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Subduction and vertical coastal motions in the eastern Mediterranean

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SUMMARY

Convergence in the eastern Mediterranean of oceanic Nubia with Anatolia and the Aegean is complex and poorly understood. Large volumes of sediment obscure the shallow structure of the subduction zone, and since much of the convergence is accommodated aseismically, there are limited earthquake data to constrain its kinematics. We present new source models for recent earthquakes, combining these with field observations, published GPS velocities and reflection-seismic data to investigate faulting in three areas: the Florence Rise, SW Turkey and the Pliny and Strabo Trenches. The depths and locations of earthquakes reveal the geometry of the subducting Nubian plate NE of the Florence Rise, a bathymetric high that is probably formed by deformation of sediment at the surface projection of the Anatolia–Nubia subduction interface. In SW Turkey, the presence of a strike-slip shear zone has often been inferred despite an absence of strike-slip earthquakes. We show that the GPS-derived strain-rate field is consistent with extension on the orthogonal systems of normal faults observed in the region and that strike-slip faulting is not required to explain observed GPS velocities. Further SW, the Pliny and Strabo Trenches are also often interpreted as strike-slip shear zones, but almost all nearby earthquakes have either reverse-faulting or normal-faulting focal mechanisms. Oblique convergence across the trenches may be accommodated either by a partitioned system of strike-slip and reverse faults or by oblique slip on the Aegean–Nubia subduction interface. The observed late-Quaternary vertical motions of coastlines close to the subduction zone are influenced by the interplay between: (1) thickening of the material overriding the subduction interface associated with convergence, which promotes coastal uplift; and (2) subsidence due to extension and associated crustal thinning. Long-wavelength gravity data suggest that some of the observed topographic contrasts in the eastern Mediterranean are supported by mantle convection. However, whether the convection is time dependent and whether its pattern moves relative to Nubia are uncertain, and its contribution to present-day rates of vertical coastal motions is therefore hard to constrain. The observed extension of the overriding material in the subduction system is probably partly related to buoyancy forces arising from topographic contrasts between the Aegean, Anatolia and the Mediterranean seafloor, but the reasons for regional variations are less clear.

Key words: Seismicity and tectonics; Continental margins: convergent; Kinematics of crustal and mantle deformation; Tectonics and landscape evolution.

1 INTRODUCTION

The active tectonics of the eastern Mediterranean is ultimately related to the N–S convergence between Nubia and Eurasia at $\sim$10 mm yr^{-1} (Reilinger *et al.* 2006; DeMets *et al.* 2010). The leading edge of Nubia is the seafloor of the eastern Mediterranean, consisting of oceanic crust (e.g. Le Pichon *et al.* 1979; Chaumillon & Mascle 1997), possibly as old as Palæozoic (Granot 2016), yet nowhere is it in contact with the stable Eurasian plate. Instead, the southern margin of Eurasia consists of continental material moving relatively rapidly (typically $>$10 mm yr^{-1}; Reilinger *et al.* 2006; Nocquet 2012) with respect to the stable interior, and in a variety of directions. The ultimate fate of the Nubian oceanic crust is subduction into the mantle, shown by the occurrence in several places of earthquakes as deep as 100–150 km (e.g. Caputo *et al.* 1970; Jackson & McKenzie 1984; Hatzfeld & Martin 1992; Hatzfeld 1994). However, at shallow levels the Nubian oceanic crust is covered by sediment up to 10 km thick, detached from the underlying basement by