NORSAR

ROYAL NORWEGIAN COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

Scientific Report No. 2-78/79

SEMIANNUAL TECHNICAL SUMMARY

1 October 1978—31 March 1979

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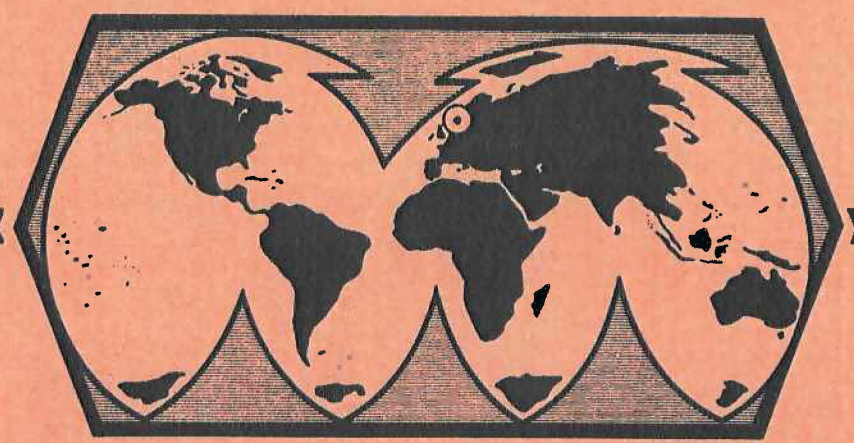
Kjeller, 30 April 1979

Sponsored by
Advanced Research Projects Agency
ARPA Order No. 2551



VI.5 Crustal Thicknesses of Fennoscandia

As a possible clue to a better understanding of problems related to exceptional propagation efficiency of Lg-type of surface waves along certain paths from Central Asia to Fennoscandia, we have undertaken an investigation of crustal thicknesses of the latter region. In the past this type of investigations, with emphasis on seismic profiling surveys, have flourished in this region, though the results obtained in our opinion are not entirely satisfactory. The reason for the latter statement is two-fold: i) the various profiling survey data have repeatedly been reinterpreted and the associated crustal models may comprise two to four layers; ii) derived crustal parameters for areas with intersecting profiles are sometimes rather dissimilar. A possible alternative to the traditional profiling surveys is to take advantage of the easily available data from the high-quality seismograph network of Fennoscandia. A suitable and proven technique for crustal studies with this kind of data is the technique of spectral ratios found from vertical and radial long-period components of P-wave recordings (Phinney, 1964; Berteussen, 1977). The essence of this method is to compare observed spectral ratios with theoretical ones based on 'response' calculations of a large number of crustal models (see Fig. VI.5.1). In practice the class of possible crustal models is rather limited as the dominant parameters here are the crustal thicknesses for the stable part of the P-wave spectrum, i.e., up to 0.15 Hz.

Altogether, we analyzed 45 events (see Table VI.5.1) with 5-12 events per station in different distance and azimuth ranges for 10 stations equipped with appropriate LP instruments. The results obtained, that is, essentially crustal thicknesses at each station, are listed in Table VI.5.2. The spectral ratio method is taken to provide rather accurate Moho depth values, as the standard error of these estimates seldom exceeds ± 0.3 km. For details on the NORSAR siting area, we refer to Berteussen (1977). Also the analysis of the Hagfors (HFS) and Bergen (BER) stations have not been completed yet.

When examining Table VI.5.2, an obvious question may be how well the spectral ratio results correlate with corresponding ones derived from profiling surveys, that is, as regards crustal thicknesses. We do consider that such a correlation is rather good if the profiling results are subjected to two conditions, namely, i) profile length should exceed 300 km and ii) only the crustal thicknesses estimated from the central part of a profile are considered reliable.

The crustal thickness estimates obtained in this study and also corresponding results from profiling surveys are displayed in Fig. VI.5.2. Our comments here are as follows: The dominant feature is the Moho bulge in the Bothnian Bay which roughly coincides with the area of maximum uplift rate and prominent free-air gravity anomalies as well. From the Umeå (UME) area where the Moho depth reaches a maximum of approx. 48 km, the crustal thickness decreases slowly to the west, north and east, but relatively more rapidly towards south-southwest. The NORSAR array is overlying an area of relatively modest crustal thickness of around 33 km though rapidly thickening westward.

