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Online Monitoring of Drilling Mud Gas in ICDP and IODP scientific drilling projects

Wiersberg, T. and Zimmer, M.

GFZ German Research Centre for Geosciences, Telegrafenberg, 14473 Potsdam, Germany
wiers@gfz-potsdam.de

Continuous mud gas logging during drilling is a standard technique in oil and gas exploration since the late 1930s where it is used to to detect and validate pay horizons while drilling or coring. This technique has been modified to meet the demands of scientific drilling, e.g. sample and study the composition of crustal gases in sedimentary and crystalline formations [1].

Drilling mud that circulates in the borehole comprises air from surface, gaseous components that are mechanically released as the drill bit, including components present in the pore space of the crushed rock, and gas entering the borehole through permeable strata, either as free gas or, more likely, dissolved in liquids. At the surface, the gases are extracted from the mud in a gas-water separator and continuously pumped into a field laboratory for real time gas analysis and sampled for further studies e.g. on isotopes. Hydrocarbons, helium, radon and with limitations carbon dioxide and hydrogen are the most suitable gases for the detection of fluid-bearing horizons, shear zones, open fractures, sections of enhanced permeability. Off-site isotope studies on mud gas samples help reveal the origin, evolution, and migration mechanisms of deep-seated fluids. Beside its scientific value, the method has important applications aiding rapid decisions if and at what depth rock or fluid samples should be taken or formation testing should be performed. Until 2014, on-line mud gas monitoring was only applied in oilfield style rotary drilling. The Collisional Orogeny in the Scandinavian Caledonides (COSC) was the first project where it was successfully tested in wireline diamond coring.

On-line gas monitoring of drilling mud has been proven being a reliable and inexpensive source of information on the composition and spatial distribution of fluids in the subsurface of fault zones, volcanoes and geothermal areas, permafrost regions, and other sedimentary and crystalline environments. It has been successfully applied on scientific drilling projects of the International Continental Scientific Drilling Program ICDP, the International Ocean Discovery Program IODP and other scientific drilling initiatives.

On-line monitoring of fluids and gases from circulating drilling mud has been conducted in ten ICDP drilling projects in crystalline and sedimentary strata with a focus on fault zones (Corinth, Chelungpu, SAFOD, New Zealand [2-5]), volcanic systems (Unzen, Long Valley [6]), collision zones (Donghai, COSC [7]), and gas hydrates (Mallik). On-line drilling mud gas monitoring has also been applied on non-ICDP continental scientific drilling projects, e.g. the Wenchuan fault zone drilling [8], and INFLUINS Integrated Fluid Dynamics in Sedimentary Basins. After its successful introduction onboard the drilling vessel D/V Chikyu in 2009, it became a standard shipboard technique for IODP riser drilling operation and demonstrated its great value during fault zone drilling (Exp. 319, 338, 348 [9, 10]) and studies on the deep biosphere (Exp. 337 [11]).

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