

## **A note on the crustal structure of the eastern Mediterranean**

P. E. COMNINAKIS - B. C. PAPAACHOS (\*)

Received on April 30th, 1976

**SUMMARY.** — A simple model is proposed for the mean crustal structure of the eastern Mediterranean. According to this model, which fits the available seismic data, the crust of the eastern Mediterranean consists of five layers of 21 km total thickness and the velocity of the longitudinal waves varies between 2.2 and 6.6 km/sec in this crust.

**RIASSUNTO.** — Si propone un modello semplice relativo alla struttura della crosta in corrispondenza del Mare Mediterraneo orientale. Secondo questo modello, che si adatta ai dati sismici disponibili, la crosta sotto il Mar Mediterraneo orientale è formata da 5 strati con uno spessore totale di 21 km, e la velocità delle onde longitudinali, in questa parte di crosta, varia fra 2.2 e 6.6 km/sec.

### **INTRODUCTION**

The eastern Mediterranean occupies the depression which is included between the southern Eurasian coast (Turkey - Greece), the northern African coast, the Calabrian arc (Calabria - Sicily - Atlas) and the coast of Lebanon.

Although considerable geophysical work has been carried out in the eastern Mediterranean, especially in the last ten years or so, the opinions as to its tectonic history is still very controversial. One of

---

(\*) National Observatory of Athens. Seismological Institute, Athens, Greece.

the reasons for this is the fact that our knowledge in regard to the deep structure of this area are not very clear.

The available information concerning the deep structure come mainly from reflection, refraction, surface waves dispersion, and gravity measurements. None of these techniques has been extensively applied to study the crustal structure of the eastern Mediterranean, but all these techniques have been used to get some information about this structure in several places of the area.

The crustal structure of the eastern Mediterranean is probably much complicated. Therefore with the available data we cannot arrive at detailed conclusions as to this structure. We believe, however, that by synthesizing properly the available geophysical results we can get a rough idea, at least, about the mean crustal structure of this area.

In this paper an attempt is made to suggest a crustal model for the eastern Mediterranean, which consists of horizontal homogeneous layers and which best fits the available results of the application of the reflection, refraction and the surface waves dispersion methods.

#### 1. - A MODEL BASED ON THE AVAILABLE INFORMATION

There have been published several results of the application of the reflection, of the refraction and of the dispersion of the surface waves methods, in the eastern Mediterranean. There is agreement between some of these results which concern certain parts of the crust but there are other parts of the crust for which no agreement exists. For this reason the final adopted model is a result of somehow weighting the information given by each method according to the depth of the crustal layers.

For the shallow layers the information coming mainly from the application of the reflection method is used. For the intermediate crustal layers the model is mainly based on information coming from the application of the refraction methods. For the lower crust and just below it the results of the refraction and dispersion of surface waves methods have been used to make the model.

The thickness of the unconsolidated sediments has been determined in several places of the eastern Mediterranean <sup>(3,4,5,6,11)</sup>.

From all these determinations a mean value equal to 0.7 km with a standard deviation equal to  $\pm 0.5$ km has been calculated.

The mean compressional velocity has been found equal to 2.2 km/sec, with a standard deviation equal to  $+ 0.3$  km/sec.

Under the unconsolidated sediments, material with compressional velocities between about 3 and 4 km/sec have been observed in several places of the eastern Mediterranean (4,5). The available values have given an average thickness equal to  $4.6 \pm 4.0$  km and an average compressional velocity  $3.7 \pm 0.3$  km/sec where  $\pm 4.0$  km and  $\pm 0.3$  km/sec are the standard deviations.

Beneath the material with average compressional velocity equal to 3.7 km/sec a layer with velocities between about 4.1 and 5.5 km/sec has been detected by the refraction method (1,2,3,4,5) and has been considered to interpret surface waves dispersion data (7,8,9). We have used all this information to find average values equal to  $4.4 \pm 2.3$  km and  $4.8 \pm 0.5$  km/sec for the thickness of this layer and the compressional velocity, respectively.

There is weak evidence that material with compressional velocities of the order of 6.0-6.1 km/sec exists in the central and eastern part of the eastern Mediterranean (2,6). There is, however, rather strong evidence that such material exists under the Ionian basin (4,10). By the use of all the published values an average equal to about 3km has been found for the thickness of this layer. These velocities are typical of crystalline rocks.

Since the existence or non-existence of a crystalline layer in the eastern Mediterranean is of decisive importance for any theory regarding its tectonic history and the available information as to this layer is controversial, further refraction and other work is necessary to solve this basic problem.

Information for the simatic part of the crust (basaltic layer) in the eastern Mediterranean has been based on refraction measurements (1,5), and on measurements of phase and group velocities of surface seismic waves (7,8,9). The available values give an average equal to  $8.7 \pm 2.2$  km for the thickness of this layer and an average equal to  $6.6 \pm 0.2$  km/sec for the corresponding compressional velocity.

Just under the crust the mean compressional velocity is equal to  $8.1 \pm 0.1$  km/sec.

