Geophysical Research Abstracts, Vol. 9, 10268, 2007
SRef-ID:

Natural gas hydrates in deep sea sediments: The effect of the host formation on pore pressure and on hydrate characteristics.

D. Marinakis and N. Varotsis

Department of Mineral Resources Engineering,Technical University of Crete, Greece (marinaki@mred.tuc.gr / Phone ++30-28210-37876).

Gas hydrates are crystalline compounds which can be formed when water or ice and suitably sized molecules are brought together under favorable conditions. Small sized molecules, such as the natural gas ones fit suitably in the hydrate lattice producing solid phase, which despite its resemblance to common ice, it contains substantial amounts of natural gas (1 m3 of gas hydrate can produce up to 175 Nm3 of natural gas). The pressure-temperature conditions for their formation depend mainly on the composition of the gas and of the water-rich phase. Conditions favorable for gas hydrate formation can be found in marine environments and in permafrost regions. Over 95% of the estimated gas hydrates globally are considered to be found below the seabed. While both single and multi component natural gas can be enclathrated in the hydrate phase in natural environments, the up-to-present research focuses primarily on single-gas-component hydrates. This may be appended both to the higher complexity of the thermodynamic behavior of the multi-component hydrates , as well as to the fact that most of the hydrates discovered so far were found either on the surface or at a depth of a few meters and were comprised of almost pure methane. Due to the high pressures that prevail in the deep sea environment, gas hydrates formed from natural gas mixtures are stable at much elevated temperatures than those found at much shallower water depths. As a consequence in such areas, the hydrate stability zone, i.e the subsea geological interval where gas hydrates can form, begins at greater formation depths and extends up to the seabed. A significant part of this zone lies at conditions so well inside the thermodynamic stability boundary for the formation of gas hydrates, that no free vapour phase could co-exist. The recent scientific interest in this part of the zone stems from the following reasons. Firstly, it remains still rather

unclear how the hydrates form in the natural environment in the absence of free vapour phase. Secondly, the latest evidence from exploration cruises at sites where hydrates have been found, indicates that this part of the zone bears a substantial portion of the total hydrate deposit. In this work, which is part of a wider project targeted to evaluate the formation of hydrates at natural subsea environment in the absence of any free vapour phase, experimental and simulation tests have been conducted in order to assess the thermodynamic characteristics and gas composition of hydrates located at the thermodynamically diphasic part of the hydrate zone. The behavior of the gas hydrates inside the marine sediments was experimentally simulated through a ternary gas mixture (C1 to C3) at conditions well inside the incipient hydrate formation region (20MPa and 12oC). The fractionation of the enclathrated gas components has been experimentally observed and measured during depressurisation of the hydrate deposit. Natural sediment, as well as berea sandstone and glass beads were used in order to simulate the effect of the host formation on the thermodynamic behaviour. The natural sediment was retrieved from the “Anaximander” mud volcanoes’ seabed, a deep sea area of the East Mediterranean, where gas hydrates were found during exploration cruises at an average depth of 2000 m below the sea level and at water temperatures of 12-14 oC. The host formation that was saturated to a specific hydrate content using the selected ternary gas mixture, it was subsequently subjected to gradual isothermic depressurisation. Hydrate phase boundary, gas composition and pore pressure data was collected during this test for all three types of the porous media. The interpretation of the experimental data revealed that the characteristics of the host formation differentiate the characteristics of the hydrate. Significant differences were also observed in the pore pressure build-ups inside the host formation as a result of the degree of hydrate dissociation.