COMPOSITION OF HYDROCARBON GASES, ORGANIC MATTER, AND AUTHIGENIC MINERALS FROM SEABED SEDIMENTS, UNITED NATIONS RISE, EASTERN MEDITERRANEAN RIDGE

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Abstract

The United Nations Rise is the newly discovered in the Eastern Mediterranean Ridge area of mud volcanism and gas venting. Two recent and several dormant mud volcanoes were found within the Rise [1]. This paper presents the geochemical study results which outline general regularities in distribution of hydrocarbon gas and organic matter (OM), and also determine their role in autigenic mineral assemblage forming. The detailed study of the cores taken from fault zone and mud volcanoes allowed for revealing the connection of hydrocarbon gas and OM with inflow from deep sources. Abundance of high-Mg calcite and dolomite in all these cores is also evident for that.

Key-words : mud volcanoes, geochemistry, Mediterranean Ridge

Introduction

This work is based on the materials obtained in 1995 on 5th UNESCO-IOC Training-Through-Research Cruise of R/V *Professor Logachev*. During this cruise, a large new area of mud volcanism and gas venting was discovered and named the United Nations Rise. Two recent mud volcanoes (Dublin and Stoke-on-Trent) were found at the southern boundary of the Rise (southern boundary of the Deformation Front), and several dormant mud volcanoes were observed onward the Deformation Front [1]. During the cruise, a comprehensive geological and geophysical investigation was carried out. It included single channel seismic profiling, swath survey with a long-range and a deep-towed sidescan sonars, as well as bottom sampling with gravity corers and a TV-controlled grab-sampler. A system of underwater navigation for the precise positioning of the outboard devices was in use. The ship navigation was fulfilled with the GPS NAVSTAR and an underwater navigation was based on the Sigma-1001 hydroacoustic system [2].

Methods

The routine analysis of the gas phase in sediments was executed on the ship board (176 samples from 20 cores). The standard methods of sampling, degassing of sampled sediments and chromatographic analysis were applied. The degassing was accomplished according to the Head-space analysis [2]. Afterwards, the collected samples were studied in Moscow State University, in Shirshov Institute of Oceanology, and in Mendeleev Institute of Geochemistry and Analytic Chemistry, Russian Academia of Science. Bottom sediments were investigated by the following set of methods: fluorescent analysis (107 samples from 10 cores); determination of total organic carbon (TOC) content (86 samples from 10 cores); solvent extraction by chloroform (36 samples from 6 cores); gas-liquid chromatography (15 samples from 5 cores); isotopic analysis $\delta^{13}C(CH_4)$ (2 samples from 2 cores) [3]; microscopic study in thin sections of the authigenic minerals (23 samples from 13 cores); powder test by X-ray method with Co-target in the limited interval of the Bragg angles (25.04Θ-55.04Θ) (23 samples from 13 cores); isotopic analysis of $\delta^{13}C(CaCO_3)$ and $\delta^{18}O(CaCO_3)$ on the Varian-MAT-230 (4 samples from 3 cores).

Results and discussion

The results of the complex geochemical analyses allowed for choosing 4 most representative cores taken from zones of different environments: Core 166G located far from gas seeps and recovered normal undisturbed pelagic sediments (was used as a reference); Core 169G located close to a fault observed on the long-range sonograph; Cores 172G and 178 G taken from the Dublin and Stoke-on-Trent mud volcanoes [2] (fig. 1).