Our data do not extend to the Kola Peninsula nor to the Barents Sea, but other studies here indicate crustal thicknesses of the order of 45 km (e.g., Levshin and Berteussen, 1979, McCowan et al, 1978). An underground nuclear explosion in the Kola Peninsula indicated extremely efficient Lg propagation southward at least as far as Copenhagen, while explosion farther northeast indicate significantly less efficient Lg-propagation paths.

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Phinney, R.A., 1964: Structure of the earth's crust from spectral behavior of long period body waves. J. Geophys. Res., 69, 2997-3017.

NC	DATE	OT	LAT	LONG	DEP	MB	DIST UME	AZI UME	REGION
1	670527	1722560	51.86	176.09	11	5.9	63.1	16.5	RAT ISLANDS
2	670729	1024247	6.84	-73.09	160	6.6	85.4	276.0	COLUMBIA
3	670826	0036474	12.18	140.80	78	6.1	91.9	57.4	CAROLINE ISLANDS
4	671015	0800526	11.91	-85.98	161	6.2	86.4	289.7	NIGARAGUA
5	671025	0059233	24.43	122.25	73	6.0	73.5	68.4	TAIWAN
6	680409	0229002	33.22	-116.19	12	6.0	77.3	323.7	CALIFORNIA
7	680514	1405054	29.93	129.39	162	5.9	71.4	59.9	RYUKYU ISLANDS
8	680702	0344517	17.61	-100.24	66	5.7	86.9	304.6	MEXICO
9	680805	1617055	33.31	132.31	48	6.2	69.5	55.9	SHIKOKU JAPAN
10	680920	0600033	10.76	-62.70	103	6.2	77.3	268.5	VENETZUELA
11	690328	0148295	38.55	28.46	4	5.9	25.8	165.1	TURKEY
12	690421	0719270	32.15	131.98	39	6.1	70.4	56.8	KYUHU JAPAN
13	700228	1052313	52.59	-175.04	161	6.0	63.3	10.4	ALASKA
14	700407	0534062	15.78	121.71	40	6.5	81.0	72.8	LUZON
15	700412	0401446	15.08	122.01	25	5.8	81.7	72.9	PHILIPPINES
16	700527	1205083	27.22	140.29	406	6.0	77.9	52.0	BONIN ISLANDS
17	700725	2241126	32.26	131.78	47	6.1	70.2	56.9	JAPAN
18	700726	0710379	32.31	131.83	47	6.0	70.2	56.8	KYUSHU, JAPAN
19	700729	1016204	26.02	95.37	68	6.4	60.4	90.9	BURMA-INDIA BORDER
20	700830	1746089	52.36	151.64	643	6.5	58.1	32.8	OKHOTSK
21	700826	1202304	6.37	-77.48	8	6.0	87.7	279.7	COLOMBIA
22	700927	0838369	6.52	-77.40	6	5.8	87.6	279.7	COLOMBIA
23	710518	2244393	63.92	146.10	0	5.9	46.4	29.6	EAST SIBERIA
24	711124	1935285	52.85	159.22	99	6.4	59.4	27.6	KAMCHATKA
25	711202	1718240	44.77	153.33	38	6.2	65.6	34.8	KURILE ISLANDS
26	720410	0206500	28.39	52.78	11	6.0	41.1	133.9	IRAN
27	720424	0957212	23.60	121.55	29	6.1	73.9	69.4	TAIWAN
28	720425	1930080	13.38	120.34	38	6.4	82.5	75.1	MINDORO.PHILIPPINES
29	720803	0440529	51.20	-178.13	24	5.7	64.4	12.7	ANDREANOF ISLANDS
30	720903	1648295	35.94	73.33	45	6.2	42.3	105.3	KASHMIR
31	730130	2101138	18.53	-102.93	48	6.1	87.0	307.3	MEXICO
32	730531	2339520	24.31	93.52	1	5.8	61.1	93.5	BURMA
33	730626	2331550	43.01	146.66	10	5.8	65.4	40.5	KURILE ISLANDS
34	730828	0950391	18.25	-96.58	75	6.6	84.9	301.6	MEXICO
35	740713	0118232	7.76	-77.57	12	6.4	86.5	280.4	COLOMBIA
36	750119	0801580	32.39	78.50	10	6.2	47.5	102.7	KASMIR-TIBET BORDER
37	750613	1808178	43.26	147.39	72	5.9	65.4	39.8	KURIL ISLANDS
38	750629	1037406	38.79	130.09	549	6.1	63.8	55.0	SEA OF JAPAN
39	750710	1829158	6.51	126.65	81	5.9	91.4	72.4	MINDANAO
40	750802	1018197	53.48	-161.39	46	6.0	63.0	1.1	SOUTH OF ALASKA
41	750815	0728245	54.92	167.87	41	5.8	59.0	21.1	KOMANDORSKY ISLANDS
42	751001	0330014	-4.83	102.24	47	6.0	90.8	99.3	SOUTHERN SUMATRA
43	760408	0240239	40.31	63.72	10	6.2	34.5	111.9	UZBEKISTAN
44	760511	1659482	37.56	20.35	33	5.8	26.3	179.8	IONIAN SEA
45	760727	1942540	39.56	117.87	10	6.1	58.5	64.0	NORTHEASTERN CHINA

