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Deterministic modelling of deep subsurface biodegradation - progress and prognosis

Bacteria(anaerobes) were first isolated from oilfields by Bastin in 1926 and microrganisms have since been implicated in the alteration of petroleum in shallow cool reservoirs below 80C. Many of the key elements of the compositional changes involved in biodegradation have been elucidated and petroleum geochemists have developed effective schemes for ranking different oils in terms of degradation level. Our understanding of most aspects of the process however, remain empirical. Increasing evidence suggests that in most deep reservoir settings degradation must be anaerobic, as suggested by Russian scientists in the 1950's with recent biological and geochemical advances by Zengler, Wilkes and coworkers providing exciting new possibilities and indications from our own studies that the 80C temperature limit of biodegradation may represent a fundamental boundary of life on(or IN) our planet. Our recent studies suggest degradation may even be isochemical on a reservoir scale in some deep settings with oxidants, nutrients and oil all locally provided for organisms to feast upon. Water flow may not be necessary, though it undoubtedly helps! Whereas most aspects of petroleum systems are now routinely and effectively deterministically modelled in exploration settings, biodegradation, to-date, lacks an effective approach though TTI-type biodegradation indices and kinetic models of biodegradation are now appearing. Our studies of biodegradation rates in-reservoir indicate that oil mixing, reservoir and aquifer topology and charge history are key factors in successful biodegradation related fluid-property prediction assessments. We discuss the future of calibrated deterministic biodegradation modelling within a basin-modelling environment, showing examples, and contrast this approach in terms of potential and actual benefits with purely statistical approaches to fluid property prediction.