New information concerning clay mineral provenance in mud volcanoes

T. A. C. Zitter[(1)]*, S. J. Van der Gaast [(2)], J. M. Woodside[(1)]
(1) Vrije Universiteit, De Boelelaan, 1085, 1081HV Amsterdam, The Netherlands, zitt@geo.vu.nl, wooj@geo.vu.nl
(2) NIOZ, postbus 59, 1790AB Den Burg, Texel, The Netherlands, gaast@nioz.nl

Abstract:
X ray-powder diffraction (XRD) analyses were conducted on matrix mud breccia samples from the MEDINETH expedition to the eastern Mediterranean mud volcano fields. The clay assemblage is dominated by high abundance of expanding clay minerals (smectite). The relative abundance of clay minerals reflects different sources of the original material: more from sources in Africa for the Olimpi area and from Turkey and Cyprus for the Anaximander and Florence areas. No evidence of deep burial diagenesis has been found.

Keywords: Eastern Mediterranean, Mud volcanoes, Clay mineralogy

Introduction:
In the Eastern Mediterranean Sea, several areas of mud volcanism were surveyed in 1999 during the MEDINETH expedition, conducted on board R/V Professor Logachev, which provides more than fifty cores. XRD analysis of the < 2µm-size fraction of the matrix sample from several mud volcanoes and from an hemipelagic core, were carried out at different percentages of relative humidity (0-50-100%) in order to identify expanding clay minerals in the complex mixture. Carbonates were removed and an internal standard was added. Analysed samples came from three different areas (Fig. 1): the Olimpi field, a well-known mud volcanic field on the top of the central Mediterranean Ridge [1], the Anaximander Mountains, rifted blocks from Turkey [2] and the Florence Rise, west of Cyprus, a newly discovered mud volcanism area [3].

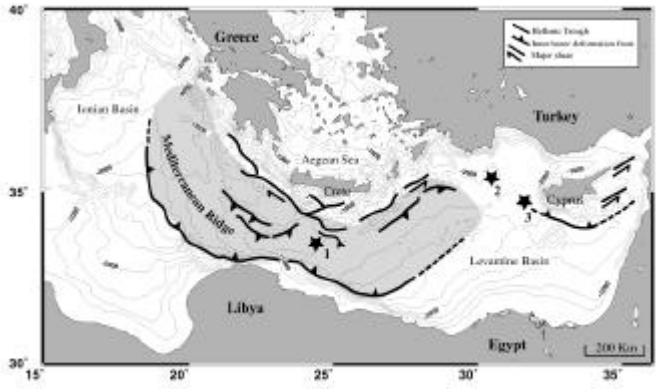

Fig.1: Main structures of Eastern Mediterranean Sea and location of surveyed area (stars), 1: Olimpi field, 2: Anaximander Mountains, and 3: Florence Rise.

Results:
All the samples show a similar clay assemblage, suggesting more a detrital origin of clay minerals than real diagenesis during burial and/or during the eruptive process of the mud volcanoes. The clay assemblage is largely dominated by an expanding type of clay mineral, smectite. Clay minerals from the kaolin group (kaolinite and hallyosite) and the palygorskite group are also found in significant abundance. Minor occurrence was observed for primary chlorite and illite. In non-mud volcanic areas of the Eastern Mediterranean Sea, this type of smectite-rich assemblage is found mainly in Messinian

deposits [4]. This could suggest a Messinian source for these mud breccia matrix sediments. Other origins could be detrital input from Africa or, especially for the Anaximander and Florence Rise areas, inherited from Cyprus and Turkey ophiolitic complexes. This high abundance of smectite, and minor illite content, indicates that no burial diagenesis transformation (from smectite into illite) has taken place in these sediments, supporting a shallow source for the matrix. This is in accord with clay mineral results from ODP core samples on Napoli and Milano mud volcanoes (Olimpi area) [5].

The relative abundance of clay minerals, however, shows significant differences from one area to another. Kaolin group minerals (kaolinite and hallyosite) are more abundant in the Olimpi field than in the Anaximander /Florence area (Fig. 2). It could either reflect a difference of source of the original material or alteration processes, but the latter is less probable. Palygorskite is also a quite abundant mineral in the Olimpi area, but absent from the Anaximander and Florence Rise samples. Both these clay minerals are inferred to have originated from Africa, especially palygorskite, suggesting aeolian input from a desert environment. This observation is consistent with the location of these mud volcanic fields: the Olimpi area, on the top of the Mediterranean Ridge, mainly composed of Nile-derived sediments, and the Anaximander Mountains showing a clear affiliation with Turkey units.

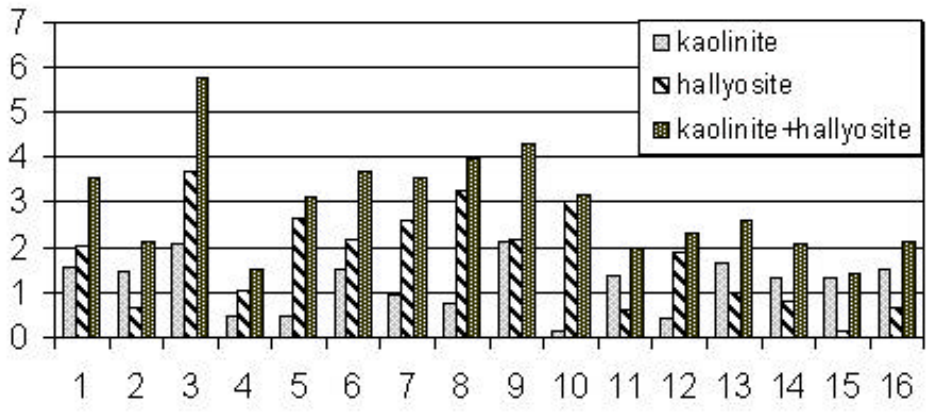

Fig. 2: Standardized abundance for kaolin group minerals (ratio of the mineral peak area on the internal standard peak area) in the different samples. Numbers refer to samples in Olimpi field: Milano mud volcano (1), Napoli mud volcano (2,3,4), Moscow mud volcano (5,6,7,8,9,10), in the Anaximander area: Amsterdam mud volcano (11,12) Kazan mud volcano (13), and in the Florence Rise area: Texel mud volcano (14,15); (16) is an hemipelagic core from the Florence Rise area.

References:

1. Cita, M.B., *et al.*, 1989. Discovery of Mud diapirism on Mediterranean Ridge.A preliminary report. *Boll. Soc. Geol. It.*, 108, 537-543.
2. Woodside, J.M., M.K. Ivanov, and A.F. Limonov, 1997. Neotectonics and fluid flow through seafloor sediments in the Eastern Mediterranean and Black Seas - Part I. *IOC Technical series,* 48 (UNESCO 1997), 128 p.
3. Woodside, J.M., J. Mascle, T.A.C. Zitter, A.F. Limonov, M. Ergun, and A. Volkonskaia, 2000. The Florence Rise, the Western Bend of the Cyprus Arc. *Marine Geology (submitted)* .
4. Chamley, H., G. Dunoyer-de-Segonzac, and F. Melieres, 1978. Clay minerals in Messinian sediments of the Mediterranean Sea. DSDP, 42, 389-395.
5. Jurado-Rodriguez, M.J. and F. Martinez-Ruiz, 1998. Some clues about the Napoli and Milano mud volcanoes from an integrated log-core approach. *in:* . Proc. of the ODP, Scientific Results, A.H.F. Robertson, K.C. Emeis, C. Richter, and A. Camerlenghi. (eds), 160, 607-624.