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Online gas monitoring during drilling of the Koyna KFD1 pilot borehole, India

Nagaraju Podugu (1), Satrughna Mishra (1), Thomas Wiersberg (2), and Sukanta Roy (1)

(1) Borehole Geophysics Research Laboratory, Ministry of Earth Sciences, Govt. of India, Karad-415 114, Maharashtra, India, (2) GFZ German Research Centre for Geosciences, Scientific Drilling, Potsdam, Germany (wiers@gfz-potsdam.de)

A 3km deep research borehole (KFD1) was drilled between 12/2016 and 6/2017 in the Koyna region, western India, where artificial water reservoir triggered earthquakes have been occurring since the impoundment of the Koyna reservoir in 1962. The 1967 M6.3 Koyna earthquake had generated a surface fissure near Donichawadi, north of the KFD1 drill site, which showed soil-gas helium anomalies even 30 years after the earthquake.

Online gas monitoring was carried out during drilling the 3014 m deep KFD1 borehole during mud drilling and, for the very first time, also during air hammer drilling to obtain information on the composition of gases present in the borehole, detect potential fluid bearing horizons and shear/fracture zones, and to confirm the southward extension of the Donichawadi fissure zone. KFD1 was drilled primarily using air hammer technique; mud circulation was employed only for the short section 1030-1500 m and during seven core runs. No formation gases could be detected during drilling, likely due to dilution with the air pumped downhole. However, formation gases (CH_4, CO_2, H_2, and He) could be observed and sampled in the water column during water flushing in $\sim$100 m intervals following coring runs.

Online gas monitoring during water flushing and laboratory analyses of gas samples from 1627-2831m depth revealed concentrations of up to 1270 ppmv CO_2, up to 910 ppmv CH_4, up to 140 ppmv H_2 and up to 13 ppmv He. Gas-rich zones are mostly below 2100m, indicating that the borehole punctured multiple fracture zones below this depth. Noble gas isotope studies to confirm whether the Donichawadi fissure zone was penetrated by the KFD1 borehole at depth as well as investigations on water samples and integration with geophysical data are in progress.