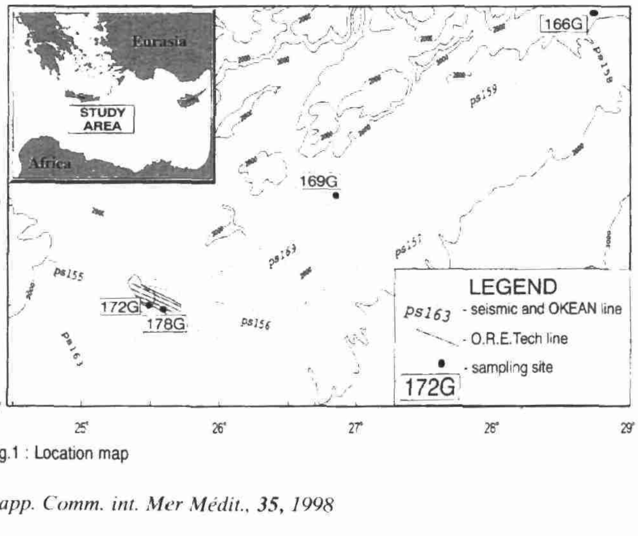

Fig.1 : Location map

Gas measurements show that the reference core generally has a very low level of gas concentrations ($0.1x10^{-4}$ - $38x10^{-4}$ ml/l) [3]. TOC content in the core varies from 0.04% till 6.06%. The main peaks of hydrocarbon gases and TOC associate with sapropel layers S1 and S5, which might be caused by good sorption capacity and higher content of organic matter (OM) normal for sapropels. Methane and TOC contents relates to each other and are almost completely controlled by lithology (fig. 2). Thus, taking into account the process of anaerobic destruction of OM in sediments, which results in methane formation, one may assume that methane there has been formed *in situ*. The extractable organic matter (EOM) composition shows that the EOM from the reference core is immature, with predominance of matter of marine genesis, partially biodegraded. The observed predominance of wax and asphaltenes among the bitumoids is also normal for recent sediments. In opposite, cores taken from the active zones are characterized by higher concentrations of hydrocarbon gases and unusual composition of EOM.

In Core 169G (fault zone), concentrations of hydrocarbon gases are 10000 times higher then in Core 166G (fig. 3). The methane concentrations increase with the depth up to 4 ml/l at 4 m, while saturated hydrocarbons predominate over those unsaturated and iC_4 predominates over nC_4. Core 178G (Stok-on-Trent mud volcano) is characterized by methane concentrations of $11.4x10^{-4}$ - $217x10^{-4}$ ml/l, with significant content of its homologues and almost complete absence of unsaturated hydrocarbon gases (fig. 4). Isotopic composition of methane δ13C from this core is about -55‰. The composition of hydrocarbon gases is similar to that for gas from the fault zone (169G) [3]. All this might indicate mixed nature of methane from the Stoke-on-Trent mud volcano (178G). In Core 172G (Dublin mud volcano), concentrations of methane vary from $7.7x10^{-4}$ ml/l to $10x10^{-4}$ ml/l increasing with the depth.

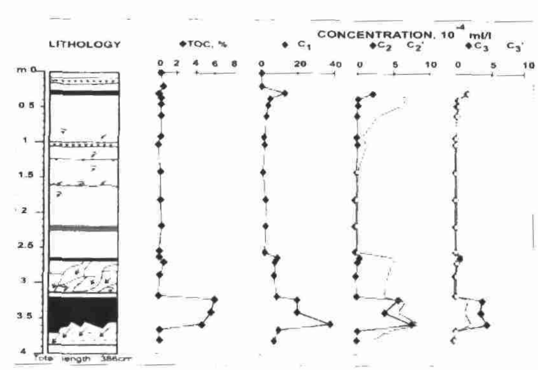

Fig.2
Distribution of hydrocarbon gases and TOC along Core 166G

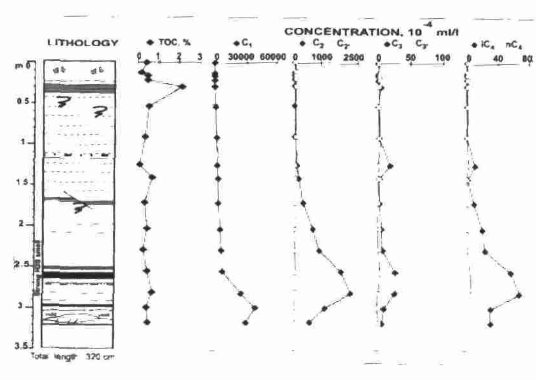

Fig.3
Distribution of hydrocarbon gases and TOC along Core 169G