EGU2020-3407
https://doi.org/10.5194/egusphere-egu2020-3407
EGU General Assembly 2020

Integration of drilling mud gas monitoring, downhole geophysical logging and drill core analysis identifies gas inflow zones in borehole COSC-1, Sweden

Simona Pierdominici[1], Thomas Wiersberg[1], Henning Lorenz[2], Bjarne Almqvist[2], Iwona Klonowska[3], and the COSC Science Team[*]
[1]Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum - GFZ, Geomechanics and scientific Drilling, Potsdam, Germany (pierdo@gfz-potsdam.de)
[2]Department of Earth Sciences, Uppsala University, Villavägen 16, 752 36 Uppsala, Sweden
[3]Department of Earth Sciences, Syracuse University, Syracuse, New York 13244-1070, USA
[*]A full list of authors appears at the end of the abstract

The continuous wireline core drilling of the COSC-1 borehole (Jämtland, Central Sweden) offered the unique opportunity to combine data and findings from drilling mud gas monitoring, downhole geophysical logging and drill core analysis. The COSC project aims to better understand deep orogenic processes in mountain belts in a major mid-Paleozoic environment in western Scandinavia. The 2.5 km deep fully cored borehole COSC-1 was drilled in 2014 into the lower part of the Seve Nappe Complex, characterized by a thick sequence of high-grade metamorphic rocks. Here, we present results from a combination of drill mud gas monitoring with data from geophysical logging and core analysis to identify and characterize fluid-bearing open fractures during drilling of metamorphic rocks. Geophysical downhole logging is an established technique for extracting information from the underground. Online monitoring of drilling mud gas (OLGA) is also increasingly used in scientific drilling operations, but a combined interpretation of the data sets obtained with these methods has rarely been carried out in the past. Nearly complete gas records were obtained by OLGA with three meter depth resolution from 662 m to 1709 m and six meter resolution from 1709 m to 2490 m depth (COSC-1 total depth: 2496 m) for hydrogen, methane, carbon dioxide and helium by on-line drilling mud gas monitoring. Between 662 m and approx. 1550 m, both He and CH_4 form broad peaks superimposed by several spike-like features. Zones with gas spikes coincide with high resistivity intervals identified by dual laterolog measurements and show fractures in optical drill core scans, borehole televiewer images, and visual core inspection. Therefore, we assume gas inflow through open fractures where deep/shallow resistivity ratios is greater than 1.5 imply the presence of free gas. The correlation between helium and deep/shallow resistivity ratios no longer appears at depths greater than 1550 m, probably because the formation gases are dissolved in formation fluids at higher pressure. 13 gas zones found in the depth interval 662 – 1550 m match with areas of higher resistivity and with open fractures identified by optical core logging. Below 1550 m depth, He drops significantly, whereas CH_4 remains relatively high and H_2 and CO_2 reach maximum values. The high amount of hydrogen and methane at depths below 1616 m, from where friction between the casing and the

drill string was reported, imply that these gases are most certainly artificially generated at depths below 1616 m and at least partly of artificial origin at shallower depths. Comparison between OLGA data and resistivity downhole logging data can help to estimate degassing depths: at depths where OLGA identified formation gases, concurrent high resistivity would be diagnostic for free gas, whereas low resistivity would imply gases dissolved in saline formation fluids.

COSC Science Team: COSC Science Team