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Genesis of mud volcano fluids in the Gulf of Cadiz - A novel model approach

Christopher Schmidt (1), Ewa Burwicz (1), Christian Hensen (1), Sara Martínez-Loriente (2), Klaus Wallmann (1), and Eulàlia Gràcia (2)

(1) GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel, Germany, (2) B-CSI, Institut de Ciències del Mar - CSIC, Barcelona, Spain

Mud volcanism and fluid seepage are common phenomena on the continental margin in the Gulf of Cadiz, North East Atlantic Ocean. Over the past 2 decades more than 50 mud volcanoes have been discovered and investigated interdisciplinarily. Mud volcano fluids emanating at these sites are sourced at great depths and migration is often mediated by strike slip faults in a seismically active region. The geochemical signals of the mud volcano fluids are affected by widespread various processes such as clay mineral dehydration, but also the recrystallization of ancient carbonate rocks and the alteration of oceanic crust have been suggested (Hensen et al., 2015).

We developed a novel fully-coupled, basin-scale, reaction-transport model with an adaptive numerical mesh to simulate the fluid genesis in this region. An advantage of this model is the coupling of a realistic geophysical and geochemical approach, considering a growing sediment column over time together with instant compaction of sediments as well as diffusion and advection of dissolved pore water species and chemical reactions. In this proof of concept study, we looked at various scenarios to identify the processes of fluid genesis for 4 mud volcanoes, representing combinations in different subsurface settings. We can reproduce the fluid signatures (chloride, strontium, 87Sr/86Sr) of all mud volcanoes. Furthermore, we can give additional evidence that alteration of oceanic crust by fluid flow is a likely process affecting the fluid composition.

Hensen, C., Scholz, F., Nuzzo, M., Valadares, V., Gràcia, E., Terrinha, P., Liebetrau, V., Kaul, N., Silva, S., Martínez-Loriente, S., Bartolome, R., Piñero, E., Magalhães, V. H., Schmidt, M., Weise, S. M., Cunha, M., Hilario, A., Perea, H., Rovelli, L., and Lackschewitz, K., 2015, Strike-slip faults mediate the rise of crustal-derived fluids and mud volcanism in the deep sea: Geology, v. 43, no. 4, p. 339-342.