bottom rock sampling along the spreading axes, tow-yo and hydrocast water sampling at spreading centers, and geological and biological seafloor observation using a deep-sea monitoring system. Further synthetic analyses of geophysical mapping, seismic crustal studies, and dense bottom rock sampling will provide a real three-dimensional picture of seafloor spreading process from the upper mantle through to surface volcanism at three different spreading systems of CIR, SWIR, and SEIR ridges. Although we were unable to find a hydrothermal vent area, the accumulated chemical data from water samples collected will provide a valuable data sets which will enhance our understanding of the chemical flux at the Indian Ocean spreading centers.

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The R/V Professor Logachev Research Cruise 09 to the Reykjanes Ridge near 59°N: Sediment Distribution on the Reykjanes Ridge (August - September 1993)

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Beginning October 1, 1991, the GEOMAR Research Centre for Marine Geosciences, the Institute of Baltic Sea Research and the Geological Department of the University of Greifswald have carried out a joint project dealing with sedimentation processes on mid-ocean ridges. The project is supported by the Federal Ministry for Research and Technology (as part of GEOMAR project no. 03R619A). The scientific program is closely connected to the international ridge research program InterRidge and the German national initiative DeRidge and is the follow-on project from similar investigations in the area of the Kolbeinsey Ridge from 1988 to 1990.

The project's scientific objective is to develop a model for the genetic evolution of the depositional environment of the mid-ocean ridge (MOR). Depositional processes being active at mid-ocean ridges, the spatial and temporal variability of these processes and consequently the various sedimentary facies, are principal objectives of investigation. Main thematic topics attempt to characterise different types of sedimentary facies and their genetic development and particle associations. Moreover, we focus on distribution patterns of distinct sedimentary facies, on the chronological order of facies types, including their genetic processes, and the demarcation of MOR sediments from adjacent basin sediments. The area of investigation is the Reykjanes Ridge between 58° N and 60° N.

During the Cruise SO82 aboard the R/V Sonne in Oct. 92, a segment of the ridge was mapped with the *Hydrosweep* multi-beam echo sounder and the sub-bottom profiler systems *Parasound* and *SEL90* (figure 1). Seven sites were cored with a large box corer, a giant gravity corer and a gravity corer (Endler and Lackschewitz, 1993). The first part of Cruise LO09 was based on the results of the SO82b cruise. Promising site positions were selected with the help of the bathymetric map and acoustic profiles. On this basis sixteen stations were selected. During the second part of the cruise program an additional area was mapped by thirteen SEL90 acoustic tracks. On the basis of these tracks seven sites were selected and cored.

The sedimentation environment in the study area is highly variable. Morphologically, three different sediment covered features are important: the rift valley at the active spreading centre, contains only thin and patchy sedimentary deposits; on the flanks of the ridge, basins are filled with thick sedimentary sequences and some elevated plateaux also show sediment coverage. Some special current controlled conditions have been observed near a seamount at 58°53'N and 30°19'W (Catalonia Seamount). Generally, the thickness of sediments increases with increasing distance from the ridge crest. The lithology of the sediments varies between nannofossil-foraminiferal oozes, foraminiferal sands, sponge spicule rich sediments, clayey sediments, and volcanic ashes. Some deposits, especially in the vicinity of the Catalonia Seamount are strongly influenced by bottom currents. The pelagic input is dominated by plank-

