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In situ gas concentrations in the Kumano forearc basin from drilling mud gas monitoring and sonic velocity data (IODP NanTroSEIZE Exp. 319 Site C0009)

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Conventional IODP shipboard methods of gas investigations comprise gas sampling from core voids and headspace gas sampling followed by shipboard gas analysis. These methods possibly underestimate the in situ gas concentration due to core degassing during retrieval and handling on deck. In few cases, a Pressure Core Sampler (PCS) was used in the past to overcome this problem, providing gas concentrations one or two order of magnitude higher than headspace gas analysis from corresponding depths.

Here, we describe two new techniques applied during IODP NanTroSEIZE Exp. 319 Site C0009 riser drilling in the Kumano forearc basin to estimate in situ gas concentrations without drill core recovery. During riser drilling of site C0009 between 703 to 1594 mbsf, gas was continuously extracted from returing drilling mud and analysed in real-time (drill mud gas monitoring). This method results in information on the gas composition and gas concentration at depth. The chemical (C1-C3) and isotope (δ^{13}C, H/D) composition of hydrocarbons, the only formation-derived gases identified in drill mud, demonstrate a microbial hydrocarbon gas source mixing with small but increasing amounts of thermogenic gas at greater depth. Methane content in drilling mud semi-quantitatively correlates with visible allochtonous material (wood, lignite) in drilling cuttings.

In situ gas concentration determination from drill mud gas monitoring based on the assumption that gas is either liberated from the rock into the drilling mud during drilling and ascent with the mud column or remains in the pore space of the drilling cuttings. Drilling mud gas data were calibrated with a defined amount of C_2H_2 (175 l [STP]) from a carbide test and result in methane concentrations reaching up to 24 $l_{gas}/l_{sediment}$, in good agreement with findings from other IODP Legs using the PCS. Hydrocarbon gas concentrations in drilling cuttings from C0009 are significantly lower, indicating cuttings outgassing during ascent of the drill mud column to the surface.

An alternative method to quantify free gas is the analysis of high quality sonic data from wireline logging to infer the porosity and estimate the water content stored in intergranular pores and the gas saturation (Doan et al., 2011). Drill mud gas monitoring and sonic velocity data analysis reveal similar depth concentration profiles for C0009 and in situ gas concentrations in fairly good agreement. The further observation implies that formation gas is located in the pore space of the rock and does e.g. not penetrate into the borehole through fractures and faults.

Doan, M.-L.; Conin, M.; Henry, P.; Wiersberg, T.; Boutt, D.; Buchs, D.; Saffer, D.; McNeill, L. C.; Cukur, D.; Lin, W. (2011) Quantification of free gas in the Kumano fore-arc basin detected from borehole physical properties: IODP Nan TroSEIZE drilling Site C0009. *Geochemistry Geophysics Geosystems*, 12, Q0AD06, doi: 10.1029/2010GC003284