PHYSICAL PROPERTIES AND THEIR RELATIONSHIP TO TEXTURE AND CONSOLIDATION EFFECTS IN SEDIMENTS FROM MUD VOLCANOES IN THE ANAXIMANDER MOUNTAINS (EASTERN MEDITERRANEAN)

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Abstract

This research is focussed on the mud volcanoes Amsterdam, Kazan and Kula located in Anaximander Mountains. These volcanoes, characterized by the presence of sediments containing gas and gas hydrate, have been sampled, recovering four gravity cores. For those sediment located inside the mud volcanoes the physical properties are controlled by lithology and volcanic processes rather than degree of compaction. This could suggest the possible present volcanic activity. Contrasting, the core located outside the Kula mud volcano displays physical properties mostly related to consolidation effects and to the type of sediment at a detailed scale, as it occurs typically in deep sea fine grained sediments. This suggests a restricted influence of volcanic processes outside the crater.

Keywords: Mud volcano, Gas Hydrate, Physical properties, Texture, Consolidation.

Physical properties of marine sediments are important variables to understand geological events of marine environments. Several studies have been conducted to examine the relationship between physical and sedimentological parameters of marine sediments (1-4). The aim of this work is to determine the effects of sedimentologic changes on the physical properties of sediments containing gas hydrate recovered on the Anaximander Mountains, offshore in the southwest Turkey. The research is focussed on the known mud volcanoes Amsterdam, Kazan and Kula, which are characterized by the presence of sediments containing gas and gas hydrate (5, 6). These volcanoes have been sampled recently with a gravity corer system, recovering four cores; An05GC1 in Amsterdam, An07GC4 in Kazan and An14GC1 and An13GC1 in Kula mud volcanoes.

The Anaximander Mountains are located in one of the most rapidly subsiding sections of the Mediterranean (7). At least, seven mud volcanoes have been identified in the area. The origin of these volcanoes is associated to the structural situation characterized by a compression zone that favours the expulsion of overpressured fluids at the surface. There are several acoustic evidences in the area suggesting the presence of gas in the sediments, such as acoustic turbidity, acoustic wipe-outs and pockmarks. Likewise, sediment containing interstitial free gas, gas hydrate, and carbonate crusts have been recovered on the volcanoes (5, 6).

The studied cores were analysed in order to know the physical (magnetic susceptibility, acoustic velocity, and bulk density) and index properties (e.g. water content, grain density, and shear strength), texture and composition of the types of sediments. The physical properties comprise continuous measurements with a multi sensor core logger, whereas the index properties and textural analysis were made on discrete samples.

Two different types of sediments have been defined, mud breccia and hemipelagic mud. Mud breccia is characterized by a high content of clay and silt ranging between 67-56 % and 19-30%, with percentage of sand and gravel of about 14 %. Hemipelagic mud is characterized by a high content of clay and silt and only a little percentage of sand (3%). The stratigraphy of cores An05GC1, An07GC4, An14GC1 comprises the vertical stacking of mud breccia, whereas the core An013GC1 is defined by mud breccia that toward the top passes to hemipelagic mud; the contact between both types of sediment is sharp.

Some differences between cores have been identified from the statistical correlation of the different studied parameters. For cores An05GC1, An07GC4, An14GC1 the physical properties are mainly controlled by lithology; in fact, only positive correlations between sand and density (R=0.47), and silt and density (R=0.69) have been observed. The physical properties of the core An013GC1 are mostly related to compactation (consolidation by overburden), but at detail scale shows variations related to variations in defined texture (hemipelagic mud versus mud breccia). In this sense, we have observed the following positive relationships: density and P-wave (R=0.47), sand and density (R=0.58), density and core depth of the sample (R=0.72), magnetic susceptibility and carbonate (R=0.73), and magnetic susceptibility and sand (R=-0.58).

Likewise, the statistical correlation indicates that carbonate content does not correlate with changes in porosity and grain density in the four cores. This may suggest that carbonate content does not show any particular effect on the physical properties of the sediments. Shear strength and water content have mostly a very low correlation to null with sample depth in the core. A negative correlation is observed between shear strength and water correlation in cores An07GC1 (R=0.79) and An13Gc1 (R=0.7). For the rest of the cores, the shear strength could be controlled by the effect of sediment fabric disruption resulting from the depressurisation after collection of samples containing gas hydrate and/or by changes in the cohesive forces developed in the clayey-rich sediment (8).

The stratigraphy and the above mentioned correlations suggest that for those sediment cores located inside the mud volcanoes (An05 GC1, An07GC4 and An14GC1) the physical properties are controlled by lithology and volcanic processes rather than degree of compaction. This could suggest recent fluid circulation, and then the possible present volcanic activity in the studied volcanoes. Contrasting, the core located outside the Kula mud volcano (An13GC1) displays physical properties mostly related to consolidation effects and to the type of sediment at a detailed scale, as it occurs typically in deep sea fine grained sediments. This suggests a restricted influence of volcanic processes outside the crater.

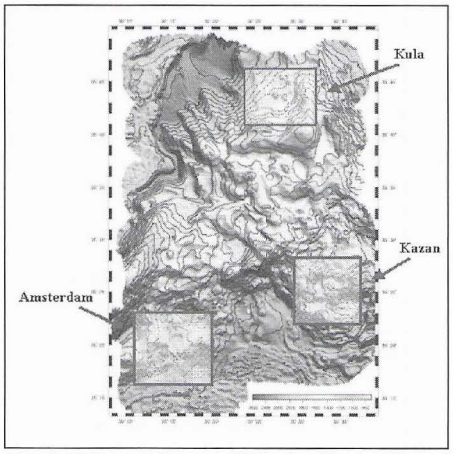

Fig. 1. Bathymetric map displaying the location of Amsterdam, Kazan and Kula mud volcanoes, in the southwest Turkey (eastern Mediterranean).

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