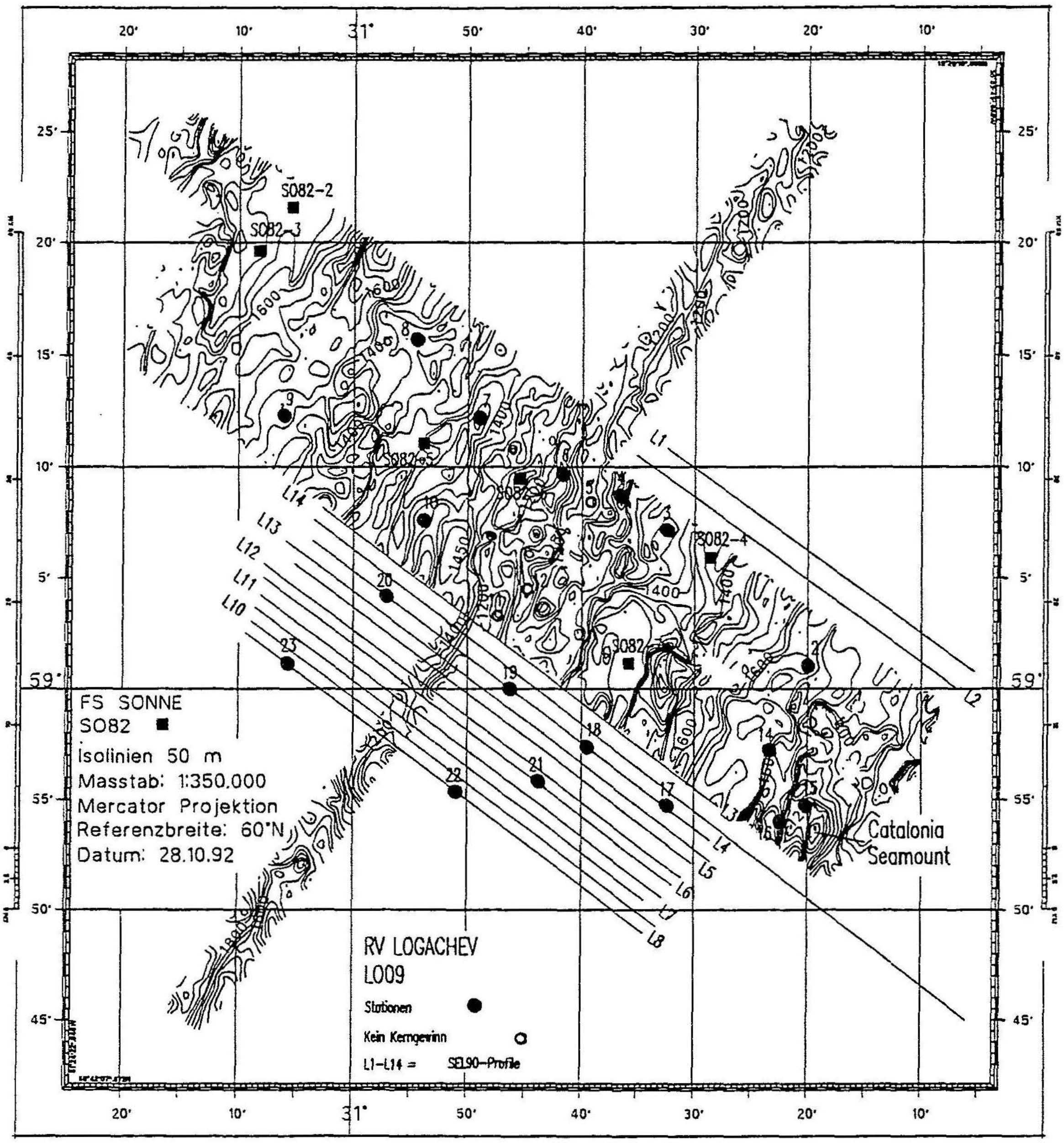

Figure 1. Study area of LO09 with site positions and SEL90 acoustic tracks (open symbols = no recovery); including SO82 stations from the cruise with R/V Sonne (Endler and Lackschewitz, 1992).

tonic foraminifers (e.g. *Globigerina bulloides* and *Neogloboquadrina pachyderma*) and calcareous nannoplankton. Sponges and sponge spicules are an important biogenic component. Volcanic material occurs in the sediments from the ridge crest, indicating volcanic activity and in distinct layers of subaerially transported ashes coming from terrestrial sources, e.g. Iceland.

In more detail some results can be concluded as follows:

Surface sediments

The differences in composition of the surface sediments suggest recent changes in the sedimentation processes in the study area. The majority of the surface sediments are marked by the influx of carbonate pelagic particles (planktic foraminifera, coccoliths). The planktonic foraminifera are dominated by the form *Globigerina bulliodes* (D'ORBNIGNY) which in large occurrences indicates the influence of a temperate water mass.

