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3-D magnetic modelling of the Ionian Sea deep-sea crust: Evidence for the oldest in-situ ocean fragment of the world

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It is well known that the Ionian Sea (Figure 1) is characterized by thin (8-11 km) crystalline crust, thick (5-7 km) sedimentary cover, and low heat flow, typical for a Mesozoic (at least) basin. Yet seismic data have not yielded unequivocal interpretations, and a debate has developed over the oceanic vs. "thinned continental" nature of the Ionian basin. Here we analyse the magnetic anomaly pattern of the Ionian Sea, and compare it to synthetic fields produced by a geopotential field generator, considering realistic crust geometry. The Ionian basin is mostly characterized by slightly negative magnetic residuals, and by a prominent positive (150 nT at sea level) "B" anomaly at the northwestern basin margin. We first test continental crust models, considering a homogeneous crystalline crust with $k=1x10^{-3}$, then a 5 km thick deep crustal layer of serpentinite ($k=1x10^{-1}$). The first model yields insignificant anomalies, while the second gives an anomaly pattern anti-correlated with the observed residuals. We subsequently test oceanic crust models, considering a 2 km thick 2A basaltic layer with $k=5x10^{-3}$, magnetic remanence of 5 A/m, and a unique magnetic polarity (no typical oceanic magnetic anomaly stripes are apparent in the observed data set). Magnetic remanence directions were derived from Pangean-African paleopoles in the 290-190 Ma age window. Only reverse-polarity models reproduce the B anomaly, and among them the 220-230 Ma models best approximate magnetic features observed on the abyssal plain and at the western basin boundary [1]. The Ionian Sea turns out to be the oldest preserved oceanic floor known so far.

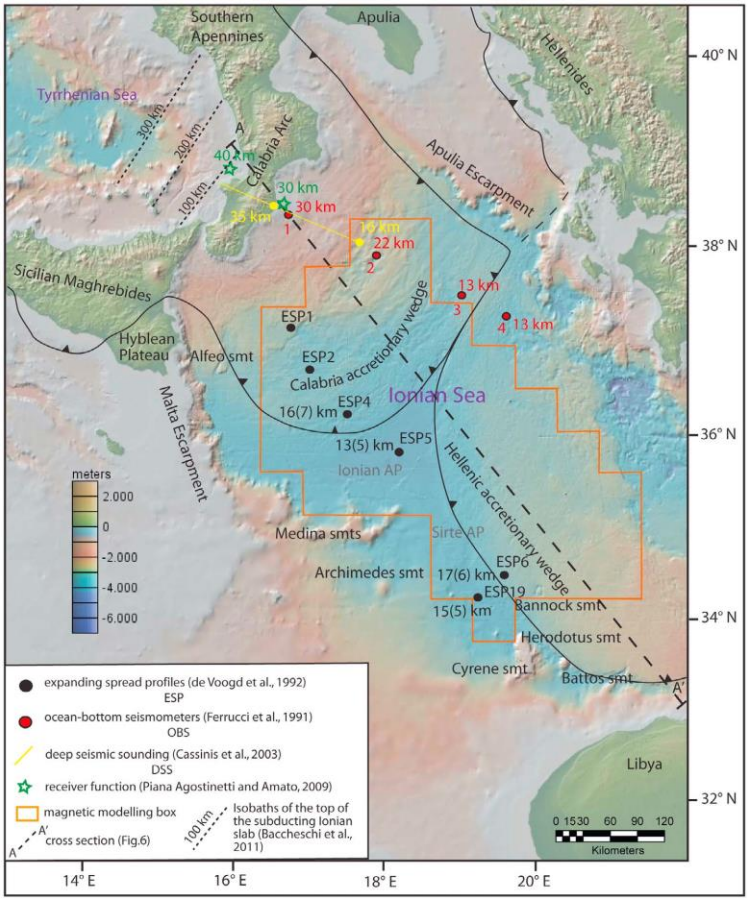

Figure 1: Digital elevation model of the Ionian Sea and surrounding areas, location of sites yielding Moho and crustal layer depths, and box of forward magnetic modeling

References:

[1] Speranza F et al. (2012) J Geophys Res 117 (B12101), doi:10.1029/2012JB009475