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The evolution of the Levant geomagnetic high captured in Mediterranean sediments

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Introduction

The geomagnetic field can vary dramatically over only decades and thousands of kilometers; the 'Levant geomagnetic high' is probably the best-known example of such short-lived feature of the Earth's magnetic field. Yet, the size, shape and temporal variations of this phenomenon are currently still enigmatic. To better constrain the Levant geomagnetic high in time and space, we obtained continuous full-vector records from three marine sediment cores from the Mediterranean Sea, Fig 1.

Figure 1. Sampling locations. The cores are located (1) between Spain and Morocco (Alboran- blue star), (2) East of Calabria, Italy (Adria- red star), and (3) North of the Nile Delta (Levant - orange star).

The sedimentation rate in all three cores is high, typically 20 to 65 cm/kyr, resulting in 15-50 years per paleomagnetic sample of 1 cm^3; age-depth models are available for all cores. The geomagnetic field variations between 8 and 1 ka are captured.

We first analyzed the rock magnetic properties of the sediment cores to assess the reliability of the sediments as recorders of geomagnetic field variations. The samples underwent alternating field demagnetization to obtain the paleodirections (e.g. relative declination and inclination), followed by a pseudo-Thellier experiment to obtain the relative paleointensity.

Figure 2. Sampling. Two rows of 1 cm^3 cubes are pushed into the sediment; the two rows are offset by half a cube to increase the sampling resolution. Yellowish colors on some cubes is light reflection.

Results

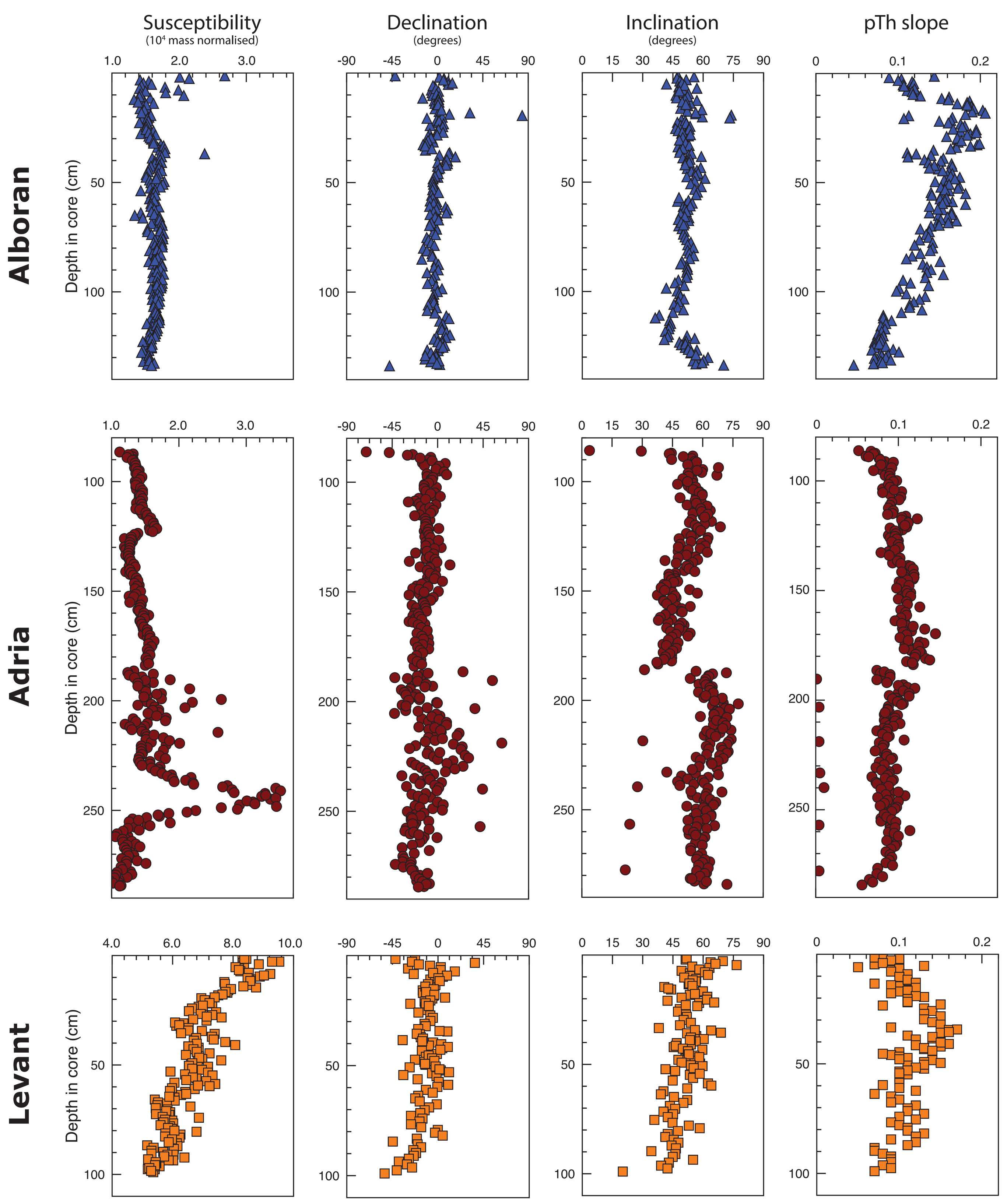

Figure 3. The magnetic susceptibility in the Alboran (blue triangles) and Adria (red dots) sediments are quite similar and constant. For the central Adria core, a peak in magnetic susceptibility occurs around a depth of 245 cm, this may be produced by larger and smaller eruptions of the Ischia, Etna, and Vesuvius volcanos. The magnetic susceptibility for the Levant (orange squares) sediments implying a higher concentration of ferromagnetic minerals. The magnetic susceptibility reveals a gradual decrease of 35% over the entire core length, and the variation in susceptibility is higher than for the other two cores. Since the decrease in the susceptibility signal gradually changes over depth this has no further consequence for the intensity experiments. The overall magnetic susceptibility data indicates that for all three cores; Alboran, Adria and Levant, enough magnetic material, i.e. ferromagnetic minerals, are present and hence they are suitable for intensity experiments.

