ARTIFICIAL ALKENES AND ALKANES GENERATED DURING DRILLING: EVIDENCE AND IMPACT ON PETROLEUM EXPLORATION.

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Past studies on drill bit metamorphism (DBM) have shown that cracking of oil-based mud (OBM) can generate methane in addition to alkenes (Faber et al. 1988, Wenger et al. 2009). Our comparison of bottomhole sample (BHS) solution gas and mud gas (C_1-isotope log and IsoTube® samples) from equivalent depths confirmed significant differences in $\delta^{13}C$ values up to 17‰ for C_1 but also 8 ‰ for C_2. Additionally, the BHS solution gas and advanced mud gas logging (AMGL) showed large differences in molecular composition as well. DBM-addition of ^{13}C-enriched alkanes, at least methane and ethane, caused these significant positive C-isotope offsets in mud gas from the true $\delta^{13}C$ values of the indigenous formation fluid. Additionally, the magnitude of the $\delta^{13}C$ offset was proportional to the inverse of carbon number (noticeable up to C_3) and to the amounts of DBM-generated alkenes.

Ethene and propene concentrations exhibited strong positive correlation in the intervals that were severely affected by DBM, with ethene concentration roughly twice that of propene. This is in line with the observations made by Wenger et al. (2009) that during DBM, the alkenes are derived from cracking of the base oil in oil based mud (OBM). Cracking at the drill bit generated shorter-chain n-alkanes, likely, also from the base oil. $\delta^{13}C$ of C_1 and C_2 (and to a lesser extent that of C_3) drifted towards the typical base oil C-isotope composition in the severely DBM-affected zones (Fig. 1a). We used weighted distance between the indigenous formation fluid (BHS solution gas) and pure cracking end-member (-27.5‰, typical average $\delta^{13}C$ of base oil) to estimate DBM-added alkane percentage in the mud gas (up to 55% of C_1 and C_2; Fig. 1b). Estimated fractions of DBM-added C_1 and C_2 correlated strongly with concentrations of alkenes in mud gas (see correlation with ethene in Fig. 1b).

Artificial alkanes with shifted C-isotopic composition can strongly bias fluid typing and maturity interpretation in petroleum exploration. In the extreme case shown below, even the C_2, which is usually considered as the most reliable maturity and fluid typing mud gas parameter is significantly affected.

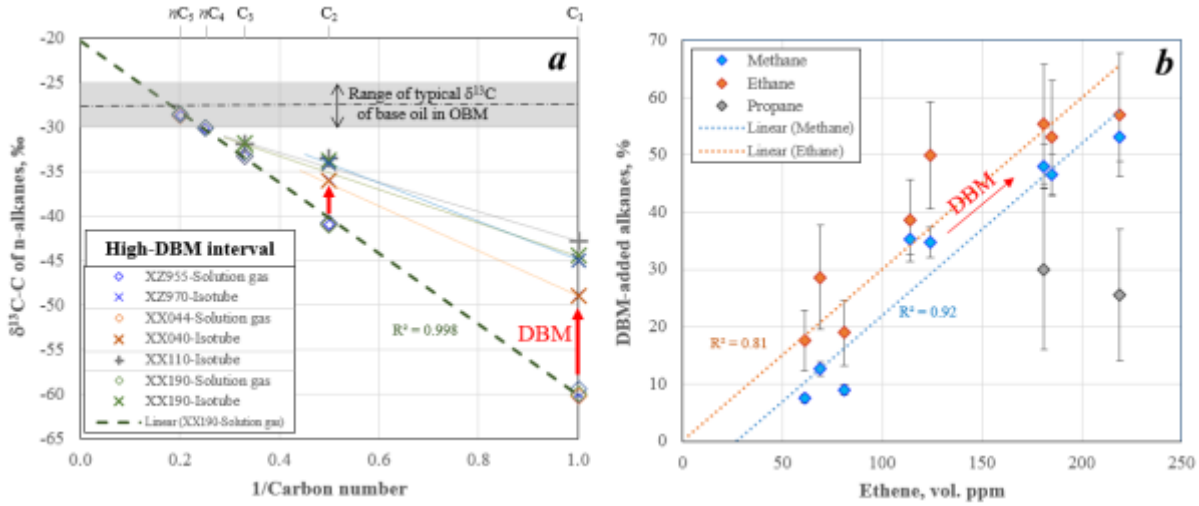

Figure 1 *Generation of alkenes and alkanes via drill bit metamorphism (DBM) and its impact on molecular and isotopic compositions of mud gas as compared with composition of solution gas of bottom hole fluid samples from equivalent or nearest depths: a) $\delta^{13}C$ offset between solution gases and IsoTubes® (red arrows) increases with decreasing carbon number (highest for C_1; natural gas plot after Chung et al. 1988); b) exclusively DBM-derived alkenes (ethene shown) correlate with fractions of C_1 and C_2 alkanes added by DBM via cracking of oil-based mud; the fractions were calculated from the isotopic offsets shown in panel a).*

References

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