A 130,000-year record of Levantine Intermediate Water flow variability in the Corsica Trough, western Mediterranean Sea

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Abstract: *We present here the first record of the inflow, ventilation and vertical fluctuations of the Levantine Intermediate Water (LIW) for the last 130,000 years.*

Key words: *Levantine Intermediate Water, western Mediterranean Sea, past climate changes.*

BACKGROUND

The Mediterranean outflow water (MOW) dynamics, at the geological timescale, is controlled by the integrated evaporative balance of the Mediterranean Sea, itself resulting from the complex interplay between climate and sea-level changes (Rogerson et al., 2013). This controls the variability of the MOW sources from the eastern and western basins: the Winter Intermediate Water (WIW, <200m water depth, mwd) and the Western Mediterranean Deep Water (WMDW, ca 600-1000 to 3000mwd) formed in the Ligurian-Provençal Basin and the Gulf of Lion (western Mediterranean), the Levantine Intermediate Water (LIW, ca 200 to 600-1000mwd) originating from the eastern Mediterranean and entering the western Mediterranean through the Sicilian Channel, and the Tyrrhenian Dense Water (TDW) that enters between LIW and WMDW (Millot, 1999). Although the MOW (e.g. Voelker et al., 2006) and the WMDW variability (e.g. Cacho et al., 2000) have been intensively studied through the last climatic cycle, very little is known about the dynamics of the Mediterranean intermediate waters. This is particularly true for the LIW, which contributes up to 80% to the Mediterranean outflow volume. Therefore, the reconstruction of the dynamics of this water mass is crucial to the evaluation of the impact of the Mediterranean thermohaline circulation on the outflow. We precisely bridge this gap by reconstructing LIW dynamics in the western Mediterranean Sea over the last climate cycle.

DATA

This study is based on the analysis of the Calypso long piston cores MD01-2434 (42°22.51'N/9°47.04'W; 780mwd; 24.9m long) and MD01-2472 (42°36.42N'/ 9°43.97'W; 501mwd; 29.1m long) collected on the lower continental slope of the east Corsica margin during the MD123-Geosciences 1 and MD124-Geosciences 2 cruises of the R/V Marion Dufresne II (IPEV) (Fig. 1). The cores were sampled for grain-size (2.5-10cm intervals, according to the sedimentary facies) and stable isotope measurements (using benthic and planktic foraminifers; 10 and 20cm intervals in core MD01-2472 and MD01-2434, respectively) and radiocarbon dating.

RESULTS AND CONCLUSIONS

Sedimentological and geochemical profiles from western Mediterranean deep-sea sediment cores MD01-2434 and MD01-2472 provide a continuous high-resolution climatic and paleoceanographic record in the Corsica Trough, northern Tyrrhenian Sea, for the last 130,000 years (Toucanne et al., 2012). The inflow, ventilation and vertical fluctuations of the LIW has been reconstructed using sortable silt particle-size data and benthic foraminifer stable isotope analyses. The results reveal that climate changes drove the Mediterranean intermediate circulation on Milankovitch to millennial time-scales according to a cold/faster (and well-ventilated) - warm/slower (and poorly ventilated) pattern consistent with the present-day response of the LIW to seasonal oscillations (Fig. 1). These changes are accompanied at the Milankovitch time-scale by large density-driven fluctuations of the LIW axis, with deepening/shoaling of the LIW axis occurring at time of climate degradation/amelioration, respectively. It is assumed that this variability, both in ventilation and position, reflects the changes of the eastern Mediterranean net evaporation, as well as the propagation to the western Mediterranean of the profound hydrographic adjustments in the Levantine Sea caused by climate forcing. Significant attendant hydrographic adjustments in the deep Ligurian-Provencal Basin and in the Gulf of Cadiz, downstream of the Corsica Trough by considering the genetic relationship existing between the LIW, the WMDW and the MOW, emphasise the LIW imprint on both the WMDW properties and the Mediterranean-Atlantic exchange. This first palaeoceanographic reconstruction of the intermediate water inflow and ventilation in the western Mediterranean almost certainly provides an additional constraint on the role of the eastern Mediterranean hydrographic changes to the whole Mediterranean thermohaline circulation, as well as for

the Atlantic Meridional Overturning Circulation and past climate changes.