With latitudes of 32° to 39° the expected inclination for the three cores assuming a geocentral axial dipole is 51-58°. The long-term average for the three cores is within this range. The only notable exception is the lower part of the Adria core, which shows inclinations up to 70°.

Conclusions

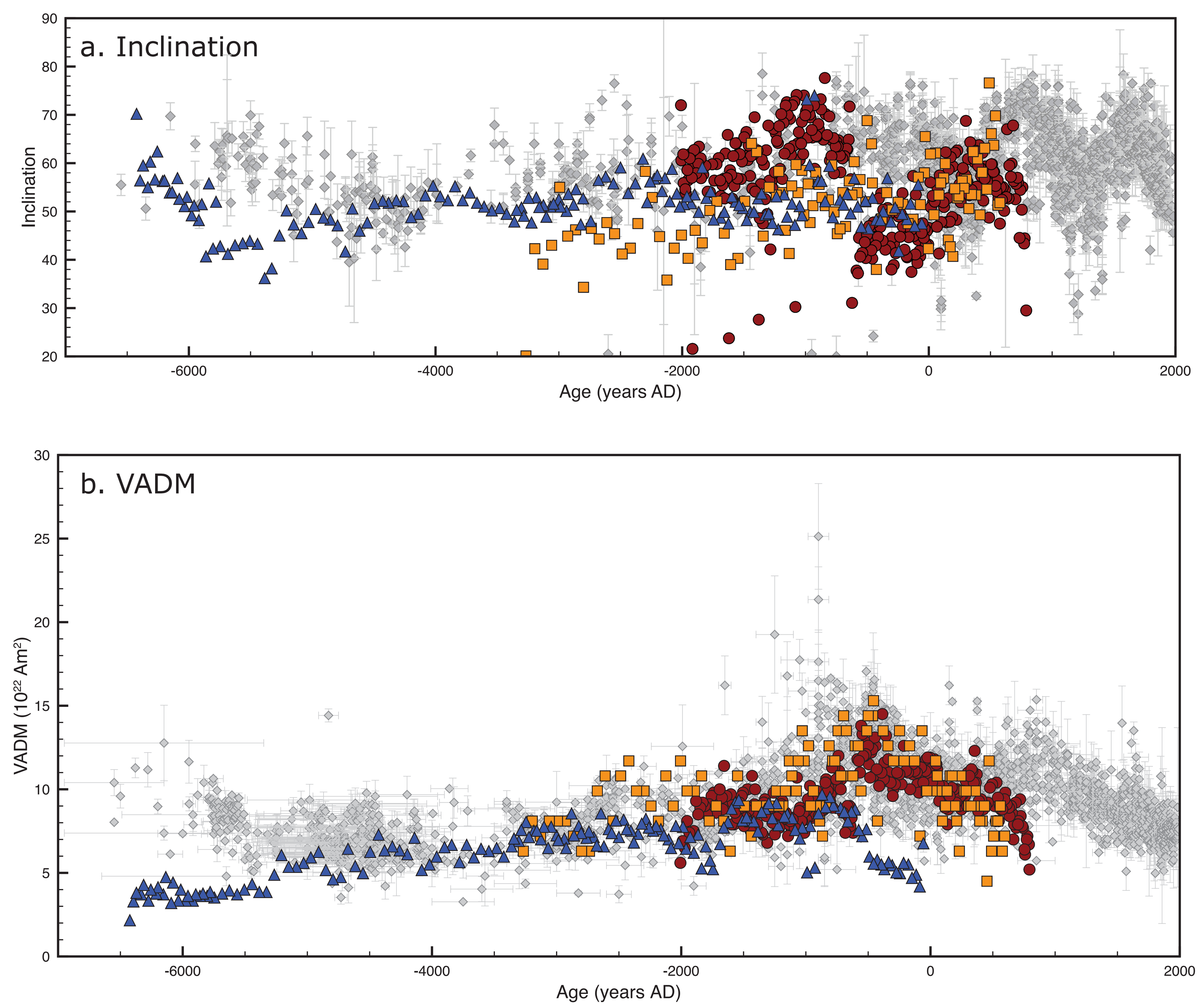

Figure 4. Continues geomagnetic record for the Mediterranean. For both pannels Alboran - blue triangles; Adria - red dots; Levant - orange squares; GEOMAGIA data - gray diamonds

Archeological and volcanic absolute intensity data from GEOMAGIA are used to calibrate our relative intensity data to virtual axial dipole moments (VADMs). The high paleointensities we find all are younger than the short-lived, high-fidelity peaks present in the Levant (1.0 - 0.7 BCE). The obtained intensity record from our cores, however, does perfectly align with overall trend in the data from the Middle East and the GEOMAGIA archeomagnetic database. The obtained data establishes a more robust and continuous intensity record for the region. The short-lived peaks known as the 'Levant geomagnetic high' are, apparently, to short to be captured in our sediments.

The obtained inclination record further constrains the geomagnetic high in time and space. Furthermore the high paleointensities seem to coincide with periods of shallow inclination, a counterintuitive observation if the high paleointensities are to be explained by a dipolar phenomenon.