MEDITERRANEAN OUTFLOW CONDITIONS DURING THE EARLY TO MIDDLE PLEISTOCENE LINKED TO PRECESSION FORCING

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Abstract

The Mediterranean Outflow Water (MOW) is an important intermediate depth water mass in the North Atlantic. Here we reconstruct changes in the MOW during the early Pleistocene interval from 630 to 1760 ky, encompassing the Mid-Pleistocene Transition (MPT), which marks an important change in orbital climate forcing. Neither MOW ventilation nor MOW flow strength reveal changes related to the MPT, but incorporate variations related to precession (insolation) forcing. The MPT related change to higher glacial benthic δ^{18}O values occurs earlier at Site U1387 than in most deep-sea records, i.e. with MIS 26 instead of the MIS 24 to MIS 22 interval.

Keywords: Paleoceanography, Gulf of Cadiz, Foraminifera, Stable isotopes

The Mediterranean Outflow Water (MOW) forms contourite drift deposits along the Iberian margin, especially in the Gulf of Cadiz, and injects heat and salt into the North Atlantic affecting the overturning circulation. We studied sediments from IODP Site U1387 (36.8°N, 7.7°W; 559 m water depth), drilled into the Faro contourite drift during Integrated Ocean Drilling Program (IODP) Exp. 339 – Mediterranean Outflow, to evaluate MOW conditions during the middle to early Pleistocene period of Marine Isotope Stage (MIS) 16 to MIS 61 (630-1760 ky). We base our observations on centennial-scale δ^{18}O and δ^{13}C records of epibenthic foraminifera (*Cibicidoides pachyderma, Planulina ariminensis*) and the weight percent of the sand fraction >63µm (Fig. 1). Higher weight percentages of the sand fraction indicate contourite layers formed by a faster flowing bottom current, namely the MOW. Whereas the benthic δ^{18}O signal combines changes in water temperature and salinity and global sea level/ice volume, the benthic δ^{13}C data reveal the level of ventilation with lower values indicating a poorly ventilated (and thus low oxygenated) water mass.

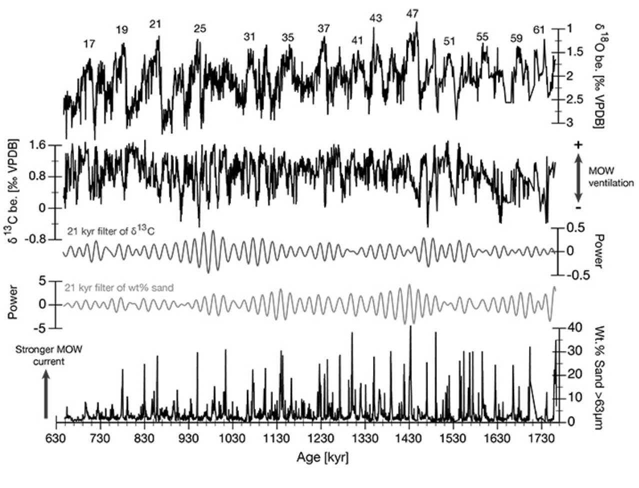

Fig. 1. Paleoclimate records of IODP Site U1387 reflecting changes in MOW conditions. From top to bottom: benthic foraminifera δ^{18}O with numbers above marking Marine Isotope Stages; benthic foraminifera δ^{13}C data with lower values indicating a poorly ventilated MOW; filter for precession frequency of benthic δ^{13}C; filter for precession frequency of the weight percent of the sand fraction >63µm; weight percent of the sand fraction >63µm with maxima representing contourite layers.

A previous study on a shorter U1387 section [1] showed that the benthic δ^{13}C variations are linked to insolation/precession with generally lower values/lesser ventilation related to insolation maxima (precession minima) and higher values/better ventilation to insolation minima (precession maxima). This pattern persisted throughout the longer period as well. The poorly ventilated MOW signal in the Gulf of Cadiz has been linked to Sapropel formation and thus reduced ventilation of Mediterranean Sea waters and thus higher precipitation caused by the African monsoon [1, 2]. The Site U1387 record indicates that the MOW experienced very poor ventilation during several interglacial periods of the early Pleistocene, such as MIS 23, MIS 25, MIS 27, MIS 31, MIS 47, MIS 57 or MIS 61. For most of them the higher amplitude of the precession-filtered benthic δ^{13}C record (Fig. 1) confirms the strong link to climate forcing by precession/insolation. Weight percent sand fraction values were low during these periods, pointing to a sluggish bottom current. On the other hand, contourite layers, related to a faster flowing MOW, are formed in response to abrupt climate events and sometimes also during/following periods of lower insolation (e.g. glacial inception) [1, 2]. The weight percent sand/contourite layer record, nevertheless, contains variations related to precession forcing as indicated by the higher amplitudes in the filtered record, in particular in the interval from MIS 32 to MIS 35 and from MIS 43 to MIS 48 (Fig. 1).

Although both MOW ventilation and flow strength reveal changes related to precession forcing, neither of them shows a clear shifts linked to the Mid-Pleistocene Transition. The change to higher glacial benthic δ^{18}O values, on the other hand, occurs earlier at Site U1387 than in most deep-sea records, i.e. with MIS 26 instead of the MIS 24 to MIS 22 interval that usually marks the Mid-Pleistocene Transition shift [3].

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References

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