Royal Norwegian Council
for Scientific and Industrial Research
(NTNF)

NORSAR

NORSAR Scientific Report No. 1-87/88

Semiannual Technical Summary

1 April — 30 September 1987

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Kjeller, December 1987

VII.7 Local geology of the regional array sites in Norway

Information on local geological conditions at the NORESS and Finnmark array sites is available from various sources. In this contribution, we have attempted to compile information that is considered relevant from the seismological viewpoint. In particular, such information may be used to provide tentative explanations of certain observed features in the seismograms.

Local geology of the NORESS site

The NORESS site is located within the Precambrian (also referred to as pre-Eocambrian) rock complexes of southeastern Norway. Maps showing the local geology of the siting area have not yet been published. However, geologists of the Norwegian Geological Survey have conducted surveys in the area and have made available to us hand-colored maps of the local surface geology. These maps show that three different rock types are present at the array site, namely: (1) granite, (2) gabbro and (3) rhyolite. The information in these maps is transcribed onto the array configuration map of Fig. VII.7.1.

Johnson and Olheft (1984) and Bott (1982) give the following typical values for density and P-wave velocities (at a pressure of 0.3 Kbar, corresponding to a depth of 1 km) for these rock types:

	Density (g/cm^3)	Velocity (km/s)
Granite	2.66	5.91
Gabbro	2.99	6.74
Rhyolite	2.60	-

One should keep in mind that these values represent averages over a large number of samples from various geological environments. Wwe think, however, that these values could be used, with due care, for

the site considered here. For instance, such values can be used to estimate reflection coefficients of possible subsurface interfaces.

The possible existence of such interfaces beneath the array can be inferred from data from a reflection seismic survey that was carried out in 1983. Reflection data were collected along the profiling line shown in Fig. VII.7.1. The length of the line was approximately 2500 m and charges of 1.4 kg of explosives were fired in 8 m deep boreholes spaced at 40 m intervals along the profile. Each shot was recorded on a spread of 24 geophones at 20 m intervals, with a constant distance of 120 m between the shot and the nearest geophone. The data were recorded using NORSAR's reflection profiling instrumentation (Texas Instruments DFS-V). A sampling rate of 2 ms was chosen, and the analog filters had cutoffs at 8 and 256 Hz. The recording interval was 20 s for each shot. The field work and subsequent processing of the data was organized and carried out by NORSAR personnel, notably Håvar Gjøystdal, Paul W. Larsen and Ottar A. Sandvin.

The data were subjected to conventional CDP-stacking with a 10 m interval between consecutive traces in the stacked section, giving a 6-fold coverage (except at the ends of the profile). The section shown in Fig. VII.7.2 resulted from this processing and shows the data filtered in the 100-250 Hz band. The section covers a two-way travel time (TWT) of 0.0-1.0 s.

Several interesting features can be observed in the section of Fig. VII.7.2. First of all, we see a dipping interface that appears to intersect the surface near the southern end of the profile. The TWT of 0.37 s observed at the northern end of the profile indicates a depth of roughly 1 km at that point, giving a dip of approximately 20°. Based on the available information on the surface geology, we speculate that this horizon represents the interface between the granite

and the gabbro, which is outcropping near the southern end of the profile, see Fig. VII.7.2. The reflection coefficient resulting from density and velocity changes across a granite/gabbro interface could become significant and would be of the order of 0.12, using the values given above.

In addition to this dipping interface, there are at least two clearly observable events in Fig. VII.7.2. One of these is dipping across the middle of the section at around 0.5-0.6 s TWT, and the other is an apparently flat horizon at about 0.8 s TWT. Suffice it here to point to these arrivals, without going any further into geological interpretations.

The recording interval of 20 s for each shot made it possible to look for coherent arrivals from depths even larger than the base of the crust. Extensive plotting of sections for TWT intervals within the 1.0-20.0 s range only revealed one such arrival that could be traced over any length of distance and tentatively attributed to a definite structure at depth. This event is seen at about 5.5 s TWT in the middle of the section of Fig. VII.7.3. The corresponding depth would be approximately 18 km.