Table VI.5.1

List of earthquakes used in this study.
Distance and azimuth are computed relative to UME,
which is the central station in our network.

Event	COP	KEV	KIR	KJF	KON	KRK	NUR	SOD	UME	UPP
1						40				
2						44				
3						44				
4						43				
5						44				
6						44				
7						44				
8						44				
9						44				
10						43				
11						45				
12						44				
13					35					
14			45		35					
15		43	45		35		45		47	43
16		41			35		45			
17			45		35					
18									46	
19			45							41
20	31	46		46			45			
21	30			46	32		44			
22		42		46			44			
23		47		49	35		44		48	
24		46					44			
25		47		43			45			
26	29	44	45	48	32		47		48	42
27										
28			43	45			46			
29	30			48	35					42
30			47		31				49	
31										42
32				46					48	
33	29				33		46		47	40
34				47	34		43			
35										43
36								43		
37								45		
38								45		
39								44		
40								46		
41								44		
42								46		
43								47		
44								45		
45								47		
Mean	29.8	44.5	45.0	45.4	33.9	43.6	44.8	45.2	47.6	41.9
St. err.	0.4	0.8	0.4	0.5	0.4	0.4	0.3	0.4	0.4	0.4
N	5	8	7	10	12	12	12	10	7	7

Table VI.5.2

Moho depths for our ten stations as derived from each individual event. The event numbers correspond to those of Table VI.5.1.

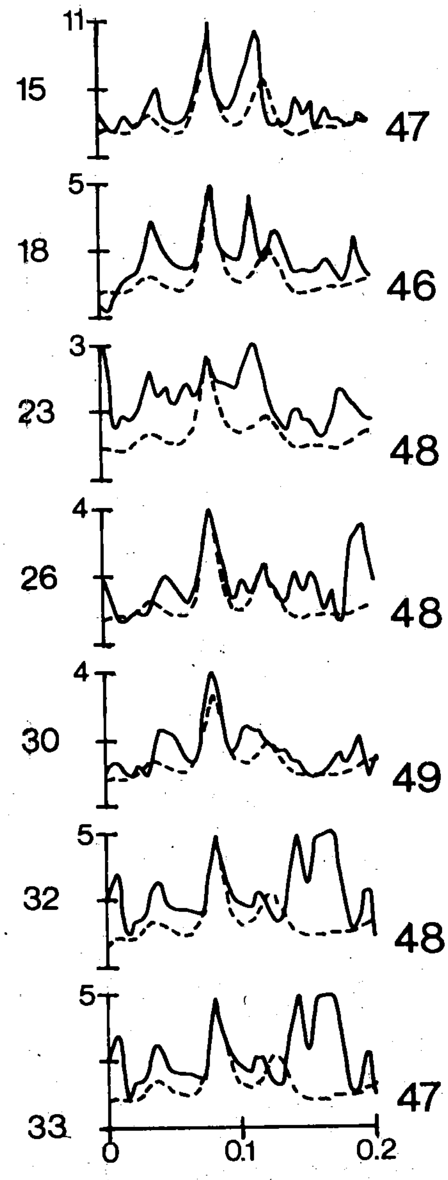

Fig. VI.5.1 Example of observed (full line) and theoretical (dashed line) spectral ratio for the seven events from UME. Event numbers are given to the left, and the corresponding Moho depths to the right.