Autochthonous sponge spicules were observed at four stations (7, 8, 14, 17). They often formed dense mats of several centimetre thickness. Similar occurrences have been reported in the areas of the mid-ocean ridge and seamounts at the Kolbeinsey Ridge in the Iceland Sea (Lackschewitz, 1991) as well as on the Jan Mayen Spur and the Vesterisbanken Seamount in the Greenland Sea (Henrich et al., 1992). These spicule mats are formed through the *in situ* decay of dead porifera and the subsequent deposition of the remaining spicules. This process also forms the substrate for the growth of subsequent generations of individual sponges. The resulting spicule mats provide tiny hollows and niches in which fine material and microfossils are collected, e.g. the diatoms seen in the darker sponge mats of Station 14.

The occurrences of microsponge needles (in the sediments of a steep slope east of the central graben, Station 14) suggest a differing oceanographic environment. The exact relationship between autochthonous spicules and marine environment is not yet clear and should be the topic of further study. The occurrence of differing bottom current relationships, as observed by Dietrich & Kontar (1990) on the Reykjanes Ridge, help to explain the wide bathymetric distribution of the spicules.

In contrast to the spicule rich localities, the clay rich stations (LO09-17, -18, -19, and -20) are indicators of depositional areas protected from strong currents. Three of these stations lie in the basin within the ridge (figure 1). Station 18 lies north of the Station SO82-7 (R/V Sonne Cruise 82) in the same basin. Sedimentary studies of this Station also demonstrated a large component of clay. Grain-size and settling velocity analyses characterise this region as an accumulation area for eroded and weathered material (Gehrke et al., in press). Further studies are necessary to determine if this is also the case for Stations 17, 19 and 20.

The foraminiferal sand facies on the slope of the Catalonia Seamount are interpreted as the result of winnowing and reworking by bottom currents. This is similar to results obtained by Gehrke et al. (in press) from surface sediments of the outer western Reykjanes Ridge and of the plateau area in the central ridge. Numerous measurements in the western North Atlantic have

