DECOMMISSIONING THE MIGHT BRENT – A NEW DAWN FOR ORGANIC GEOCHEMISTRY

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Brent is an iconic field in the oil and gas industry located in the northern North Sea area of the UK. After 40 years of service the field has moved into the final part of its lifecycle, decommissioning. Brent well abandonments represent a unique opportunity and an incredible challenge due to size (4 platforms), scale (154 wells) and complexity (wells with up to 8 side-tracks). This project is shaping our understanding with respect to decommissioning in the North Sea, across Shell globally and the industry as a whole. The boundaries met, pushed and broken by the surface and subsurface teams continue to attract, help develop and create a wealth of in-depth skills and expertise in the field of decommissioning. Within Shell organic geochemistry is one of the subsurface disciplines that plays a pivotal part as a forensic tool kit to help establish the source of pressures observed in the to-be-abandoned well infrastructures. In particular, the low cost characterisation of the gas or liquid in the annuli and wellbores through detailed molecular and stable carbon, hydrogen and nitrogen isotope analyses proved extremely valuable. As a result, decommissioning has the potential to be a significant part of the petroleum geochemistry workload in years to come.

At the beginning of the Brent abandonment journey a "three barriers" isolation strategy with associated well durations of approximately 45 days/well was utilised. Although sources of reliable information were available to monitor the operations, there was an opportunity to acquire an integrated data set that could further develop the strategy and drive abandonment decision making in a more efficient way. This data set was based on three main aspects: field wide pressure monitoring, hydrocarbon source identification and flow potential.

Detailed geochemistry of over 250 annuli and wellbore samples have been collected to date and compared with the available Brent production data (Fig. 1). Initially simple assessments of biogenic (C_1 dominated gas with $\delta^{13}C$ values of approx. -73‰) *versus* thermogenic gas (C_1 approx. 83 mol% and $\delta^{13}C$ values between -42‰ to -48‰) were used to determine hydrocarbon source. However, with the increase of samples and the continuous monitoring, a wealth of data became availably yielding a much larger variability in molecular and stable isotope composition than expected. Methane carbon isotope values were shown to range between -88‰ and -15‰ indicating different biodegradation and transformation processes influencing the hydrocarbon envelope. Also the ethane, propane and CO_2 carbon isotope values were shown to be extremely valuable in assessing the active biodegradation within the infrastructure. Ethane values shifted to more negative values whereas the CO_2 varied between -45‰ and +65‰, the latter never seen before in any of our projects. Finally, distinct newly formed organic molecules were identified providing new insights into the biogeochemical processes occurring in these systems widening our scope of information that can be used to evaluate the origin and genesis of hydrocarbons observed during decommissioning.

Having completed approximately 65 well abandonments the Integrated Brent Abandonment team reviewed all parts of the isolation strategy applying real field data and incorporating all abandonment experiences to date, mapping out a risk based approach. This combination of engineering, geology and geochemistry data led to the greater understanding of sources of gas

and pressures in the wells and quantified the flow potential. The conclusion from this questioned the necessity for the upper most barrier in many of the wells. Thanks to this innovative approach the team has improved the abandonment efficiency to less than 20 days/well leading to a reduction from 6 to 3 years in the overall Brent abandonment plan with an expected impact on the Brent Decommissioning project to several tens of millions of pounds.

The current presentation will explain in detail how the organic geochemical data has helped to improve the abandonment efficiency, what to look for in the data (the devil is in the detail) and what lessons can be learned for future decommissioning projects. Looking at the size of the global decommissioning portfolio in the foreseeable future and the opportunities this provides for organic geochemical involvement, both from an industry and academic point of view, this is now a very exciting new area to expand in.

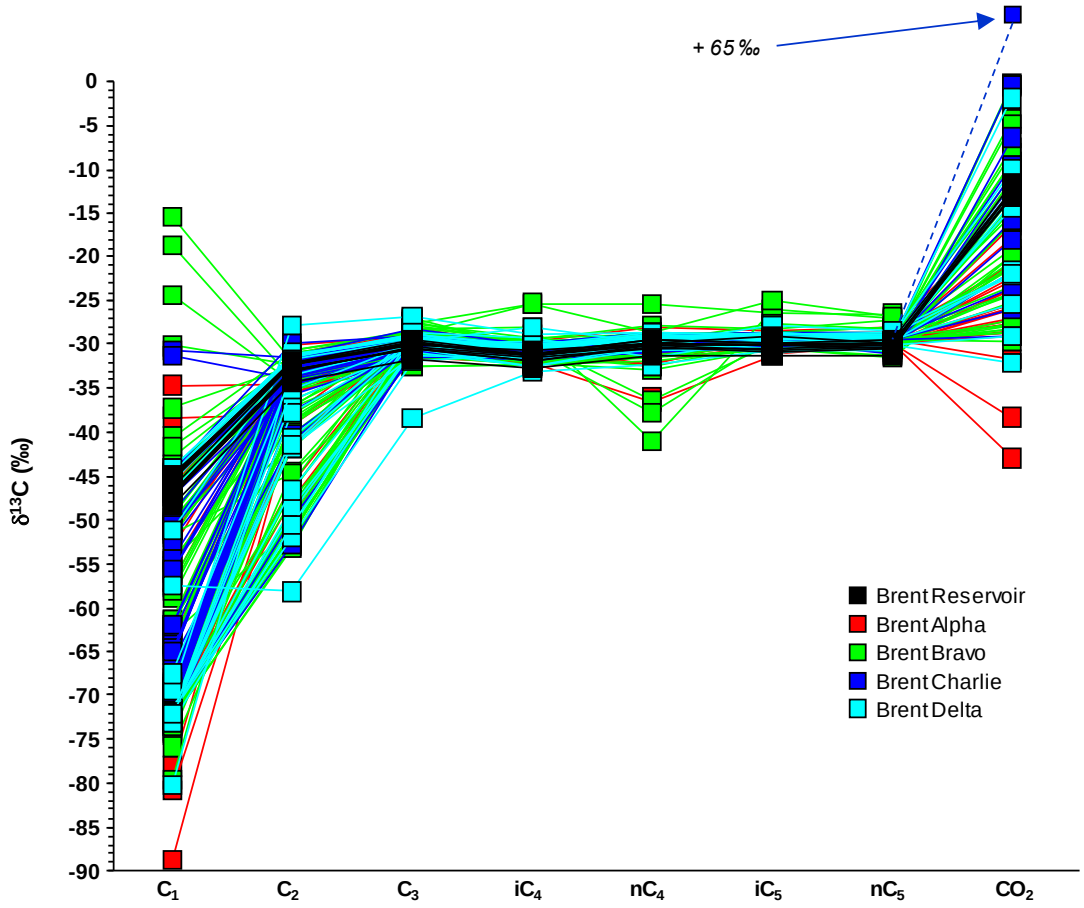

Figure 1 *Stable carbon isotope variability observed in the gas species collected from Brent annuli and wellbores relative to the original Brent production data (in Black).*