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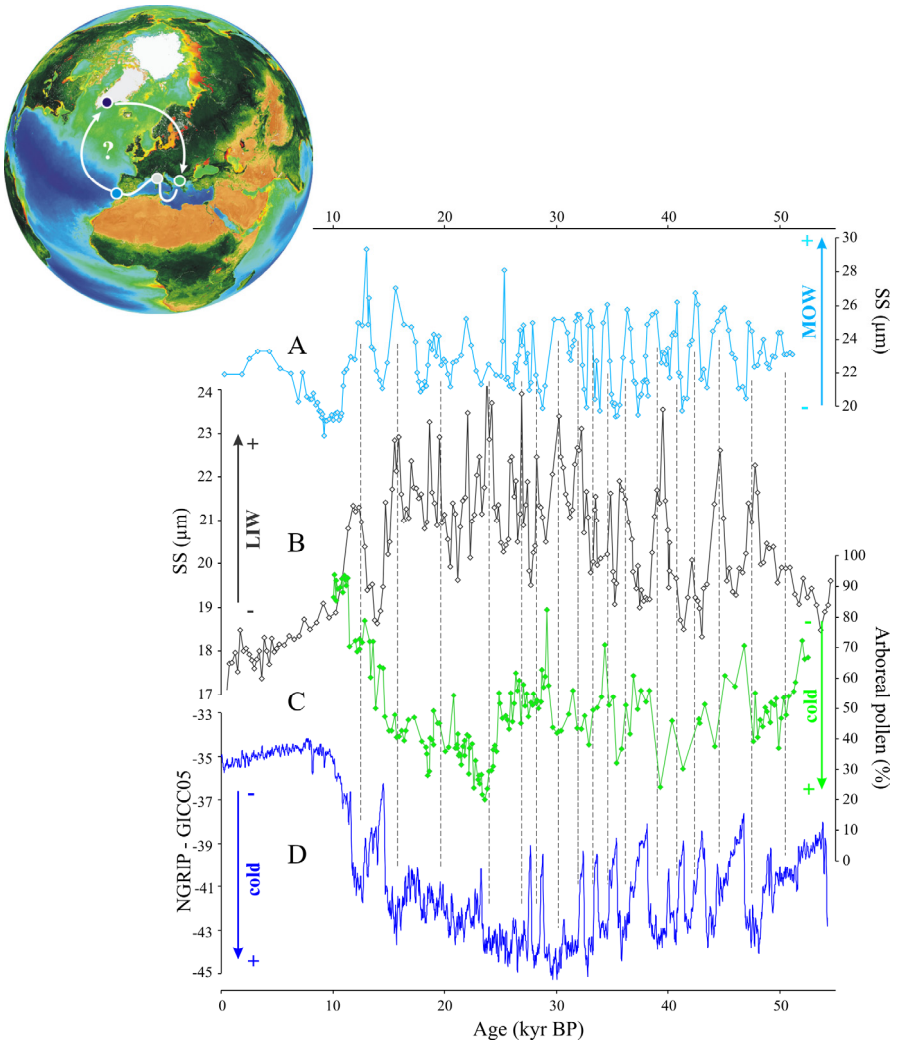

FIGURE 1. (A) Downcore grain-size record (sortable silt, SS) of core MD99-2341 (Gulf of Cadiz) (Toucanne et al., 2007); (B) Downcore grain-size record SS of core MD01-2434 (Corsica Trough) (Toucanne et al., 2012); (C) The pollen percentages of arboral pollen of core I-284 from Lake Ioannina in western Greece (Tzedakis et al., 2004); (D) NGRIP $\delta^{18}O$ (GICC05 chronology; Svensson et al., 2008).