

Two seismic reflection profiles from the vicinity of Surtsey, Iceland

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A seismic reflection survey carried out on the r/v Árni Fridriksson in October 1980 included two lines in the vicinity of Surtsey, off the south

coast of Iceland. Although not perfect, the profiles contain information on the stratigraphy of the area around the island. The survey lines are

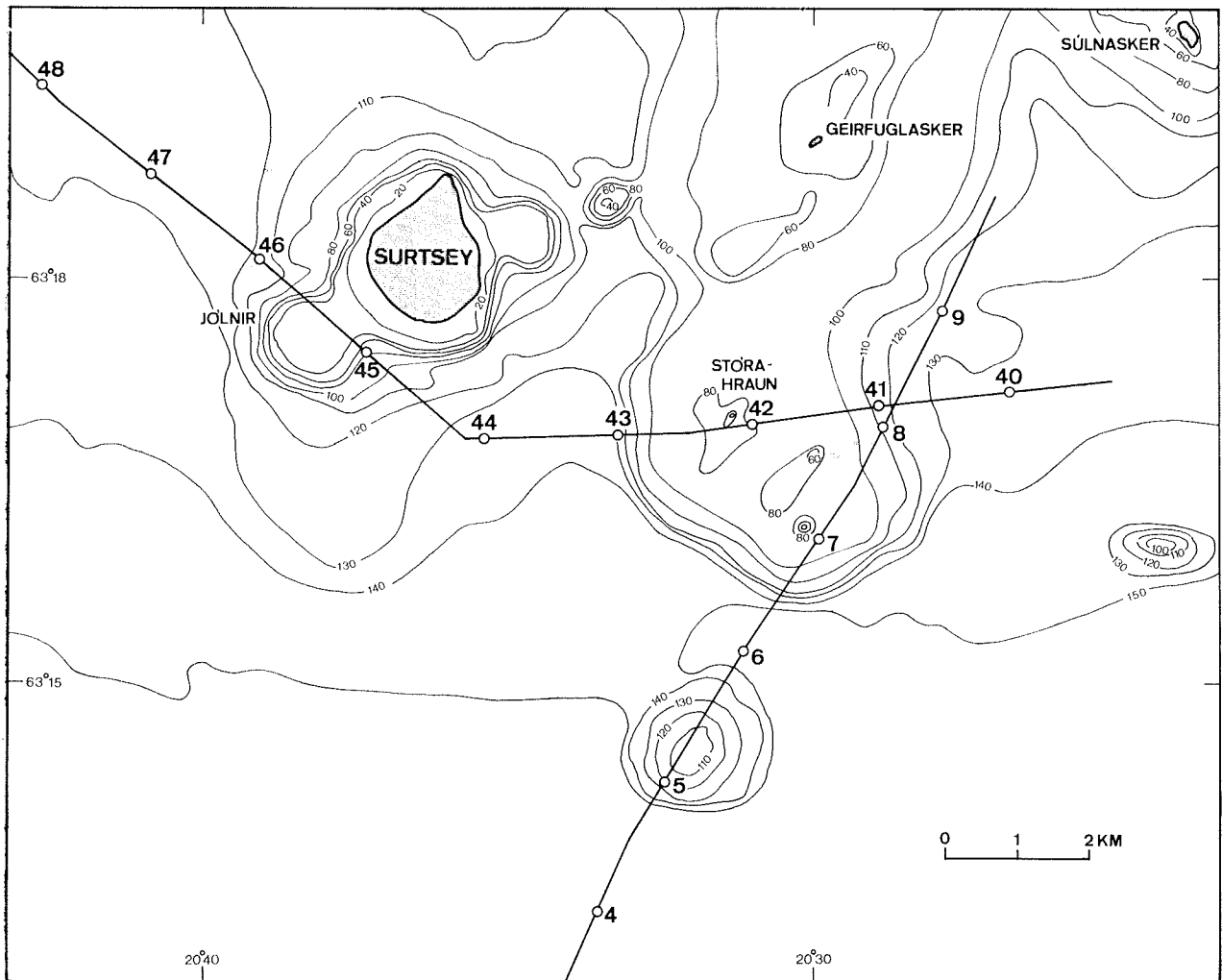


Fig. 1. Seismic reflection lines in the vicinity of Surtsey, the Vestmannaeyjar archipelago off the south coast of Iceland.