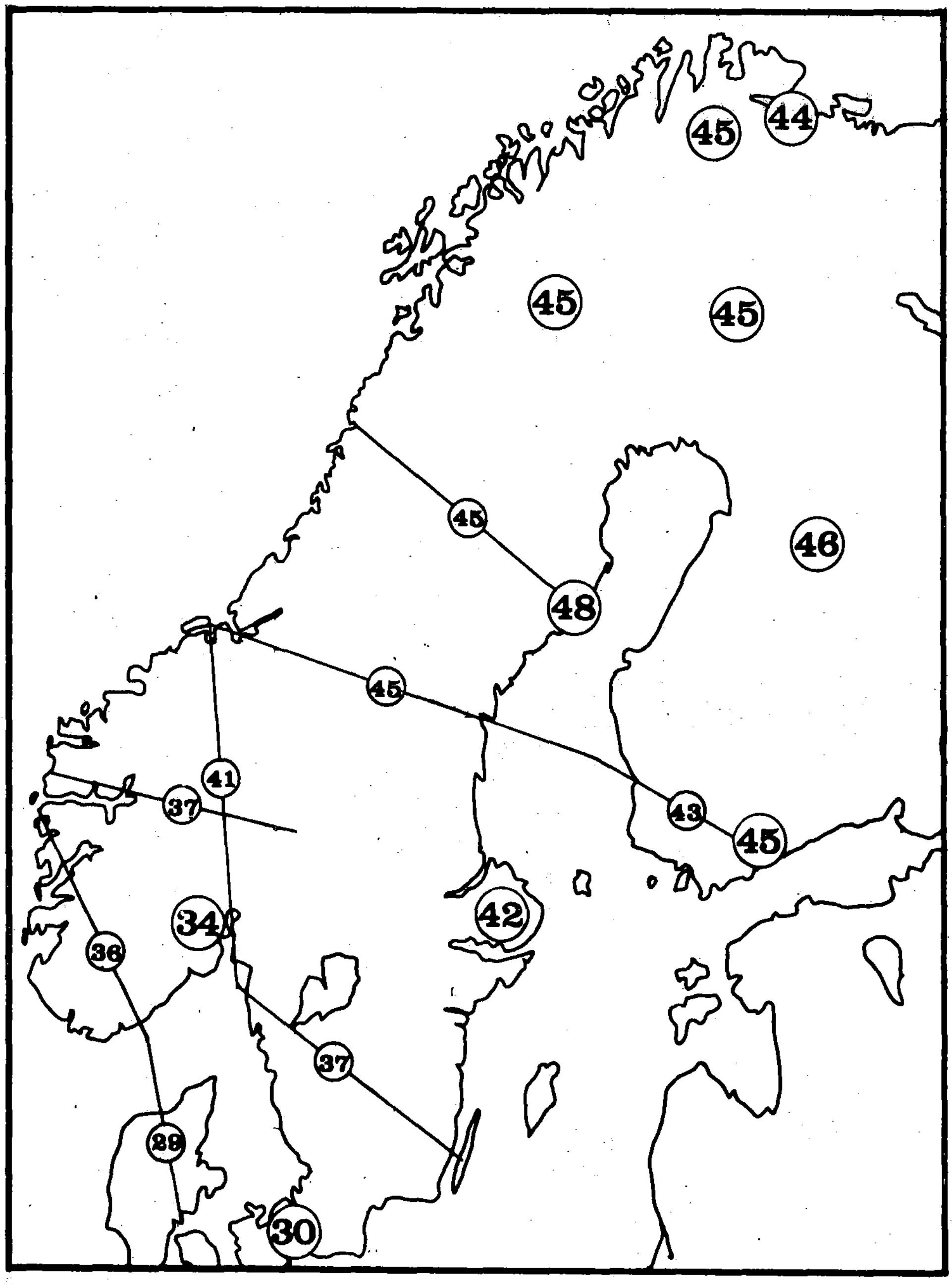

Fig. VI.5.2 Moho depths for Fennoscandia. The depths derived in this study are plotted as large encircled numbers, and the smaller numbers refer to average depths from refraction studies, where also the profile is indicated by a straight line.