Local geology of the Finnmark array site

Only very limited information is yet available on the local geology of the new regional array site in Finnmark, northern Norway. The Norwegian Geological Survey has published a regional geological map of the Karasjok, Finnmark area (Skålvoll, 1972). This map shows that all seismometers of the new array are within an outcropping gabbro formation approximately 4 x 10 km large. This gabbro window is located within the Karasjok Group, which consists of metamorphic sedimentary and igenous rocks of age 2000 million years. It is therefore reasonable to assume the existence of high-density, high-velocity material

at the surface all across the new array. The possible existence of subsurface layering is, however, unknown at this time.

S. Mykkeltveit

References

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Johnson, G.R. and G.R. Olhoeft (1984): Density of rocks and minerals, In: CRC Handbook of Physical Properties of Rocks, Vol. III. R.S. Carmichael, ed., CRC Press, Boca Raton, Florida.

Skålvoll, H. (1972): Beskrivelse til geologisk kart over Norge 1:250 000, Karasjok. Norges Geologiske Undersøkelse.

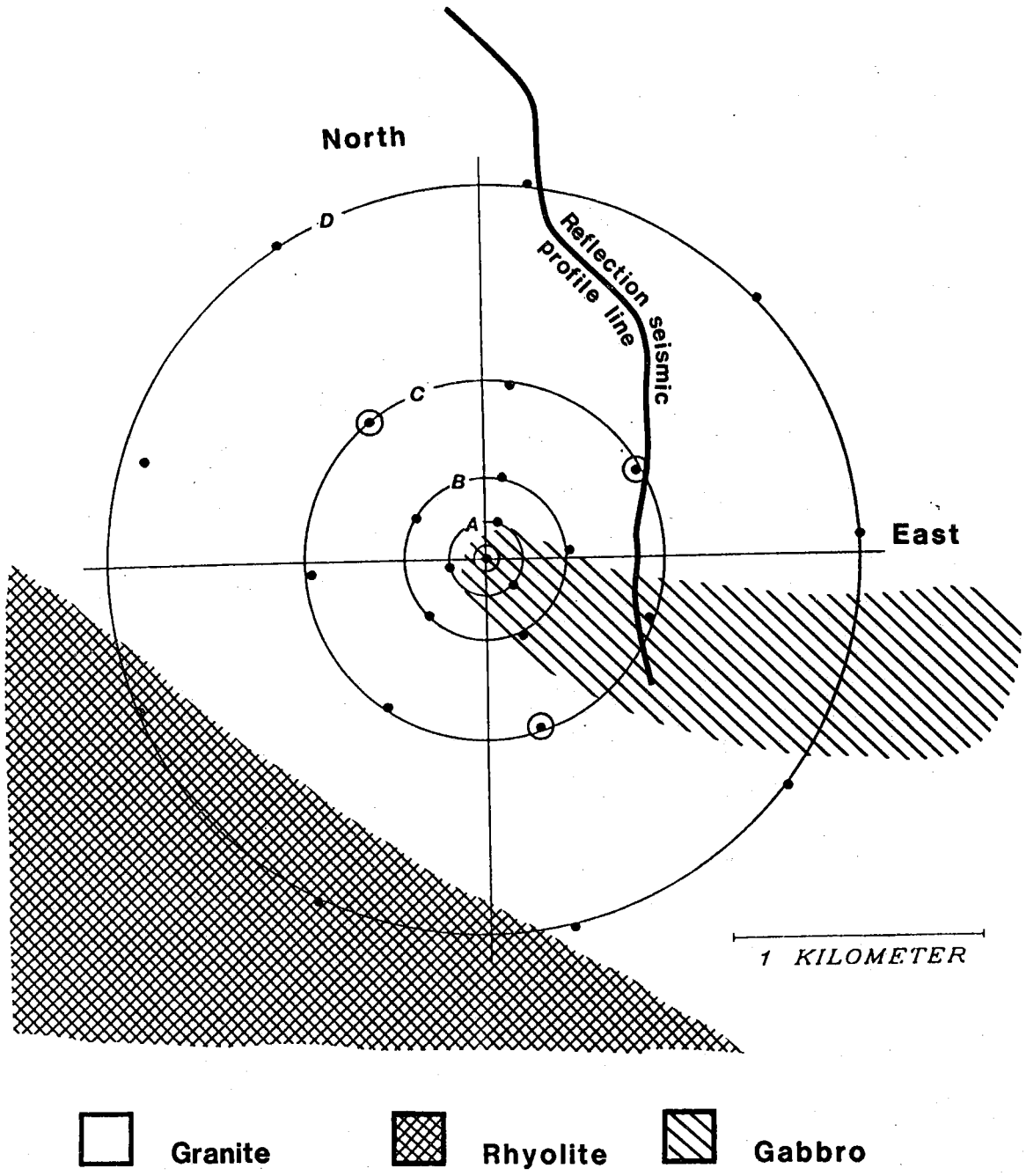

Fig. VII.7.1 Configuration and local geology of the NORESS array. The four three-component stations are marked with special symbols. The station at the center of the array is named A0. The surface geology of the site is transcribed from a map provided by the Norwegian Geological Survey. A 60 m deep borehole was drilled at site A0. According to the drilling log, this hole was drilled in gabbro all the way down to its bottom. A reflection seismic survey was conducted with shots and geophones along the line running into the array from the north.

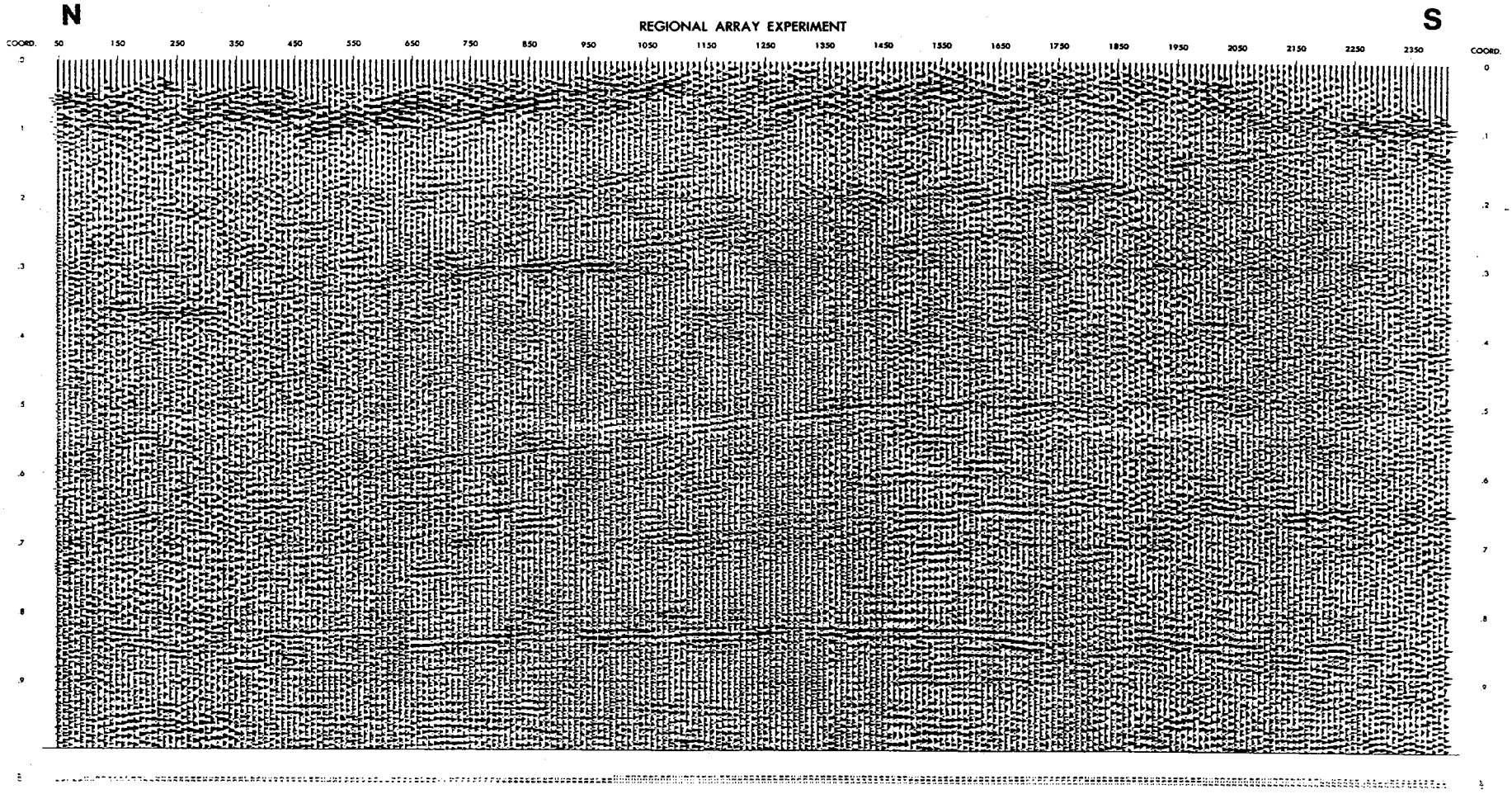

Fig. VII.7.2 CDP-stacked section, for the TWT interval 0.0-1.0 s. The filter used was 100-250 Hz.

