Rialtas na hÉireann
Government of Ireland

FUTURE DIRECTIONS

Merlin Energy Resources Ltd

PIP
Petroleum Infrastructure Programme

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F. FUTURE DIRECTIONS

This section outlines future work that could be carried out to follow up the IS16/04 project.

F.1 AREAS FOR FUTURE WORK

Below are some suggested specific areas for future work that are considered to have some merit to the further understanding of the Ireland offshore area, building upon the results of the current study. These are not listed in any order of importance or priority.

- ***Biostratigraphic analysis of further wells***. This study is based on 197 offshore Ireland wells and boreholes (which contain legacy or newly generated biostratigraphy data). A further 33 wells exist, which have not been included in the study. These are wells that currently lack biostratigraphy data (and are either production wells, shallow abandoned wells that were subsequently re-entered or failed side-tracks), however, further evaluation work could be done on a selection of these wells, in order to tie them into the newly defined stratigraphy.
- ***Use of charophytes for potential subdivision of the Wealden and Purbeck groups***. Charophytes hold significant potential for the subdivision of the Wealden and Purbeck groups in the North Celtic Sea Basin in future studies, to parallel the use of this microfossil group in the Wealden and Purbeck groups of southern England and northern mainland Europe.
- ***Use of charophytes for potential subdivision for the Beara Group***. Charophytes hold significant potential for the subdivision of the Beara Group, Minard Formation, in the northern Porcupine and Slyne basins in future studies.
- ***Inferred chronostratigraphy interpretations***. The well summary logs display the chronostratigraphic ages interpreted on the basis of the available biostratigraphic data in each well or borehole. The interpreted age boundaries are placed at the actual data points from which the age diagnostic biostratigraphic data in question are present. For this reason, there are data gaps between samples and also in some cases interpreted ages inappropriately appear to cross lithostratigraphic boundaries. It would be possible to carry out a further interpretation step of extrapolating the ages from the sample points to wireline log and lithostratigraphic boundaries, however, this would need to be separated as a different "interpreted age" data type within the stratigraphic database.
- ***Further study of Albian interval***. More work on Albian of Porcupine Basin may be worthwhile to try to obtain greater resolution of the rather broadly conceived "Early-Middle Albian" interval currently interpreted. In particular it would merit more calcareous nannofossil and palynological analysis work that has good potential over this interval.
- ***Detailed chronostratigraphic summary charts***. Chronostratigraphic summary charts have been created for all stratigraphic intervals in offshore Ireland. Due to time constraints, detailed chronostratigraphic summaries of each well have not been created. This would be a useful exercise, however, and would provide well by well detail on the precise age of missing section which would be of use for any assessment of structural history, burial history etc.
- ***Palaeoenvironmental assessment of all wells***. In the current study, palaeoenvironments have been assessed collectively for all described rock units. Palaeoenvironmental interpretations have not been carried out for all wells and intervals on a well by well basis (i.e. added to the well database and displayed on summary logs). If required, this could be carried out.
- ***Sequence stratigraphic interpretations***. At present, sequence stratigraphic interpretations have been carried out on certain intervals in certain wells, but not in all wells and intervals in the database. Stratigraphic sequences have been interpreted in sufficient key well intervals in order to define sequence stratigraphic schemes for selected intervals of offshore Ireland, and over a sufficiently wide area to prove regional applicability. It would be possible to carry out sequence interpretations of all wells in which those intervals are present, as a further phase of work.
- ***Update stratigraphy as new wells are drilled***. It will be important to continually update and refine the lithostratigraphic, chronostratigraphic (biostratigraphic) and sequence stratigraphic schemes initially defined by this project as new wells are drilled in future. A particular region lacking wells is the southern part of the Porcupine Basin and it is highly likely that new lithostratigraphic units will be encountered in wells drilled in this region. It will be necessary to describe and document these as soon as such wells are released into the public domain. Two important wells drilled in recent years in this area are the 52/4-1 and 53/6-1 wells.
- ***Extend stratigraphic and seismic interpretations into new seismic data areas***. Merlin has not had access to large volumes of recently acquired proprietary and speculative 3D seismic survey data, particularly in the Porcupine Basin, for the current project. Nor has it been possible to access any of the recent speculative high quality 2D seismic data that is available in the Celtic Sea and Fastnet Basin areas, for example the GeoPartners North Celtic Sea and St Georges Channel broadband long offset survey (see Attree *et al*., 2016). It is therefore anticipated that further advances in understanding will be possible as exploration efforts proceed, and additional survey data become released. It is recommended that the seismic interpretations presented in this project, and their correlation to the newly defined stratigraphy, are extended into and tested against these new 3D and 2D surveys, upon their release. [Note that some lines from the GeoPartners survey were released by the UK Oil and Gas Authority from the UK Celtic Sea area, some of which were used in this project].
