DEEP STRUCTURE AND DYNAMICS OF THE LITHOSPHERE-ASTHENOSPHERE SYSTEM IN THE MEDITERRANEAN REGION

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In plate-tectonic terms the Mediterranean-Alpine region can be described as a broad transition zone between the African and Eurasian lithospheric plates which is outlined by the recent seismicity (Fig. 1). The present crust-mantle structure is the result of a dramatic evolution since the Early to Late Cretaceous with dynamic processes mainly governed by the counterclockwise rotation of Africa versus Europe which has led to an increasing lithospheric shortening from West to East (MUELLER and KAHLE, 1993). Superimposed on this large-scale dominant motion are regional tectonic deformations which are associated with compressive, strike-slip and extensional structures. The observational data available indicate that most of these features reach deeply into mantle and can only be understood as manifestations of processes involving the entire lithosphere-asthenosphere system.

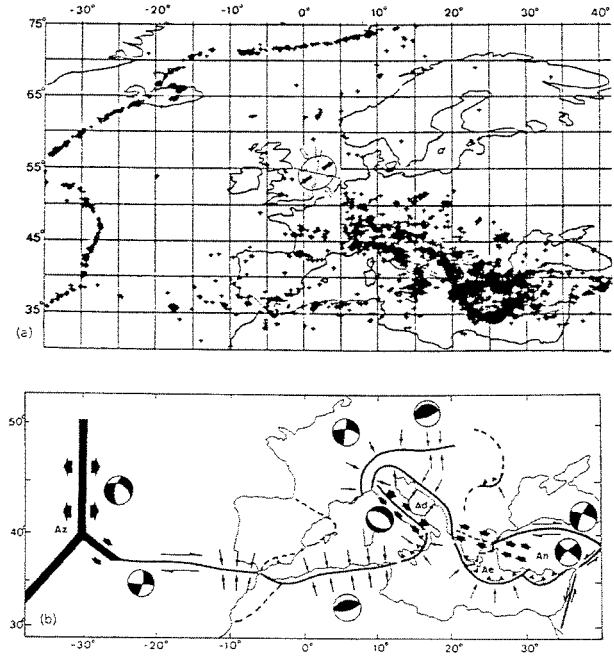

Figure 1: **(a)** The plate boundaries between N-America, Africa and Eurasia as outlined by the recent seismicity. The inset in the North Sea depicts a simplified seismotectonic stress scheme for central and NW Europe. **(b)** Generalized plate boundaries and seismotectonic stress patterns in the E-Atlantic as well as in the Mediterranean and Alpine region (after MUELLER, 1989). **Ae** = Aegean plate; **An** = Anatolian plate. **Az** = Azores triple junction; **Ad** = Adriatic promontory (or Apulian "microplate").

An attempt has been made to present a summary of the dominant structural and dynamic features which characterize the broad transition zone between the two major plates (Fig. 1). The multidisciplinary synthesis is based on the most recent geophysical and geodetic data for the Mediterranean-Alpine region. It can be demonstrated that - superimposed on the large-scale counterclockwise rotation of the African plate - complex seismotectonic processes affecting the lithospheric fragments between Africa and Europe play an important role. Their dynamics is triggered by thrusting, transcurrent motions, rifting and back-arc spreading associated with seismicity. Examples of regional cross-sections illustrating lateral heterogeneities of the upper-mantle structure are derived from the dispersion analysis of seismic surface-waves, the tomographic inversion of P- and S-wave traveltimes, long-range seismic refraction profiling and deep-reaching near-vertical reflection surveys. Beneath a highly differentiated crustal structure pronounced lateral variations of seismic wave velocities are indicative of abruptly changing features in the upper mantle. Based on space-geodetic data obtained as part of the WEGENER-MEDLAS Project within NASA's worldwide Crustal Dynamics Project (CDP) it has been possible for the first time to define in more detail the active tectonic framework by very-long baseline interferometry (VLBI), satellite laser ranging (SLR) and at the same time to aim at resolving in finer detail the kinematics of active earthquake belts by densifying the network of existing GPS measurements. In hazardous areas either continuous monitoring or repetitive measuring campaigns at shorter time intervals should now be carried out. This would allow to finally determine the space and time variations of the regional strain and stress tensors.

The results available so far have illustrated that intra-lithospheric detachment and wedging phenomena (MUELLER, 1990), differential rotations and strongly variable deformation rates have shaped the present tectonic appearance of the Mediterranean-Alpine realm. They quantitatively substantiate ongoing crustal movements (of up to 50 mm per year), such as the present northward motion of the Arabian plate, the westward motion of the Anatolian plate, the back-arc spreading in the Aegean sea and the subduction along the Hellenic arc. It could be shown that the plate contact in the Western Mediterranean region is primarily under a SE-NW compressive stress leading to a lithospheric shortening of 4 mm per year in the west to 9 mm per year in the northern Ionian sea. There is now sufficient evidence that the entire lithosphere-asthenosphere system is involved in these deep-reaching processes which significantly contribute to the potential hazard associated with impending earthquakes and volcanic eruptions.

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