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FINAL REPORT
(REVISED)

ON

AN INVESTIGATION OF CRUSTAL AND UPPER MANTLE STRUCTURE BENEATH THE RIYADH REGION FROM SPECTRAL ANALYSIS OF LONG PERIOD P-WAVE AMPLITUDE RATIOS

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ABSTRACT

The crustal and upper mantle velocity structure of the central Arabian Platform has been derived using the spectral analysis of long period P-wave amplitude ratios. The ratio of the vertical to the horizontal component is utilized to obtain crustal transfer function based on thickness variations , crustal velocities , densities and the angle of incidence at the lower crust and upper mantle.

Forty well-defined earthquakes recorded at the long-period RYD station during the period from 1986 to 1994 were selected for analysis based on the following criteria : focal depths with a range between 10 and 300 km , body-wave magnitudes greater than 5.0 and epicentral distances with a range from 7 to 97 degrees. Spectral analysis calculations were based on the comparison of the observed spectral ratios with those computed from theoretical P-wave motion obtained using the ‘’ Thomson- Haskell ‘’ matrix formulation for horizontally layered crustal models.

The derived crustal model indicates a change in crustal thickness in two different azimuthal sectors :

1) from N 20^{o} W to N 150^{o} degrees (NW to SE) and
2) from N 190^{o} to N 30^{o} W degrees (SW to NW).

The selection of the most suitable model was based on the identification of the theoretical model which exhibits the highest cross correlation coefficient with the observed transfer function ratio. The model suggested that the crust consists of five distinct layers. The upper crustal layer has a P-wave velocity of about 5.6 km/sec and is about 1.6 km thick. The second layer has a velocity of about 6.2 km/sec and 9.7 km thick. The third layer shows a velocity of 6.6 km/sec and 7 km thick. The fourth layer has a velocity of about 6.8 km/sec and 13.3 km thick. The lower crustal layer has a velocity of about 7.5 km/sec and 10 km thick. The Mohorovicic discontinuity beneath the Arabian Platform varies from 43 km depth in the NE and SE to 41 km depth in the NW and SW with 8.2 km/sec upper mantle velocity.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The objective of this study was to determine the crustal and upper mantle structure beneath the Arabian platform from the spectral analysis of long period P- wave amplitude ratios.

In order to achieve our objectives, suitable earthquakes which were recorded at Riyadh long-period station during the period from 1986 to 1994 have been utilized for the analysis based on the following criteria : focal depths range between 10 and 300 km, body-wave magnitudes greater than 5.0 and the epicentral distances range from 7 to 95 degrees. Spectral analysis calculations were based on comparing the observed spectral ratios with those computed from theoretical P-wave motion obtained using the ‘’ Thomson- Haskell ‘’ matrix formulation for horizontally layered crustal models.

The derived crustal model indicates a change in crustal thickness in two different azimuthal sectors : 1) from N 20° W to N 150° (NW- SE) and 2) from N 190° to N 30° W (SW - NW). The selection of the most suitable model was based on the identification of theoretical model which exhibits the highest cross correlation coefficient with the observed transfer function ratio.

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Platform varies from 43 km depth in the NE and SE to 41 km depth in the NW and SW with 8.2 km/sec upper mantle velocity.

The drived models show a little higher P-velocity for the upper crust in the shield than in the platform. However, the lower crust shows a clear higher P-velocity in the platform than in the shield. Also, the transition zone layer shows a higher P-velocity in the platform than in the shield and it continue to increase up to 8.2 km/sec beneath a depth of 30 km. The crustal platform seems to have a greater thickness than the shield by about 3 km.

Table XI

This study			Mooney, 1985			Mokhtar et al.,1995			Badri, 1991			East Africa			Indian shield		
depth	**thickness**	**Vp**	**depth**	**thickness**	**Vp**	**depth**	**thickness**	**Vp**	**depth**	**thickness**	**Vp**	**depth**	**thickness**	**Vp**	**depth**	**thickness**	**Vp**
0	**1.56**	**5.57**							**0**	**3**	**5.98**				**0**	**3**	**5.6**
1.56	**10.2**	**6.16**	**0**	**20**	**6.35**	**0**	**20**	**6.1**	**3**	**12**	**6.1**	**0**	**20**	**6.1**	**3**	**7**	**6.15**
11.76	**6.78**	**6.62**							**15**	**10**	**6.4**				**10**	**9**	**6.55**
18.54	**12.33**	**6.82**	**20**	**20**	**7.2**	**20**	**20**	**7.1**	**25**	**15**	**6.8**	**20**	**28**	**7.0**	**19**	**7**	**6.7**
30.87	**9.33**	**7.43**													**26**	**17**	**7.2**
40.2	**-**	**8.2**	**40**		**8.2**	**40**		**7.8**	**40**		**8.13**	**48**		**8.01**	**43**		**8.1**

Table XII

This study			Mohktar, et al., 1995			Badri, 1991			Jordanian					
depth	**thick**	**Vp**	**depth**	**thick**	**Vp**	**depth**	**thick**	**Vp**	**depth**	**thick**	**Vp**	**depth**	**thick**	**Vp**
0	**1.6**	**5.62**	**0**	**5**	**3.93**	**0**	**2**	**3.86**	**0**	**1.5**	**3.5**			
1.6	**9.2**	**6.3**	**5**	**20**	**5.8**	**2**	**3**	**6.1**	**1.5**	**8.5**	**6.0**			
10.8	**7.2**	**6.62**				**5**	**7**	**6.2**	**10**	**8**	**6.2**			
18	**14.2**	**6.88**	**25**	**20**	**6.81**	**12**	**18**	**6.35**	**18**	**2**	**6.4**			
32.2	**10.8**	**7.59**	**45**		**7.45**	**30**	**15**	**6.85**	**20**	**8**	**6.6**			
43	**-**	**8.2**				**45**		**8.2**	**28**	**6**	**7.4**			
									34		**8.1**			

RECOMMENDATIONS FOR FURTHER INVESTIGATIONS

The present work represent the first detailed study of the central Arabia using earthquake data for crustal structure studies. The geology of this region was given more attention. Applying Thomson-Haskell matrix formulation in our study has been found to be a good, economic, and reliable technique for crustal structure determination on the basis of single-station seismic data through system identification techniques. The accuracy of this method is based primarily on the quality and frequency band of seismic data and number of the parameter pertaining to the layered crustal model . The derived model is not unique due to the theoretical assumption in this method and also due to the complexity of the crustal structure of the earth. This method can be used effectively in combination with seismic refraction or gravity surveying.

In order to fully understand the detail geophysical and seismological picture of central Arabia, this study recommends an extensive research covering the following points :

1. An expensive but potentially insightful line of research is to carry out a detailed seismic deep refraction and gravity profiles between Riyadh and the Arabian Gulf in the east to obtain a precise bulk composition of crustal layers and improve velocity model.

2. Investigation of the crustal structure beneath Dhahran station from the spectral analysis of long period P-wave data based on the Thomson- Haskell matrix formulation. This will be integrated with our results for correlating and comparing crustal thickness variations.

3. Upgrading of the existing system at Riyadh and Dhahran stations from analog to digital recordings is strongly recommended for getting better quality signals, time consuming and make it possible to include short period data in the analysis.

4. Installation of strong motion accelerographs to estimate the attenuation characteristics in the region and to evaluate the seismic hazard assessment.

The aforementioned recommendations would not significantly change our basic conclusions in this study but would help create parallel tracks of investigation.