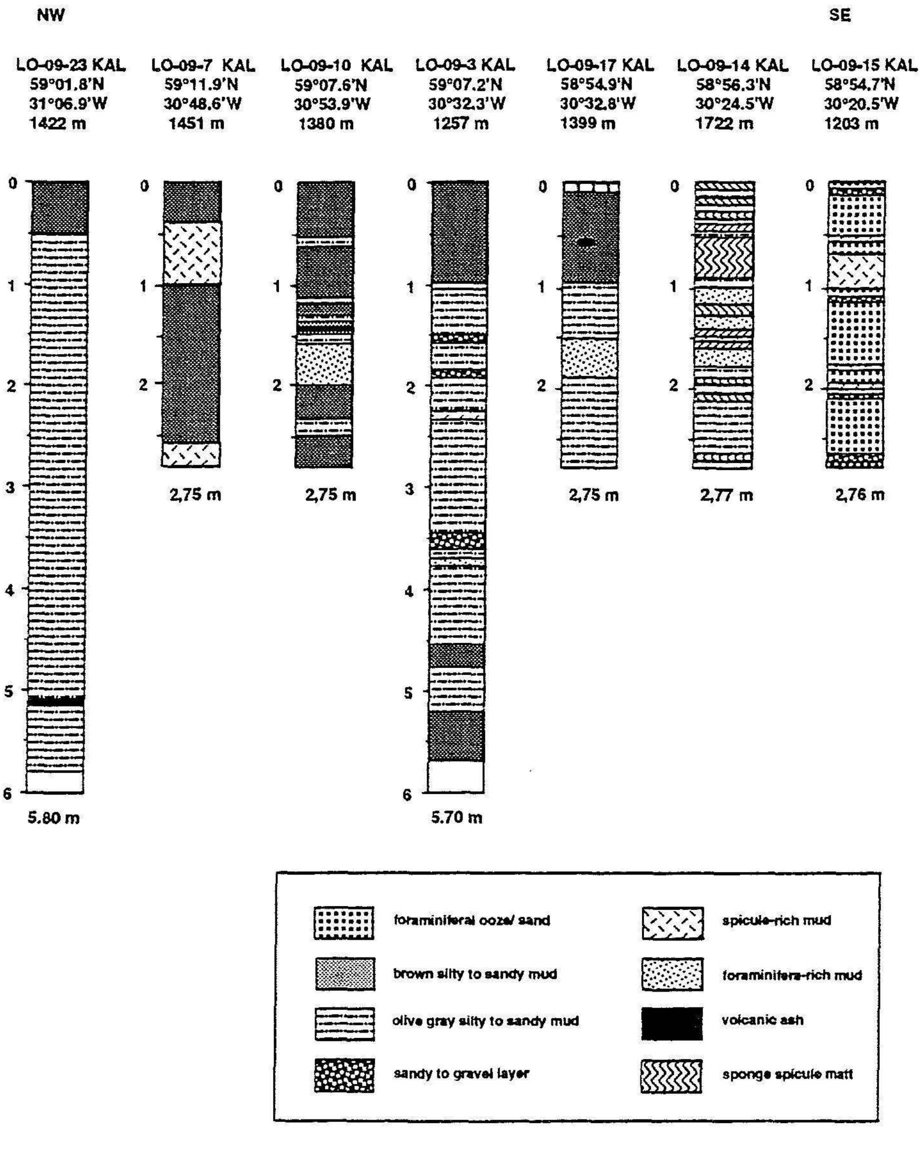

Figure 2. Lithology of GGC cores of LO09.

shown persistent westerly and southwesterly currents of 5-20 cm/s (Shor et al., 1984).

An increase in the amount of brown (basaltic) volcanic glass in the central graben (Station 6) provides evidence for submarine volcanic activity along the ridge axis. The free form blocky vesicle of the glasses suggests a hyaloclastic origin. Other stations in the central graben were devoid of volcanogenic sediments. The clear silicic glasses of Station 23 document large, inter-regional subaerial eruptions. There is no clear indicator as to their origin, they could have easily travelled many thousand kilometres.

Benthic fauna

The benthic fauna of the deeper, oceanic regions of the Reykjanes Ridge is still poorly known. First results show that some of the surface samples seem to have a rich benthic fauna. Most of the samples were taken from sites with fine, soft mud bottoms. Especially, the surface sediments from the stations LO-09-7, -8 and -17 have a rich epifauna and are characterised by an abundance of sponges. At these sites the spicule meshwork provides an ideal substratum for fixosessile benthic organisms like bryozoans. Branched bryozoans are often attached to the sediment surface. Concentrations of brachiopods and pteropods were also observed in the spicule meshwork. Besides the sponges there are gastropods (e.g. *Conus* sp., *Turitella* sp.) and molluscs (e.g. *Pecten* sp.) on the sediments of these stations. Other stations such as LO-09-15, -19, -22 and -23 also exhibited some sponges.

On the surface sediment of the station LO-09-9 fragments of basalt form the substratum for smaller types of sponges. The surface sediments of the stations LO-09-3 and -4 reveal some brittle stars of the species *Ophiura textura*. Abundant coral fragments were observed in the subsurface sediments of station 3. The red corals are several centimetres in length and of *Lophelia* type including L. pertusa (Linne) (pers. comm. A. Freiwald).

Subsurface sediments

The cores are characterised by brown and olive coloured pelagic sediments often intercalated by spicule rich layers. In addition, some cores reveal tephra layers of different composition and texture. Simplified lithologic profiles from the cores are shown in figure 2.

A basaltic ash layer were observed in core 10. This ash layer is the only indicator in the cores of volcanic activity in the Late Quaternary. The ash layer in the sediments of core 23 matches the widespread Ash Zone II in the North Atlantic both in form and position in the core. This zone is dated at 57,500 yr B.P. by Ruddiman and McIntyre (1984). These tephra layers can provide important local stratigraphic markers.

Disperse coarse-grained (> 100 μm) terrigenous material was observed spread throughout most of the cores recovered. Previous studies of marine sediments from the North Atlantic have shown that coarse terrigenous particles (> 63 μm) can be interpreted as ice-rafted material (Ruddiman, 1977, Bond et al., 1992). This indicates occasional melting of the icebergs in the region.

The common change from foraminifera-rich sand layers and fine-grained sponge needle-rich sections in core LO-09-15 on the Catalonia Seamount indicates changes in the energy level of the sea-floor water mass with time. This is probably related to the complex physiographic conditions and the effect of latitude dependent climatic changes on the properties of the sea-floor water mass.

These results indicate that mid-ocean ridges are a highly diverse sedimentary environment with strong changes in depositional process in time and space. In contrast to the more unique and widespread facies types of the deep-sea basin sediments deposits of mid-ocean ridges are highly influenced by the ridge topography and local bottom current systems.

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