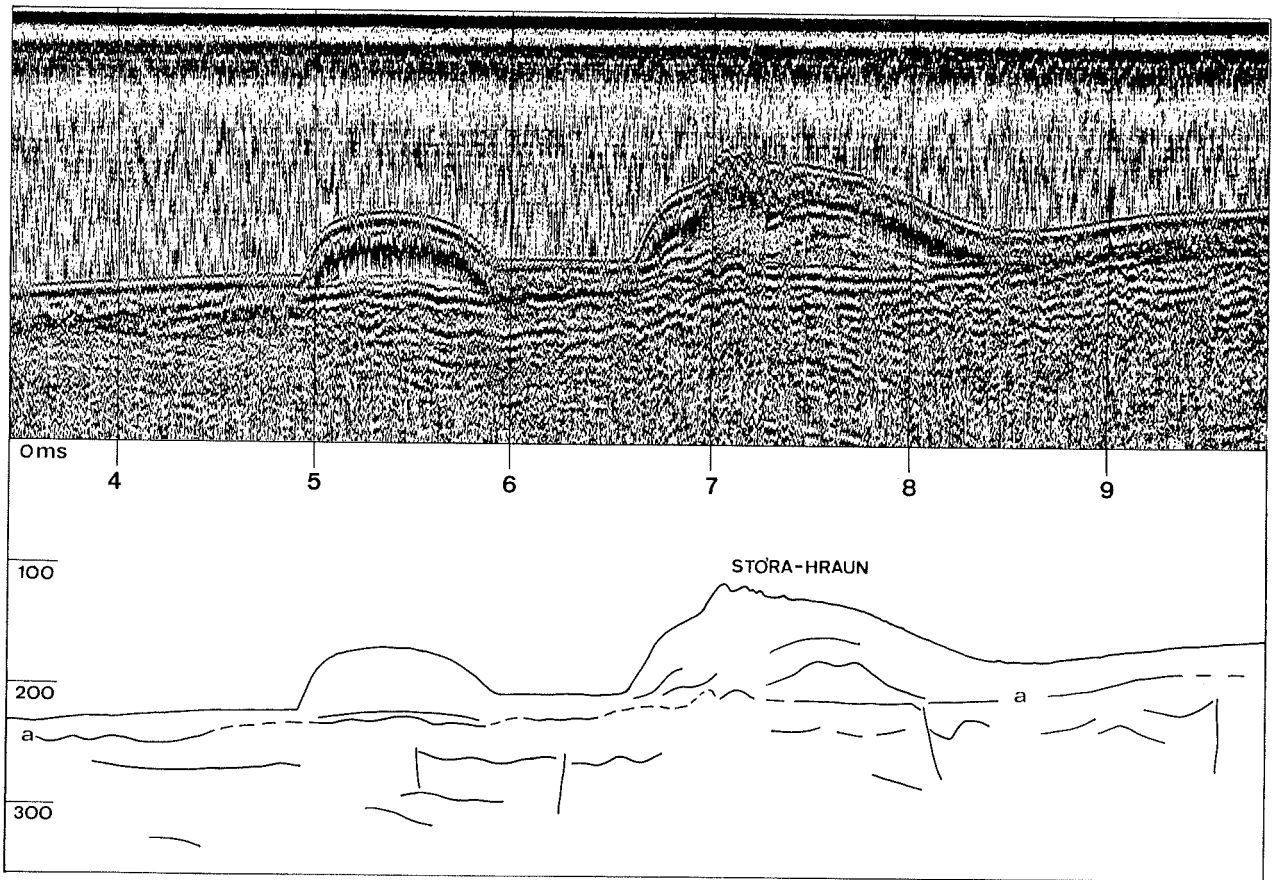


Fig. 2. Original, and interpreted profile from SW to NE. The reflector "a" is assumed to mark the top of Pleistocene sediments. Vertical scale in milliseconds of two-way travel time. Horizontal divisions of one nautical mile.

