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Seismic Investigation on the Western and Northern Margin off Svalbard*

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Abstract: Some results of a marine geophysical research programme carried out by the Seismological Observatory, University of Bergen, on the continental margin off Svalbard are presented which show that the eastern escarpment of the Knipovich Ridge block and the Hornsund fault, extending from south of Bear Island to 79° N, are the most prominent structures of the western margin of Svalbard.

Zusammenfassung: Es wird über Ergebnisse eines marinen geophysikalischen Forschungsprogramms des Seismologischen Observatoriums der Universität Bergen am westlichen und nördlichen Kontinentalabhang Svalbards berichtet. Der östliche Steilabfall des Knipovich-Rückens und die von südlich der Bäreninsel bis 79° Nord verfolgbare Hornsundstörung im westlichen Spitzbergen sind die wichtigsten westlichen Randstrukturen Svalbards.

The Seismological Observatory at the University of Bergen has been running a continuous marine geophysical research programme since 1965, devoted to the continental margin off Norway. During the last few years this programme has concentrated on the continental margin off Svalbard (SUNDVOR & ELDHOLM, 1976; SUNDVOR & al., 1977; SUNDVOR & ELDHOLM, in press).

The main objective has been to map the major structural units of the margin with respect to its geological development. Furthermore, we have attempted to investigate the marginal Yermak Plateau which resembles physiographically the more thoroughly investigated Vøring Plateau off central Norway. Fig. 1 outlines the study area and includes the multichannel reflection lines and the seismic refraction sonobuoys, together with the main geophysical and geological features of the Svalbard continental margin. The western margin (75°—80° N) is of a sheared-rifted type, along which the rifted margin developed subsequent to a change in the pole of plate rotation at about 36 m. y. b. p.

The seismic reflection records show that the two most prominent marginal structures are the eastern escarpment of the Knipovich Ridge block and the Hornsund fault (Fig. 1). An eastward shift in the spreading axis approximately 5—6 m. y. ago (ELDHOLM & SUNDVOR, in press) has caused the active rift axis to be located at or just beyond the continental slope. The Hornsund Fault can be traced from just south of Bear Island to about 79° N. Landward of the fault we cannot observe any consistent reflectors and the sea-floor velocity is, in general, higher than 3.8 km/s. The eastern Knipovich Escarpment and the Hornsund Fault define a regionally elongated sedimentary basin with a north-south trend and consisting of an upper low velocity unit (1.9—2.2 km/s) and a lower sedimentary unit which exhibits average velocities of 2.7, 3.2, 3.7 and 4.4 km/s respectively. A 5 + km/s velocity is defined as seismic basement. This velocity distribution is representative of the entire margin between 75° N and 79° N. Approaching the Knipovich Ridge, we have not attempted to correlate the deeper refractors because velocities in the range of 4.5—5.5 km/s may be interpreted as oceanic layer 2, consolidated sediments and crystalline basement.

