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Investigations on fault zone gases in South African gold mines

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The ICDP-supported **DSeis** project **(D**rilling into **Seis**mogenic zones in deep South African Gold Mines) drilled boreholes in several deep South African gold mines to gain new insights on mining-induced earthquake nucleation and fault slip processes, the status of the stress field at great depths, deep microbiological life and the role and origin of the linked fluids. Two boreholes (817 and 700 meters long) were drilled from a 2.9 km deep mining level of the Moab Khotsong gold mine in order to penetrate into the aftershock plane of the M 5.5 Orkney earthquake that occurred in August 2014 and to retrieve core, fluid, and microbial samples from the seismic active zone.

After drilling, an automated gas analytical system was deployed at depth to monitor the concentrations of specific gas released by the boreholes. The main components of the monitoring system include gas specific sensors for H_2, CH_4, CO_2, O_2, O_3 (ozone), and ^{222}Rn. The gases are monitored at one minute intervals; the data is transmitted in real time and later correlated with seismic data. Gas monitoring and laboratory measurements of gases will help clarify the process of hydrogen generation (radiolytic, mechanochemical, water reduction on transition metals/metal oxides, or FFT-reactions), the origin of other gases, and if and how the gases may serve as feedstock for a deep microbial community. A gas sample collected from Hole A revealed a baseline composition of formation gases mainly of CH_4, followed by He, N_2, H_2, Ar and higher hydrocarbon gases. The carbon isotope composition (δ^{13}C) of C1-C4 hydrocarbons suggests an abiogenic source for hydrocarbons by water-rock interaction.