Confirmation of central volcanoes off the Icelandic coast

The Icelandic shelf and slope region occupies much of the transition zone between the complex Icelandic hot spot and more uniform ocean-ridge areas to the north and south. This transition zone is relatively little known geologically, but in this communication we summarise some recent observations on the nature of its basement. It is well known that the shelf is generally narrower off the eastern half of Iceland than off its western half. This is most obvious south of Iceland, where the shelf width changes suddenly at the eastern volcanic zone; the insular slope is also steepest off southeastern and north-eastern Iceland. Recent geophysical surveys in the southern and south-eastern shelf area have indicated the presence of an abrupt basement scarp now covered by sediments, 5–14 km inside the bathymetric shelf break (Fig. 1). This scarp is at least 1 km high and only a few km in mean width. No such basement scarp is indicated in comparable surveys conducted so far off western Iceland, north-east of the island, detailed data is not yet available.

A causal relationship between this and other observed east–west asymmetries in the geology of Iceland, including the much greater uplift and erosion in eastern than in western Iceland since the Upper Tertiary, is likely to be found in differences in crustal thickness or upper mantle composition respectively east and west of the eastern volcanic zone. Similarly, the abrupt change in the chemistry of recent volcanics occurring north of Iceland very close to the shelf break, may directly reflect changes in crustal thickness, rather than damming effects of the Tjörnes fracture zone on subcrustal flow.

Another point concerns the central volcanoes of Iceland, first described by Walker, which are of major significance in its geological evolution. Over 60 such centres, active or extinct, have now been identified on the island. From the results of geophysical surveys it has been concluded that several central volcanoes occur on the insular shelf off eastern and western Iceland, and that the trace of the Icelandic hot spot in the North Atlantic may coincide with the greatest density of such centres.

In an attempt to confirm the occurrence of central volcanoes on the Icelandic shelf, we have dredged at three sites (Fig. 1) where topographic highs are associated with the major magnetic anomalies believed to be characteristic for such volcanoes. The dredging was carried out by the RV Hafthor, of the Marine Research Institute, in November 1975, and a collection of igneous rock boulders was recovered at each dredge site.

These features of a dredge collection which might be used to indicate the presence of a central volcano include (1) a large proportion of acidic, intermediate or gabbroic rocks (2) rocks having suffered intense hydrothermal alteration, and (3) unusually magnetic and magnetite-rich rocks. Accordingly, the rock types in these dredge samples were identified in thin section, and their magnetic susceptibility and natural remanence were measured in core specimens. The results (to be published in more detail) may be summarised as follows.

Of the two dredge sites off western Iceland (20 km apart), one yielded six basalt boulders and six rhyolite boulders, while the other yielded 71 basalt and diabase boulders and two rhyolites. Alteration state and magnetic properties of these samples are similar to those found in lavas on shore.

At the Diónubodi dredge site 14 km off Gerpir promontory, eastern Iceland, the samples recovered were predominantly (21 out of 35) of acid and intermediate rock types, including granites, rhyolites, acid tuff, and andesites. Two samples contain epidote. The magnetic properties of this collection are also unusual: thus, nine specimens out of the 34 measured have volume susceptibilities exceeding 0.1 T A$^{-1}$ m (8$\times$10$^{-3}$ G Oe$^{-1}$), compared with only 1% of the specimens in a collection from 740 Eastern Iceland basalt lavas recently measured by us.

We are confident that the Diónubodi dredge collection can only be derived from a local central volcanic complex, which also causes the large (up to 6,000 nT) magnetic anomaly observed there. It is, furthermore, difficult to explain the high proportion of acid rocks at one of the western sites without recourse to similar conditions. These findings strongly support previous hypotheses on the occurrence of other central volcanoes on the Icelandic shelf.

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