INTERNATIONAL OCEAN DRILLING PROGRAMME

PROPOSAL 1116-L2S-WS

Nature of the crust beneath Iceland and the Greenland-Iceland-Faroe Ridge

Abstract

The Icelandic crust comprises an upper crust a few km thick composed of Cenozoic volcanic rocks, underlain by a 10–30 km thick lower crust. The crustal structure is similar along the whole Greenland-Iceland-Faroe Ridge (GIFR). The geological nature of the lower crust is currently unresolved and controversial. The GIFR has long been considered to have been formed by local excess magmatism on the north Atlantic spreading ridge compared to typical spreading ridges. A hypothesized high-temperature 'mantle plume' has been proposed to deliver this excess magmatism and to have built a predominantly mafic and ultramafic crust covered by lavas and thin sediments. An alternative hypothesis interprets the geological and geophysical data on the GIFR as a composite, extended volcanic rifted margin underlain by stretched, magma-inflated continental crust which has not yet fully broken.

Among the fundamental questions to be answered is the origin and composition of the anomalously thick crust (up to 40 km) and lithosphere (up to 135 km) beneath Iceland and the GIFR. A purely magmatic origin, i.e., partial melting of upper mantle rock for generating the thick crust would imply a high proportion of ultramafic volcanic rocks, which are not present. Also, the proportion of felsic volcanic rocks in Iceland is much higher than on oceanic spreading ridges elsewhere and is difficult to explain by fractional crystallization of basaltic melt. Isotope data suggest the presence of continental crust in SE Iceland. Numerous state-of-the-art geophysical methods (active and passive seismic, seismological, gravity, GPS, magnetic and electromagnetic) have revealed the structure of the lower crust but not resolved its nature.

Resolving the nature of the lower Icelandic-type crust requires onshore and offshore drilling. Previous industrial and scientific drilling in Iceland (by ICDP) and on the GIFR (by IODP) have not reached the lower crust. While the thickness of the upper crust in Iceland and GIFR is typically 5 – 6 km, we have delineated a number of potential drill sites, where the GIFR lower crust could be penetrated at depths of <5 km onshore and <2.5km offshore.