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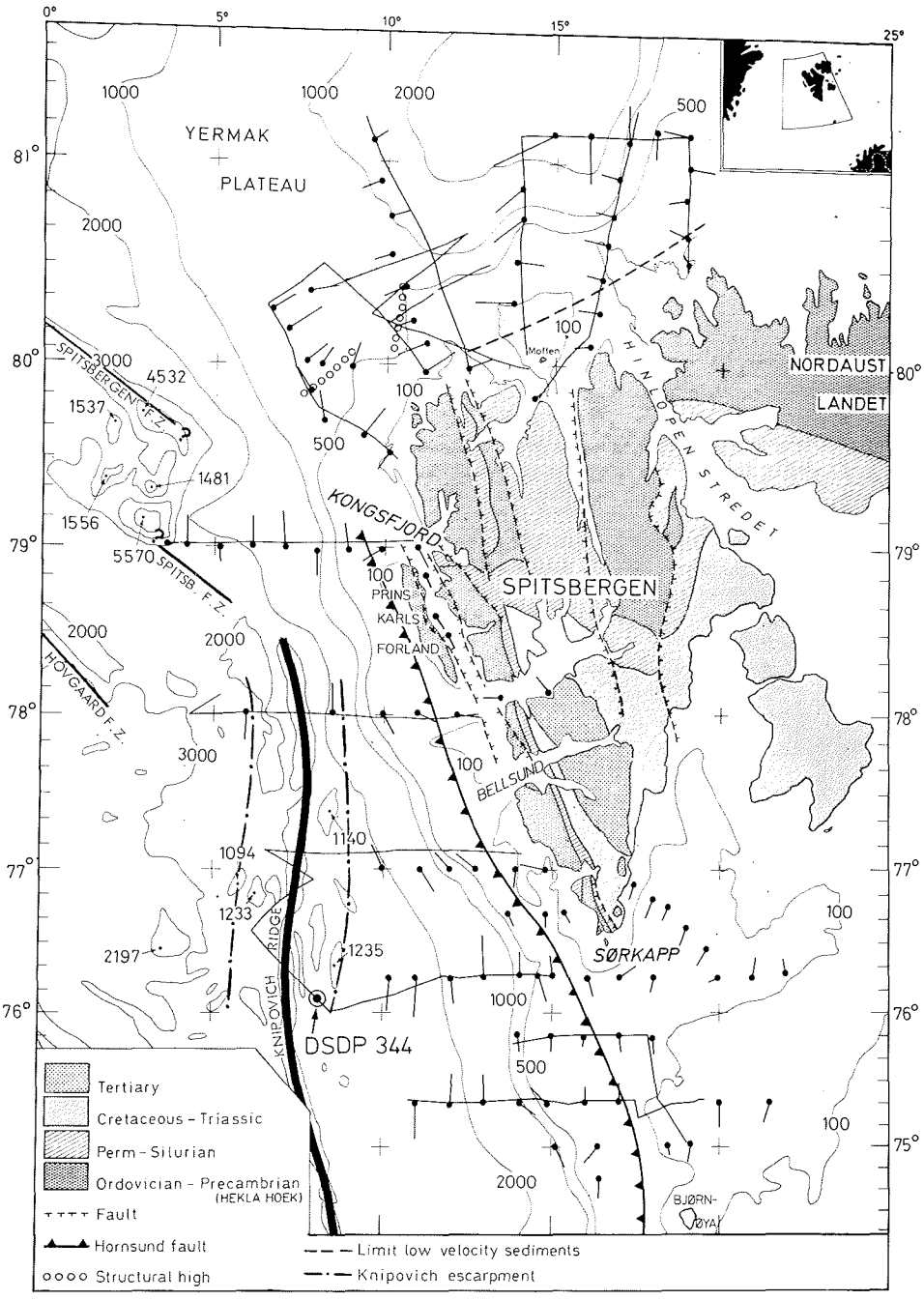

Fig. 1: Geological sketch map of Svalbard and location of sonobuoy stations and seismic reflection lines recorded by the Seismological Observatory, with outline of the main features on the continental margin between 74° N and 81° N. On the western shelf the eastern limit of low-velocity sediment follows the Hornsund Fault.

Abb. 1: Geologische Kartenskizze von Svalbard und Lage der Sonobojen-Stationen und reflexionsseismischen Profile des Seismologischen Observatoriums mit den bedeutendsten Strukturen und Einheiten am Kontinentalabhang zwischen 74° N und 81° N. Auf dem westlichen Schelf folgt die Ostgrenze der Sedimente mit niedrigen seismischen Geschwindigkeiten der Hornsund-Störung.

On the western margin low-velocity sediments are restricted to the region between the rift axis and the Hornsund Fault. On the other hand, it is evident that the low-velocity section typifies almost the entire northern Svalbard margin. Here the crystalline basement exposed onshore dips steeply towards the north under a progressively thicker sedimentary pile. However, there is an obvious difference in structure between the inner Yermak Plateau and the margin east of the plateau. The eastern part of the area exhibits a thick low-velocity section (1.5—2.5 km) without any significant structures. This marginal sedimentary basin continues onto the inner Yermak Plateau. At the base of the plateau we have mapped a structural high within the sedimentary basin. This highly reflective opaque acoustic surface can also be observed in the very northern part of the survey area and is associated with a velocity of 4 + km/s. The opaque reflector has been subjected to faulting, but this has not affected the overlying sediments.

The change from continental to oceanic crust in the Svalbard region is not reflected in the magnetic field because of the low amplitude level in this region. The seismic data are also ambiguous, because basement cannot be mapped across the entire margin. It would be true to say, however, that the Hornsund Fault defines the maximum landward extent of oceanic crust and that the eastern escarpment of the Knipovich Ridge defines the maximum eastern extent of continental crust.

The northern Svalbard margin is difficult to interpret because of the limited data coverage northwards. However, the passive margin east of the Yermak Plateau is most probably underlain with continental crust in our area of study.

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