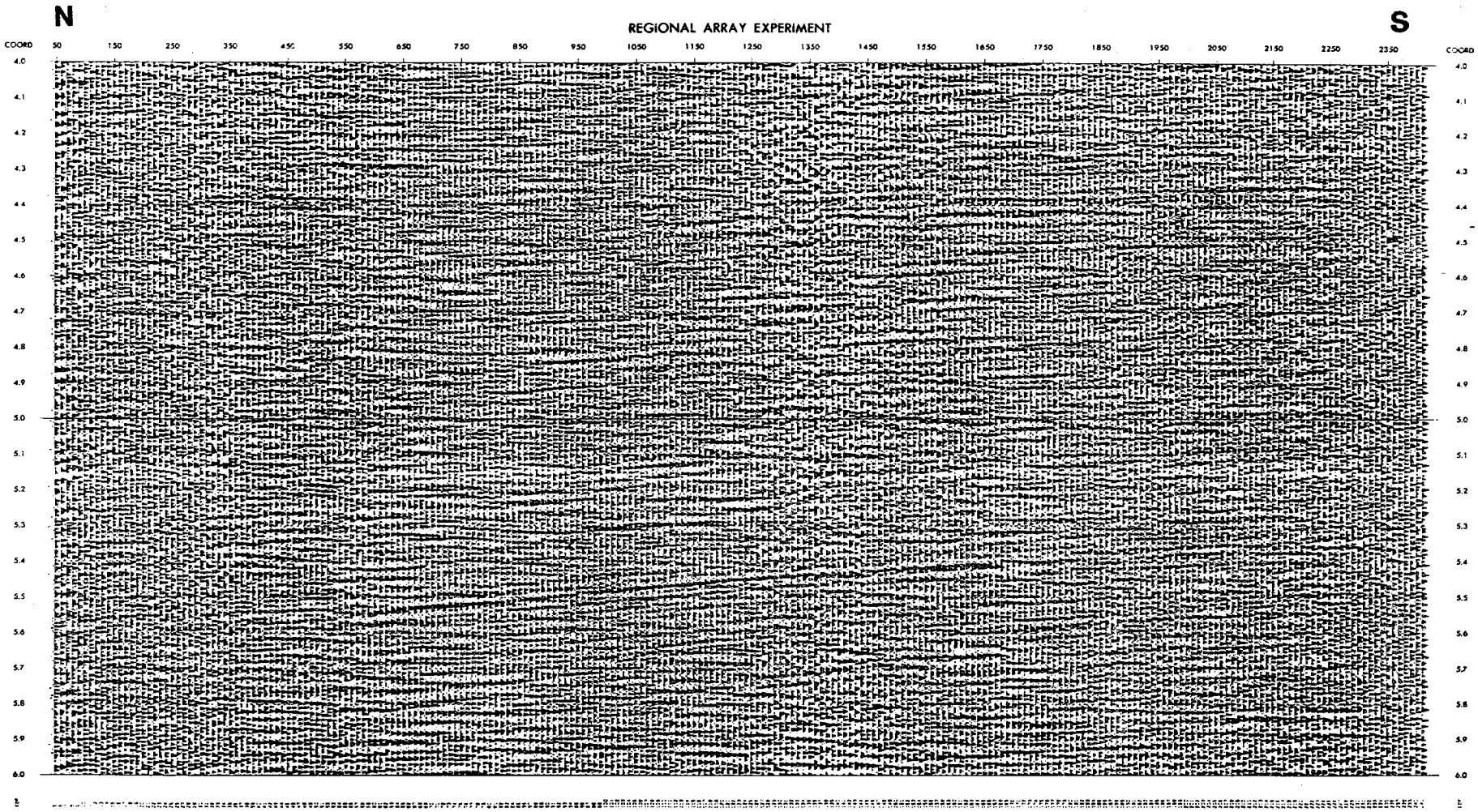

Fig. VII.7.3 CDP-stacked section, for the TWT interval 4.0-6.0 s. The filter used was 20-120 Hz.