# The story of real-time noble gas analysis in the field, Black Smokers and the Paleocene-Eocene-Thermal Maximum

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We recently developed a membrane inlet mass spectro-metric system operating at gas / water equilibrium (GE-MIMS) enabling real time (noble) gas analyses under field conditions. The new second-generation of the system ('Mini-Ruedi-Rüssel') is portable (i.e., < 40 kg, operated by car batteries). Concentrations of He, (and newly) Ne, Ar, Kr, $N_2$, $O_2$, $CH_4$ and $CO_2$ can be measured simultaneously and quasi-continuously (< 10 min.) in various kinds of terrestrial fluid under field conditions on site [1, 2]. Such a system was also used onboard the German RV Sonne to determine dissolved gas concentrations in deep waters of the Gulf of California (Mexico) and to analyse seafloor fluid emission from cold and hot seeps in the northern Guaymas Basin [3]. The GE-MIMS was modified such to enable quantitative gas analysis in 8 L of water taken from a single standard Niskin bottle within 10 min [2].

Most of the investigated seafloor sites were found not to emit fluids. However, a dissolved gas plume was detected in the northern Guaymas Basin and its source could be identified as an active Black Smoker hill sitting off the spreading axis within the sediment strata. Numerous Black Smokers emit $CH_4$-, $CO_2$-and He-rich fluids. The gas concentrations are linearly correlated, which is interpreted as a binary mixture between deep seated gas sources and dissolved gases from ocean water. Laboratory analyses of selected gas samples showed that He originates from a depleted MORB-source whereas $CH_4$ was formed during thermal degradation of organic matter. Our measurements indicate that magmatic activity within organic-rich sediments forces strong green house gas emissions.

The Guaymas Basin is interpreted as a recent analogue of the young Atlantic Ocean during its opening. In combina-tion with seismic results, our findings support the idea that the Paleocene-Eocene-Thermal maximum (55 Ma) was caused by magmatism in response to the formation of the Atlantic Ocean [4].

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