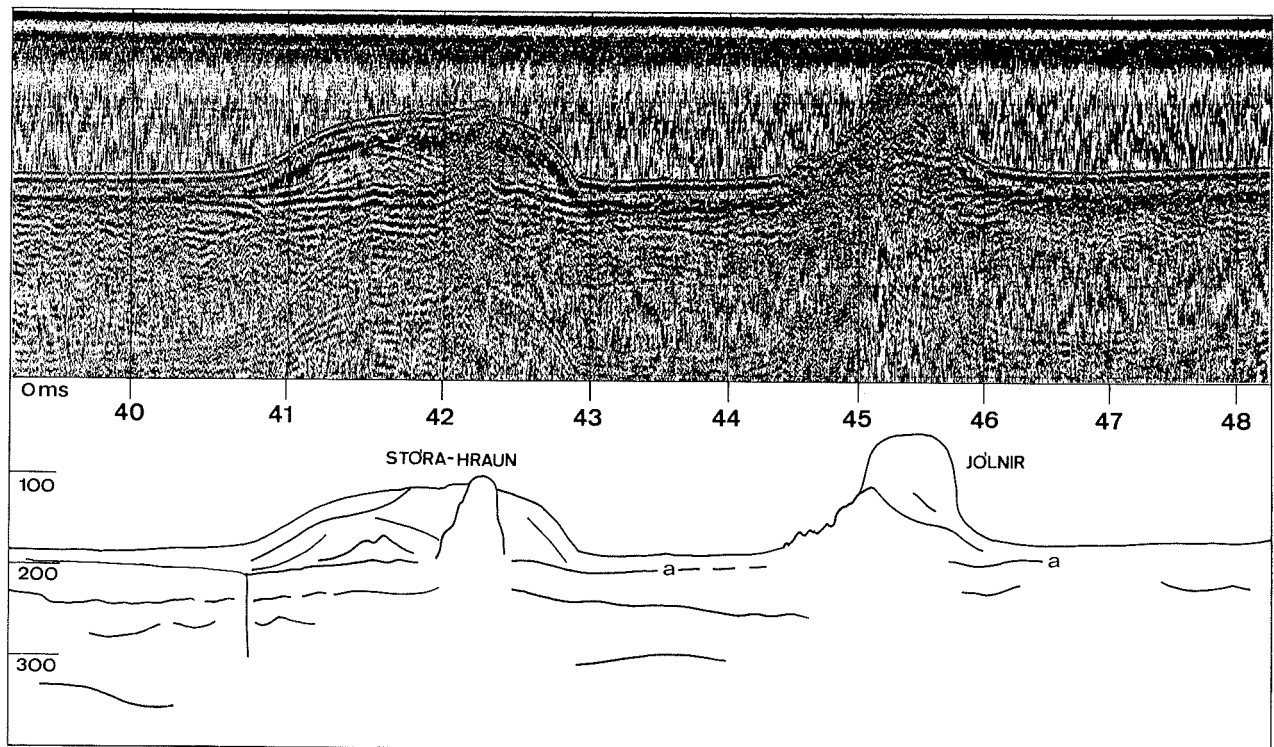


Fig. 3. Original, and interpreted profile from E to W. Legend and scale as in Fig. 2.

displayed in Fig. 1, and the two profiles in Figs. 2 and 3.

In essence, the profiles show three volcanic mounds on an otherwise relatively flat sea-floor. The southernmost of these is as yet unnamed, but the other two are Stóra-Hraun and Jólnir.

The volcanic features rest on a stratified sequence with a layering that is visible some 100 meters below the sea-floor. Sediments in this area are therefore at least 100 meters thick, and probably considerably thicker. It is not surprising to find an accumulation of sediments in this area: a borehole drilled in 1964 on nearby Heimaey island, penetrated a massive pile of pyroclastic sediments, mostly marine, before reaching crystalline rocks at 850 meters below sea-level (Pálmason et al. 1965, also discussed by Tómasson 1967 and Alexandersson 1972). Fossiliferous sedimentary xenoliths are common in the pyroclastics of Surtsey and Heimaey. The xenoliths are assumed to stem from the above-mentioned sedimentary sequence, and an examination of the fossils indicates different Quaternary ages (Simonarson 1982). Some of the xenoliths have even been lithified during Holocene time (Alexandersson 1972).

