Press Release

GEOMAR
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New insights into the mysterious ocean floor

Marine scientists from Kiel present new concepts of the formation of mud volcanoes and cold seeps in the deep sea.

24 March *2015/Kiel.* During an expedition of the German research vessel METEOR in 2012 scientists of the GEOMAR Helmholtz-Centre for Ocean Research Kiel together with colleagues from Bremen and Halle, Portugal, Spain and the UK, discovered previously unknown mud volcanoes on the seabed of the Atlantic Ocean. In the international journal *Geology* they now show, why the structures provide new insights about the processes below the seafloor – and why they simultaneously raise new questions.

For the ancient Babylonians Abzu and Tiamat were the gods of fresh- and saltwater. For today's ocean sciences two mud volcanoes of the same names could serve as a key to the understanding of previously undiscovered processes underneath the ocean floor. The two cones are located about 200 kilometers southwest of Portugal, in about 4500 meters water depth at the bottom of the Atlantic Ocean. They were discovered together with a third mud volcano, named after the late Russian scientist "Michael Ivanov" during an expedition of the German research vessel METEOR in 2012. "The mud volcanoes were found in an atypical location. Additionally, further analysis showed that fluids expelled at the seabed in these places has a much deeper origin than at most other mud volcanoes," says Dr. Christian Hensen, geologist with the GEOMAR Helmholtz Centre for Ocean Research Kiel and chief scientist of the 2012 expedition. Together with colleagues from the UK, Spain, Portugal and the Universities of Bremen and Halle he now presents the results of the investigations in the international journal *Geology*.

Mud volcanoes are morphological structures where fluids, including water and gases, are released from the subsurface. "Sometimes cones emerge during this process, which appear as small-scale volcanoes", explains Dr. Hensen. They are found at nearly all continental slopes and they often occur on thick sedimentary deposits, for example at large deep-sea fans such as the Nile Delta, where huge amounts of sediments have accumulated over the millennia. A large number of mud volcanoes are known from the Gulf of Cadiz south of Portugal and Spain, where they have formed on thick sedimentary sequences that have been partly thrusted by movements of the earth's crust. "But Abzu, Tiamat and M. Ivanov are not situated on this so-called accretionary wedge. They are located further west near a fracture zone along the African-Eurasian plate boundary. Before our expedition took place, we only hypothesized about the existence of mud volcanoes in this area. Now we have the proof," says Dr. Hensen.

The research team aboard the METEOR mapped the volcanoes with the autonomous underwater vehicle (AUV) ABYSS and then sampled it with gravity corers. Later scientists analyzed the samples precisely in the laboratories of the participating institutions. The results were surprising. "Usually gases and fluids emerging from mud volcanoes are only derived from the sediments below. The material coming out of these three mud volcanoes also refers to a source in the crust underneath the sediments," explains Dr. Hensen.

This brought up a new set of questions for further research: What are the exact subsurface mechanisms feeding the mud volcanoes? Where do other seeps of this type exist? "We know hot vents at mid-ocean ridges, where new crust is formed. These places are relatively easy to find,

because almost no sediments are lying on top of the crust, the ascent rates of the fluids are high, and due to the chemical composition of the fluids conspicuous traces on the sea floor are formed, for example the famous Black Smokers," says Dr. Hensen. There may be similar processes in other areas of the seabed, especially near fracture zones. "The newly discovered mud volcanoes are a clear indication that this conjecture is true", he adds. However, it is more difficult to find these systems with increasing distance from the mid-ocean ridges, because they become less dynamic and the sediment thickness increases.

The current publication is an important basis for further research projects, which should help to better understand the mechanisms of fluid transport in the seabed. During the recent expedition of the new German research vessel SONNE (SO237) the sea floor of the Atlantic Ocean along a prominent facture zone was mapped again by the AUV ABYSS to get more data for future projects. The knowledge about hot and cold springs at the seafloor, their formation mechanisms, and their supply routes is important for a better understanding of specific plate tectonic processes and related earthquake risks.

"The ancient Babylonians presumed a large, hidden freshwater ocean under the salt water ocean Tiamat, whom they called Abzu. Mud volcanoes connect the ocean with the underground of the seafloor, which is still mysterious to us, and, in many cases, they release freshwater. Therefore, we found the names very appropriate for these important discoveries", says Dr. Hensen.

Reference:

Hensen, C., F. Scholz, M. Nuzzo, V. Valadares, E. Gràcia, P. Terrinha, V. Liebetrau, N. Kaul, S. Silva, S. Martínez-Loriente, R. Bartolome, E. Piñero, V.H. Magalhães, M. Schmidt, S.M. Weise, M. Cunha, A. Hilario, H. Perea, L. Rovelli and K. Lackschewitz (2015): Strike-slip Faults Mediate the Rise of Crustal-Derived Fluids and Mud Volcanism in the Deep Sea. Geology, http://dx.doi.org/10.1130/G36359.1

Links:

www.geomar.de GEOMAR Helmholtz Centre for Ocean Research Kiel
www.flows-cost.eu The project FLOWS (Impact of Fluid circulation in old oceanic Lithosphere on the seismicity of transfOrm-type plate boundaries: neW solutions for early seismic monitoring of major European Seismogenic zones)

Images:

Images are available for download at www.geomar.de/n2339-e

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