiles I, J, K), median ridge (R), faults (f) and sedimentary sequence.

*Mynd 3. Endurvarpsnið úr Skjálfandaflóa og Skjálfandadjúpi, sem sýna storkubergsklöpp vestan flóans, hrygg (R) sem liggur út flóann, og misgengi (f) sem skera þykk settlög á svæðinu.*

platform disappears under sediments towards Flatcy (cf. profile F), suggesting that the fault is relatively inactive at present.

#### *Grímseyjargrunn sediments*

The sediments observed in profiles A-G may be divided into four units on the basis of their appear-

ance in seismic profiles. The bottom unit (1.) is represented in profiles A and B by landward-dipping reflectors at 300-400 ms. This is overlain by a unit (2.), approximately 60 ms thick, characterised by jumbled reflections and faulting, especially in the southern (landward) part of the profiles. A third unit is a transparent layer which reaches a thickness of about 80 ms in profiles C and D. Finally the topography is smoothed by a thin blanket of sediment (4.) which thickens to form a terrace-like feature (submerged beach?) seen near the middle of profiles C and D and the southern end of profiles E and F.

No direct information is available on the age of the four seismic units observed. The uppermost unit is likely to be of Holocene age and the underlying units Pleistocene. The faulting observed in the sediments is probably due mainly to tectonic movements on the Húsavík fault system. The island of Flatey is made up of SW-dipping, mid-Pleistocene lava flows and is thus younger than the Tertiary rocks of the adjacent land (Birgisdóttir 1982). Profile G shows faulted sediments lapping against the deeper part of this formation.

#### Basement rocks in Skjálfandaflói

In the western part of the bay of Skjálfandaflói basaltic basement is seen to form an escarpment below which it eventually disappears under sediments. The escarpment swings from the ESE-direction of the Flatey fault to a more southerly orientation, following the coastline. A north-trending ridge of crystalline rock crosses the middle of the bay. This feature is reflected in the topography only in profile K (Fig. 3) but is seen buried in sediments

farther south. To the north of profile K the ridge form is traceable in sediments. The sediment-filled troughs to the east and west of the ridge are presumably glacially carved valleys and the ridge itself an erosional feature. The apparent transition in the composition of the ridge, from crystalline to sedimentary rock occurs near a line joining the Húsavík faults and the Flatey fault and probably represents a structural boundary.

Igneous rocks are indicated as an offshore continuation of the headlands to the north of Húsavík faults. The headlands are made up of Tertiary lavas overlain by the Pliocene Tjörnes sediments (Einarsson 1968, Aronson and Sæmundsson 1975, Eiriksson 1980). Reflectors in the northern part of profiles K, L, N are thought to correspond to these sediments.

#### Skjálfandaflói sediments

Skjálfandaflói may be described as a double valley with the two troughs separated by a narrow ridge which is now almost completely buried in sediments. A similar morphology is found in the glacially carved valley and bay of Skagafjörður, some 100 km to the west, but here the central ridge is still emergent. The irregular, jumbled attitude of reflectors in the lower parts of profiles H through O in Skjálfandaflói suggests that these represent glacial sediments. Profiles H and O show these sediments to continue up the flank of Grímseyjargrunn and correlate with sediments to the west of Flatey.

The youngest sediments in Skjálfandaflói are represented by a transparent sequence reaching a thickness of over 100 ms in the inner reaches of the bay. The sequence is probably made up of outwash