Figure 1 shows schematically a simple crustal model of the eastern Mediterranean based on the above mentioned information. It consists of five homogeneous and horizontal layers, excluding the water layer. The mean thickness of each layer and the mean velocity of the compressional waves in each layer are shown. The total crustal thickness

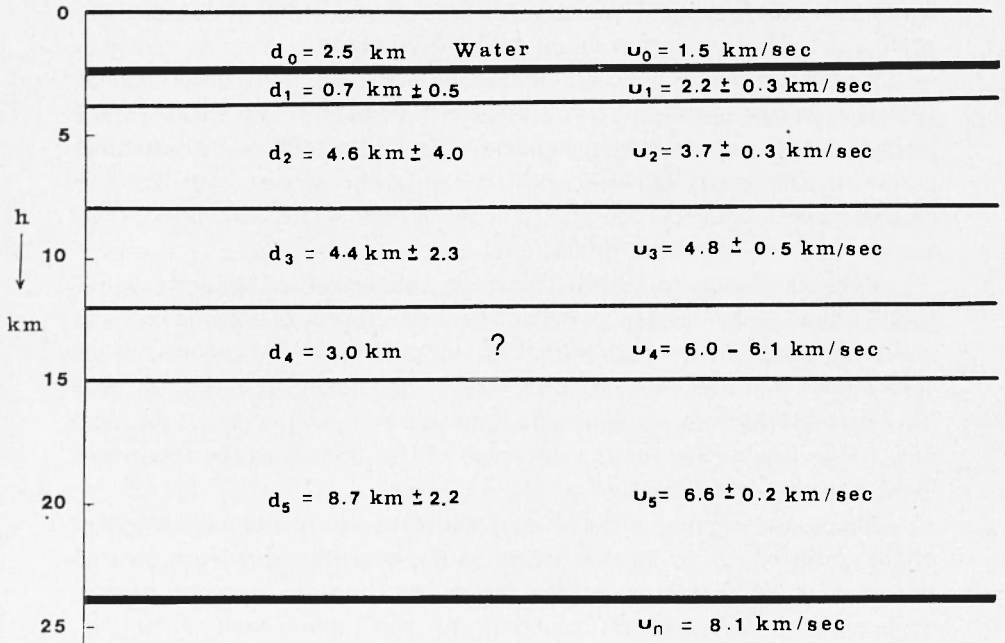


Fig. 1 - A model of the mean crustal structure of the eastern Mediterranean Sea.

in this model is equal to 21.4 km. It is understood that the crustal model of figure 1 is a first rough approximation of the real crustal structure in the eastern Mediterranean.

#### CONCLUSIONS

The crustal structure in the eastern Mediterranean is neither typical oceanic nor typical continental. The available information permit to get a rough idea only about the mean structure of this area.

The published seismic results can be interpreted by a model which consists of five horizontal and homogeneous layers with mean thicknesses equal to 0.7 km, 4.6 km, 4.4 km, 3.0 km, 8.7 km and corresponding compressional velocities equal to 2.2 km/sec, 3.7 km/sec, 4.8 km/sec, 6.0-6.1 km/sec, 6.6 km/sec, but the existence of the layer with 6.0-6.1 km/sec velocity is doubtful at least in the eastern part of the area.

## REFERENCES

- (1) EWING J. I., and EWING M., 1959. - *Seismic - Refraction Measurements in the Atlantic Basins, in the Mediterranean Sea, on the Mid-Atlantic Ridge and in the Norwegian Sea*. "Geol. Soc. Am. Bull.", **70**, pp. 291-318.
- (2) FINETTI I., MORELLI C., 1973. - *Geophysical Exploration of the Eastern Mediterranean Sea*. "Bollet. di Geofis. Teor. ed Appl.", **XV**, pp. 262-341.
- (3) GASKELL T. F., HILL M. N., and SWALLOW J. C., 1958. - *Seismic Measurements Made by H. M. S. Challenger in the Atlantic, Pacific and Indian Ocean and in the Mediterranean Sea, 1950-53*. "Roy. Soc. London, Phil. Trans.", **A251**, pp. 28-83.
- (4) HINZ K., 1974. - *Results of Seismic Refraction and Seismic Reflection Measurements in the Ionian Sea*. "Geol. Jb.", Hannover, E<sub>2</sub>, **24**Abb., pp. 33-65.
- (5) LORT J. M., LIMOND W. Q., and GRAY F., 1974. - *Preliminary Seismic Studies in the Eastern Mediterranean*, "Earth and Planetary Letters", **21**, pp. 355-366.
- (6) MOSKALENKO V. N., 1966. - *New Data on the Structure of the Sedimentary Strata and Basement in the Levant Sea*. "Oceanology", **6**, pp. 828-836.
- (7) PAPAZACHOS B. C., 1969. - *Phase Velocities of Rayleigh Waves in South-eastern Europe and Eastern Mediterranean Sea*. "Pure and Appl. Geophys.", **75**, pp. 47-55.
- (8) PAYO G., 1967. - *Crustal Structure of the Mediterranean Sea by Surface Waves, Part I, Group Velocity*. "Bull. Seismol. Soc. Am.", **57**, pp. 151-172.
- (9) PAYO G., 1969. - *Crustal Structure of the Mediterranean Sea. Part II, Phase Velocity and Travel Times*, "Bull. Seismol. Soc. Am.", **59**, pp. 23-42.
- (10) WEIGEL W., and HINZ K., 1970. - *Preliminary Results of Seismic Measurements in the Ionian Sea and on the Malta Shelf*. Paper Presented XII<sup>e</sup> Assemblée Générale de la Commission Seismologique Européenne. Luxembourg 21-29 Sept.
- (11) WONG H., ZARUDSKI E. F. K., 1969. - *Thickness of Unconsolidated Sediments in the Eastern Mediterranean Sea*. "Geol. Soc. Am. Bull.", **80**, pp. 2611-2614.