GEODYNAMICS OF THE EASTERN MEDITERRANEAN SEA

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Abstract

As a response to the rapid convergence between the African plate and the Aegea-Anatolia block, an accretionary complex (the Mediterranean Ridge) has grown in the Eastern Mediterranean basins by offscraping the upper sedimentary sequences of the downgoing plate. The boundary between this prism and its rigid backstop does not coincide with the so-called "Hellenic trenches" as previously stated. The rigid backstop instead occupies nearly one third of the surface of the Mediterranean Ridge system. The backstop might represent a seaward extension of the Hellenic nappes system. Incipient collision between this backstop and the Lybian margin results in internal deformation of the backstop and some lateral escape of the prism both westward to the West and eastward to the East. Fluid migration from deep origin causes mud diapirism and brine seeping by leaching the Messinian evaporites.

Key Words : Deep sea trench, Active margins, Tectonics, Mediterranean ridge

Introduction

Our knowledge of the active processes in the Eastern Mediterranean basins has greatly improved during the last decade, mostly because a great number of oceanographic research cruises have been conducted by european scientists. Among those, our group has been leading or co-leading five cruises. In this paper, we present a synthesis on the Eastern Mediterranean Sea mainly based on our experience but including results of other groups as well.

1) Plate kinematics : new insights from space geodesy

It has been noticed since the early days of the Plate Tectonics that the large scale motions of the plates resulted in a slow convergence between African and Eurasian plates during the Cenozoic times (1 cm/y in a S-N direction presently), is responsible for the building of the mountain chains bordering the Mediterranean Sea (*e.g.* [1]). The Aegean Arc is by far the most seismically active part of the Mediterranean due to the subduction of the African plate beneath the Aegean Arc system (*e.g.* [2]) nicely depicted by seismic velocity tomographic images [3]. However, the question whether crustal motions were related to a continuum of plastic deformation [4] or rigid rotations of platelets [5] remained unsolved until recently. Le Pichon and Angelier [6] have proposed however a rigid-type kinematic scheme for the relative motion between Africa and the Aegean Arc based on the focal mechanisms of the subduction earthquakes. The major breakthrough came from the space geodesy techniques allowing to get the motion not only at the plate boundaries but inside the plates. Le Pichon *et al.* [7], based on S.L.R. data, proposed that the deformation can be described by a rigid rotation of an Anatolian block (most part of Turkey and Southern Greece) with respect to stable Eurasia around a eulerian pole located near the Nile cone. This hypothesis has been recently confirmed by Oral *et al.* [8] or Reilinger *et al.* [9], using a dense array of more than 50 G.P.S. stations spread over the same area (Figure 1). Combined with the Eurasia/Africa, this predicts a convergence of about 4 cm/y in a NO2O°E direction along the Hellenic trenches, direction compatible with the slip vectors of the subduction earthquakes [10]. We further investigate the consequences of this subduction on the recent evolution of the Eastern Mediterranean Basin.

2) The Mediterranean Ridge : an accretionary prism related to the Aegean subduction zone

Most of the Eastern Mediterranean Sea is occupied by the Mediterranean Ridge (Figure 2), a broad submerged mountain chain (length about 1500 km, average width 200 km and average height above the abyssal plains of 1.5 km). After ruling out the hypothesis of a mid-oceanic spreading center, a compressional origin for the Ridge has been widely accepted. However, whether the compressional deformation involved the crust [11] or was restricted to accreted sedimentary sequences [12, 13] was still debated until recently.

In order to precise the internal structure of the Mediterranean Ridge, our group carried out a refraction study of the area in 1988 using two french research vessels (R.V. *Jean Charcot* and R.V. *Le Noroît*) in a E.S.P. (Expanded Spread Profile) experiment. As a main result of this cruise, we showed that the Eastern Mediterranean deep basins (Ionian Basin, Syrte abyssal plain and Herodotus basin) are most probably remnants of oceanic lithosphere [14]. We also showed that the velocity structures and thus the density distributions were in good agreement

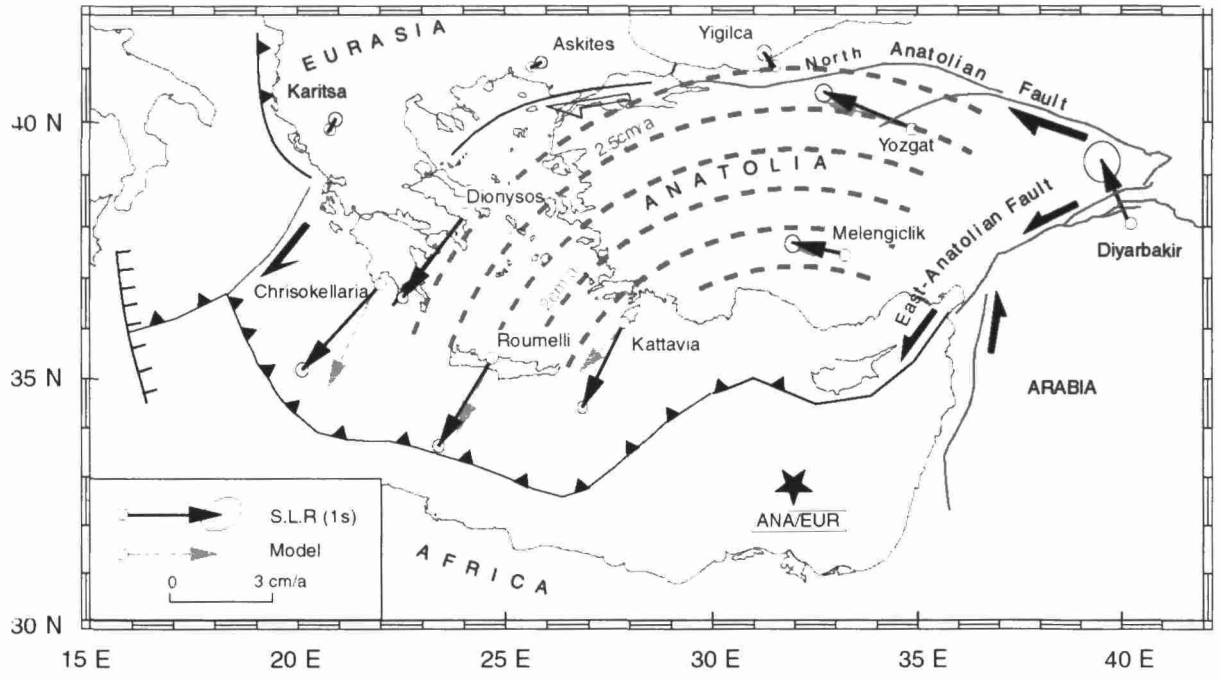

Figure 1. Plate kinematic scheme of the Anatolian platelet based on space geodesy results (from [7] modified).