Using PY-GC to evaluate the cleaning quality of hydrocarbon in shale

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Shale is a major energy source, and researchers have developed many methods on the core analysis. Prior to most laboratory measurements (i.e. porosity, permeability and others), the original fluids must be completely removed from the core samples. But there is still no known general method to determine when the hydrocarbons have been suitably cleaned. Lack of method to prove the cleaning quality reduces the reliability of results on matrix parameters. The pyrolysis and gas chromatography (PY-GC) techniques are introduced to evaluate the cleaning quality of hydrocarbons in shale.

In shale, a proper core cleaning means to remove all fluid hydrocarbons but keep the solid organic matter, since organic matter compounds in it show fluid and solid dual characteristics. Consequently, the evaluation method for shale should able to discern the fluid from solid hydrocarbons clearly and tell the integrity of solid organic matrix[1]. The fluorescence detection method has no idea to analyse the cleaning quality quantitatively. Pyrogram from Rock Eval II fails to differentiate free hydrocarbons and solid organic matter components in shale due to its progressive pyrolysis mode. An insufficient cleaning result would be submitted, because a portion of fluid-like hydrocarbon residues (FHR, which naturally are free hydrocarbon) are inappropriately classified as the solid organic matter matrix[2,3].

The aforementioned problems can be solved by using the pyrolysis cycle modified with the GC data analyzed on the extracted shale aliquot. The cleaning quality is evaluated by comparing the differences between pyrograms measured on the uncleaned and cleaned aliquots. Hydrocarbons are divided into finer fractions on pyrogram: $S1_E$, light free hydrocarbon; $S2a_E$, FHR; and $S2b_E$, solid organic matter. The complete cleaning are expressed as the disappearance of $S1_E$ and $S2a_E$ fractions (all free hydrocarbons) and the invariant of $S2b_E$ fraction on the pyrogram of cleaned sample. Tests show that the criterions are different on samples with different kerogen richness, where the TOC content may play a key role. We expect this new approach to dramatically increase the evaluation quality in cleaning, and hence ensure the further testing reliability viable.

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