TIME SERIES OF WATER PRESSURE AND BOTTOM TEMPERATURE IN A MARINE SHALLOW WATER HYDROTHERMAL VENT OF MILOS ISLAND (AEGEAN VOLCANIC ARC): PRELIMINARY RESULTS

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Abstract

Time series of measurements of water pressure and temperature were obtained from submarine hydrothermal vents off Milos Island (Aegean Sea). The presence of diurnal and semidiurnal frequencies of tidal origin were found in the temperature. The influence of water pressure on vent temperature is evident and the presence of other unknown and unpredictable factors superimposing tide during some periods is shown.

Key-words : thermal vents, sea level, temperature, time series, Aegean sea

Introduction

The venting of hot fluids from the seafloor is best known from the mid-ocean ridges. Many sites, however, are also known from shallow waters, especially along volcanic arcs, where the venting can have a marked influence on coastal waters (1, 2, 3, 4, 5, 6). Venting in shallow water produces large volumes of free gas (gasohydrothermal vents), both because of the lower solubility of the gases at low pressure, degassing of the subducted crust under the volcanic arcs and the breakdown of sedimented marine carbonates at high temperature. In shallow water much of this gas (largely carbon dioxide) is released directly to the atmosphere making flux calculations difficult.

Time series of venting periodicities are required in order to calculate long term fluxes from short term flow measurements. Temperature is the main parameter measured in long term studies due to its ease of measurement and to the sensor stability in corrosive environments. Knowledge of the variations in water temperature is important both in determining the distribution of vent biota (7, 8) and in following the dilution of hydrothermal water with seawater (9).

Temperature time series at deep vents have shown diurnal and semidiurnal frequencies which have been explained in terms of tidal cycles (10, 11). Short term time series relating venting periodicity to tidal changes have also been reported at Santorini (12) and Milos (13) in the Aegean Sea and Capo Palinuro in the Tyrrhenian Sea (14).

In this study, standard spectral analysis is used to investigate whether the temperature changes at a shallow hydrothermal vent off Milos (Fig.1) can be explained by tidal fluctuations.

Sea level in the Northeast Mediterranean basin was studied by Lascaratos & Gacic (15) and Yüce & Alpair (16) but the only measurements of sea level on Milos available at present are from Tsimplis and Vlahakis (17) that compared level data from a sea level meter positioned in the island of Siros with meteorological data from Milos, assuming that distance between two islands was not very far. Previous studies on hydrothermal activity in Milos were performed by Dando *et al.* (5), Fitzsimons *et al.* (13) but long term data of temperatures were not reported and start was not synchronised with sea level meters.

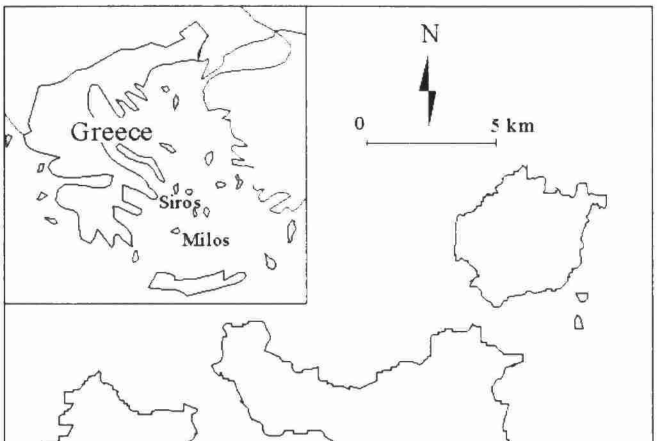

Fig. 1. Milos Island and the Aegean Sea.

Methods

Pressure data was collected from 28 June to 19 September 1996 using Aanderaa WLR7 depth gauges positioned on the sea bed in Paleochori Bay (Milos Island). This was compared to temperature data collected during the same period by a Venco Minilog temperature logger. The pressure sensors were calibrated and checked in the factory, a sampling interval of 30 minutes was used for all instruments. The temperature logger was placed at 5 cm sediment depth close to a vent outlet in 7 m water depth off Paleochori, Milos.

Time series were synchronised and spectral analysis was performed by Fast Fourier transformation on the sea level and temperature data sets. The average and trend were deleted from the series and power spectra were calculated by the autocovariance method. The software was developed from IMSL libraries of the VMS system.

Results

The bottom pressure oscillations were small in amplitude with a maximum of 1636.86 hPa and a minimum 1612.48; mean 1623.39, standard deviation 4.013 hPa. The plot of bottom pressure against time is shown in Fig. 2. The components of atmospheric pressure were not separated from the water pressure because they both contribute to the value of the bottom pressure and the contribution of every external pressure forcing was therefore included.

The plot of temperature vs time (Fig. 2) showed some large changes from a maximum temperature of 86.45 °C to a minimum of 24.06 °C with two large decreases in temperature. The reason of these fluctuations is still unknown but we can reject a lost of calibration because sensors worked well during post deployment checks. Such abrupt temperature falls could be caused by removal of overlaying sand, but no marked change in sensor burial depth was noted in logger retrieval. The pressure data did not show changes corresponding to the abrupt drops in temperature.

The time series were separated into three main periods (A,B,C) according to the temperature. Periods A and B presented similar trends (standard deviation 1.66 and 2.04). A greater variability in temperature was found during period C (standard deviation 4.5).

A comparison of the daily data of pressure and temperature from June 29 to July 1 (with no filtration and a sampling interval of 30 minutes) clearly indicated that a maximum in pressure corresponded to a minimum in vent temperature (Fig. 3).

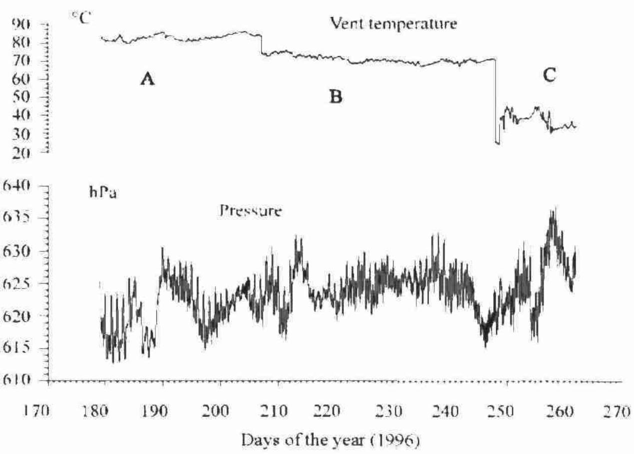

Fig. 2 : Plot of pressure and temperature. Three distinct periods are evidenced in the temperature series.