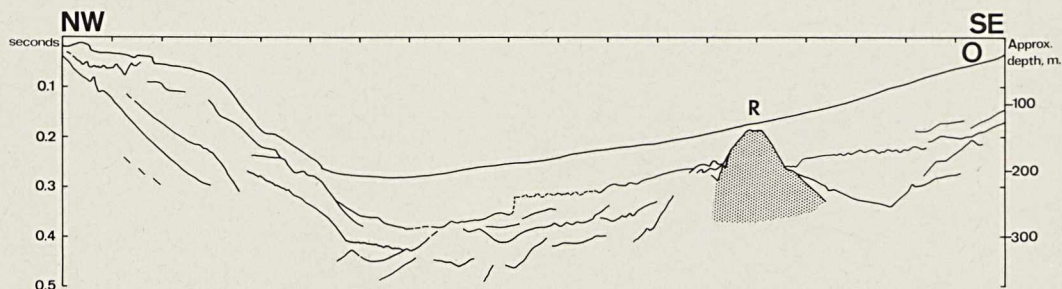


Fig. 4. Profile O, showing reflectors in Skjálfandaflói sediments continuing up the flank of Grímseyjargrunn. Section of median ridge shaded.

Mynd 4. Sníð O, frá Flateyjarsundi að ósum Laxár. Þykk settög í flóanum hylja hrygg úr storkubergi (R).

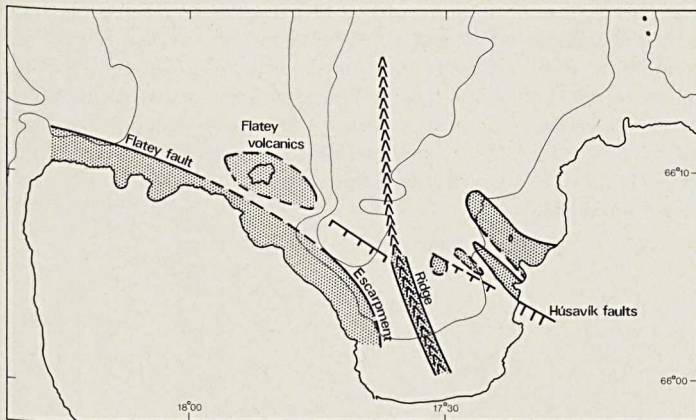


Fig. 5. Geological features of the area. Basement rock shaded.

Mynd 5. Drættir í jarðfræði mælingarsvæðisins. Svæði með storkubergeri nærri yfirborði eru skyggð. Ung skástig misgengi tengja Húsavíkurmisgengi við Flateyjarmisgengi.

from the rivers emptying into the bay, the Laxá on the eastern side, and particularly the glacial Skjálfandaflljót on the western side.

It is worth pointing out that this youngest sequence is cut by faults as illustrated on profiles I, J, L, and Fig. 5. The faults occur between the Húsavík faults and the Flatey fault and indicate postglacial movements on this fault system. Their strike is slightly oblique, or en echelon to major faults, which suggests a component of right-lateral strike-slip movement. Structural deformation on land south of Flatey and evidence on the Húsavík faults support this view (B. Voight, pers. comm. 1982).

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#### ÁGRIP JARÐFRÆÐI HAFSBOTNS Á GRÍMSEYJARGRUNNI OG SKJÁLFAFANDA

Kjartan Thors, Hafrannsóknastofnun

Seismiskar endurvarpsmælingar á hafsvæðinu milli Eyjafjarðar og Tjörness sýna mikið misgengi milli Flateyjar og lands, eins og rannsóknir Guðmundar Pálmasonar, Kristjáns Sæmundssonar og fleiri höfðu bent til. Landmegin við misgengið rísa

fjöll, yfir 800 metra há en norðan þess sáust setlög á rúmlega 300 metra dýpi og er þá ekki komið niður úr setlagastaflanum. Flateyjarmisgengið er í beinu framhaldi af Húsavíkurmisgengjunum og tengist þeim með skástígum misgengjum í Skjálfandaflóa sem virðast hafa verið virk á Nútíma.

Skjálfandaflói og Skjálfandadjúp er jökulsorfinn dalur, sem grafinn er í storkuberg syðst, en í setlög

norðan áður nefndra misgengja. Dalur þessi skiptist í tvennt af hrygg, sem liggur út eftir honum endilöngum og minnir á svipaðan hrygg í Skagafirði (Hegranes). Hryggur þessi virðist úr storkubergi sunnan misgengjanna en seti norðan þeirra. Landslag í Skjálfandaflóa hefur jafnast út vegna árfraumburðar á Nútíma.