It is likely that the sediments in our profiles correspond to the uppermost part of the sedimentary accumulation discovered under Heimaey. From the uneven, faulted nature of the sediments in our profiles we assume that they are of late Pleistocene age, and that the reflector labelled "a" in the profiles marks the top of Pleistocene.

The volcanic mounds seem to rest on reflector "a" as far as can be judged, and should therefore be of Holocene (Postglacial) age. This is certainly true of Jólnir, formed during May–October 1965. Dredge samples from the nameless hill in the south also indicate a Postglacial age (Jakobsson 1982). As seen on the left-hand side of Fig. 2, this hill is made up of a rather homogeneous mass of material which is quite transparent to the seismic signal. This section of the hill probably represent an accumulation of pyroclastic deposits without a great deal of crystalline material. In contrast the two sections of Stóra-Hraun shown in Figs. 2 and 3 exhibit internal reflections indicative of a more complex structure. Fig. 3 shows the summit of Stóra-Hraun to be part of a seismically opaque (crystalline) plug which penetrates a pile of transparent (pyroclastic) material. Layering within the pile indicates a least one episode of eruption older than the one represented by the plug. Further-

more, the bathymetry of Stóra-Hraun (Fig. 1) shows at least three peaks, indicating more than one eruptive vent.

The section of Jólnir shown on Fig. 3 reveals two main stratigraphic divisions. The base of Jólnir is made up of a mound of mainly opaque material rising to a minimum depth of some 115 milliseconds (equivalent to about 85 meters). The opaque nature of this feature suggest that it is of crystalline material. A proof of this point came in November 1982 when a dredge sample taken from the deep southeastern flank of Jólnir yielded fragments of pillowlava (cf. Jakobsson 1982). The origin of this unit is probably to be found in the Surtsey submarine activity of approx. May–July 1964 (Thorarinsson 1965). A bathymetric survey carried out in 1964 (cf. Kjartansson 1966, Fig. 5) revealed a positive feature in this spot which later surveys showed to have been buried by the 1965 Jólnir eruption.

The upper portion of Jólnir is a rather homogeneous mass of transparent (pyroclastic) material showing faint traces of stratification. This is undoubtedly the product of the phreatic activity of the Jólnir eruption of December 1965 – August 1966.

Ash from volcanic activity in the Vestmannaeyjar archipelago has undoubtedly been spread over the adjacent shelf area. The smoothness of the sea-floor between the volcanic hills in our profiles is without doubt due to a blanket of volcanic ash spread from modern eruption sites. The finer structure of this blanket (lying on top of reflector "a") is beyond the resolution of our instruments, and it is therefore not possible to assign it to particular eruptions.

References:

- Alexandersson, E.T. 1972: The sedimentary xenoliths from Surtsey: Turbidites indicating shelf growth. *Surtsey Res. Progr. Rep.* VI, 101–116.
- Jakobsson, S.P. 1982: Dredge hauls from Vestmannaeyjargrunn, Iceland. *Surtsey Res. Progr. Rep.* IX, 142–148.
- Kjartansson, G. 1966: Stapakenningin og Surtsey [A comparison of table mountains in Iceland and the volcanic island of Surtsey off the south coast of Iceland]. *Náttúrufræðingurinn* 36, 1–34.
- Pálmason, G., Tómasson, J., Jónsson, J. & Jónsson, Í. 1965: *Djúpbörum í Vestmannaeyjum*. State Electric Authority. Reykjavík (mimeogr.) 43 pp.
- Simonarson, L. 1982: Fossils from Heimaey, Iceland. *Surtsey Res. Progr. Rep.* IX, 152–154.
- Thorarinsson, S. 1965: *Sitt af hverju um Surtseyjargosid* [Some facts about the Surtsey eruption]. *Náttúrufræðingurinn* 35, 153–181.
- Tómasson, J. 1967: On the origin of sedimentary water beneath Vestmann islands. *Jökull* 17, 300–311.