RECENT WARMING OF DEEP SEA SEDIMENTS IN THE EASTERN MEDITERRANEAN

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Abstract

Marine geothermal data, collected in 1993 and 1994 during three cruises of the MEDRIFF project along a 300 km SW-NE oriented transect traversing the Mediterranean Ridge accretionary complex, are used to deduce recent changes in bottom water temperatures in the Eastern Mediterranean. About 130 temperature profiles in the sediments showed decreasing temperatures from the seafloor down to 3 to 6 meters depth, indicating transient temperature regimes. Modelling the conductive heat propagation into the sediments suggests a warm deep water intrusion that started to propagate from the Hellenic Trench in summer 1992 and reached the Mediterranean Ridge crest in late 1992-early 1993.

Key-words : Ionian Sea, deep waters, deep sea sediments, temperature, global change

Introduction

We present a novel application of heat flow (HF) measurements in deep sea sediments to reconstruct temporal changes in the bottom water hydrography. We use temperature profiles in the sediment, integrated by CTD profiles in the water column, to document the recent intrusion of dense and warm water masses in the deep Eastern Mediterranean [1,2]. The data, collected from September 1993 to May 1994, record the variability of the thermal structure of the deep water masses and indicate transient thermal regimes, at week, month and interannual time-scales [3]. A regional transect (Fig.1) of closely spaced HF measurements was performed during three oceanographic cruises within the MEDRIFF project (An Integrated Investigation of the Fluid-Flow Regime of the Mediterranean Ridge). The purpose was to identify areas of anomalous HF that could be interpreted as possible sites for fluid outflow from the Mediterranean Ridge (MR) accretionary complex [4]. Instead, a completely different scenario was encountered: temperature profiles in the sediments showed strong negative thermal gradients just below the seafloor, with temperature minima at depths ranging between 3 and 6 m below sea-bottom [5]. Moreover, the temperature profiles in sediments had modified in the few months of time elapsed between cruises.

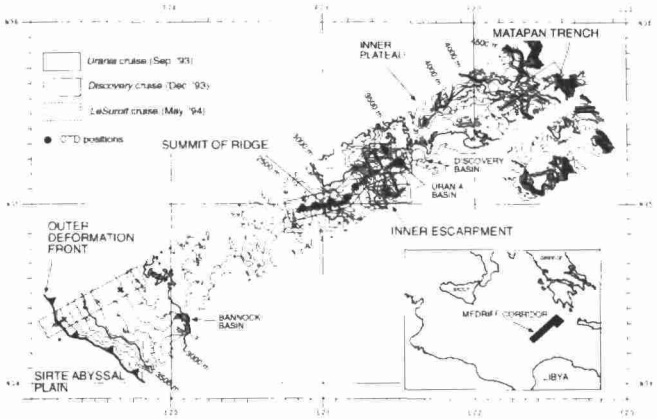

Fig.1. Simplified multibeam bathymetry of the MEDRIFF survey corridor in the eastern Mediterranean, showing the major features of the morphology of the ridge and the CTD and HF measurements collected during the MEDRIFF cruises.

MEDRIFF data set

During the *Urania* cruise (Sept. 1993), 80 HF measurements were acquired in the NE portion of the MEDRIFF corridor (Fig. 1), from the Matapan Trench (nearly 4600 m water depth) to the MR crest (about 2400 m water depth). The upper 5-6 m of sediment were found colder than the overlying bottom-water (Fig. 2), with temperature profiles mostly upward convex or with highly variable temperature gradients, including zero gradient. Seventeen other HF acquisitions, collected on the ridge crest during the *Discovery* cruise (Dec. 1993 - Jan. 1994), confirmed the anomalous thermal structure of the sea-bottom sediments.

During the *Le Suroit* cruise (May 1994), seventeen HF measurements were performed at the SW end of the corridor, on the outer deformation front of the MR. In this area, temperature profiles in sediments are normal, with values increasing with depth.

Seven CTD profiles from sea surface to seafloor, collected along the MR transect from the crestal area to the Inner Plateau (Fig. 1), show the highest values of temperature and salinity, below 1800 m, at the sea bottom. This means that the deep waters of the investigated area are warmer and denser than the overlying seawater.

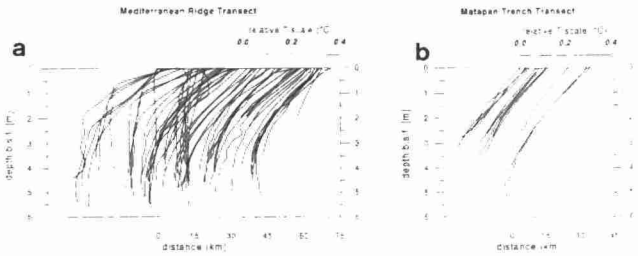

Fig.2 - Temperature distribution in the few upper meters of sediment along the MR transect (a) and Matapan Trench transect (b), collected during the Urania cruise. The location of each measurement along the transect is given by the position of the temperature profile at zero depth.

2-D thermal distribution in sediments and bottom-water

The 2-D distribution of potential temperature in shallow sediments of the MEDRIFF Corridor closely matches that in bottom-water (Fig. 3). The lowest bottom-water temperatures are on the Ridge crestal area (13.4 °C), whereas a progressive increase occurs toward NE, with 13.75 °C on the Inner Plateau and an estimated temperature of 13.95 °C in the deep Matapan Trench. As in the water column, the lowest sediment temperature are found on the crestal area (minima < 13.4 °C and thermal gradients close to zero).

Moving toward NE, temperature gradients in the sediments show increasing negative values, with minimum temperature observed deeper and deeper. In the Matapan Trench, thermal gradients are strongly negative and the minimum temperature is predicted at about 6 m depth or more. The thermal structure of the sediments clearly indicates unsteady-state heat transfer between the water column and the seafloor sediment. We propose that an increase of bottom-water temperature is transferring heat conductively into the seafloor.

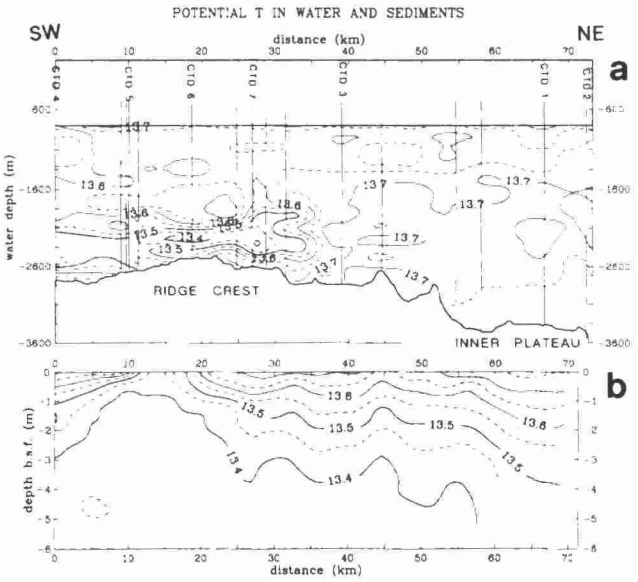

Fig.3 - Composite vertical section showing the contoured potential temperature (°C) distribution with depth in the water mass (a) and in the upper few meters of sediment (b) from the MR crestal area to the Inner Plateau (central three-segment profile in Fig. 1). CTD profiles and intercalibrated HF probe thermistor data were used in the seawater and thermistor data only, in the sediment.