- ***Extend seismic interpretations and stratigraphic extrapolation into previously unstudied and undrilled basins.*** There are several basins within the overall project bounds that are currently undrilled; these include the Cockburn and Little Sole basins, to the south east of the Fastnet Basin, and many small basins on the eastern flank of the Rockall Basin, including the Colm, Fursa, Padraig, South Bróna and Cillian basins. These basins have not been interpreted in any detail as they sit outside the agreed project scope of the current project. No detailed mapping has been carried out that incorporates these basins, though some of them are mentioned where relevant. It may be useful in a follow up study to evaluate these areas (using existing seismic data) to assess the likely, as yet undrilled stratigraphy, in these basins.
- ***Place new stratigraphic understanding of offshore Ireland into a regional North Atlantic context.*** Now that a new understanding of offshore Ireland is in place following this project, it would be valuable to carry out a detailed comparison with other conjugage margin countries. For the current project stratigraphic comparisons have been made using published data from other countries, but a more detailed assessment, particularly of items such as major sequence development, structural evolution and timing, source rock development and reservoir development, would be valuable.
- ***Structural evolution assessment of offshore Ireland***. With the new stratigraphic schemes now defined, it would be worthwhile carrying out a full study of the structural evolution, with accurate timings of structural events, such as uplift and faulting, calibrated by the new chronostratigraphy, of the offshore Ireland area. This would be key to any geological modelling, basin analysis or source rock basin modelling evaluations in the future. It is evident from published work that there are disagreements between authors regarding the structural evolution of particular areas, for example of the North Celtic Sea Basin (see discussion in Johnston *et al*., 2001, page 255), and the new stratigraphy, tied to high quality seismic data, would undoubtedly help clarify the timings and nature of structural changes, both within and between basins.
- ***Structural elements redefinition***. Allied to the above, a rigorous redefinition of the structural elements of the whole offshore Ireland area, is recommended, tied in particular to modern 3D and 2D seismic, and calibrated by the new chronostratigraphy. For example, with the extensive 3D seismic that is now available from the Porcupine Basin, a more detailed assessment and definition of subbasins and structural highs would be possible.
- ***Fastnet/North Celtic Sea Basin boundary further study***. The boundary area between the Fastnet Basin and North Celtic Sea Basin has been redefined in this project (see section A.4), however, a more thorough study of this structural region, together with a detailed assessment of the stratigraphic changes that took place in this area, and the underlying controls, is recommended, to further the understanding of this important structural area.
- ***Controls on unconformity/sequence boundary development***. It would be worthwhile to more fully consider the controls on the development of unconformities, the full evaluation of which has been beyond the scope of the current project. It is highly likely that these are related to major structural changes across the offshore area, however, a full evaluation of this aspect is recommended.
- ***Source rock distribution detailed mapping***. Given that information is now available regarding the definition of source rock intervals, it is important to map their distribution using an appropriate grid of seismic data.
- ***Incorporate additional source rock data from boreholes***. The geochemistry data that exists in DSDP/IODP/ODP holes was not collated as part of the IS16/01 project and therefore has not been analysed in the current study. It would be worthwhile incorporating this data into results of the current evaluation at some future point in time.
- ***Additional geochemical analyses***. It would be useful to obtain improved sample and well coverage for the geochemical characterization of some stratigraphic intervals where data coverage is currently insufficient to draw reliable conclusions on their source rock potential. Carrying out additional analyses on samples from the ten formations that were characterised as showing limited source potential in this study (see plots in Appendix E) should improve understanding of their hydrocarbon generation potential. Additional analyses are also considered useful for the Carboniferous Pennine Coal Measures, an age equivalent of the Blackthorn Group which does show some source potential. Data availability for this interval was very limited in this study, and although increased TOC contents up to 7% show the Pennine Coal Measures can be organic rich, no Rock-Eval data were available to characterize its source potential.

- ***Hydrocarbons to source rock correlations***. This study has produced a different assessment of some source rock intervals (ages and lithostratigraphic assignment) compared to the legacy operator reports. Based on this new scheme it would be valuable to carry out a hydrocarbon-source correlation exercise.
- ***Geochemistry& reservoir data matching***. For this project, significant time was spent addressing inconsistencies in naming for pilot holes, well re-entries and side-tracks and correctly allocating biostratigraphic data (and wireline logs) to the appropriate well, re-entry or sidetrack. Considerable effort was made to check that biostratigraphic reports were correctly attributed to the appropriate well, re-entry or sidetrack, and a number of errors of attribution were corrected. A similar check of the allocation of data to the correct well is recommended for other data types from legacy operator reports.
- ***Basin and maturity modelling***. Following from several of the above evaluations (e.g. structural evolution of basins), carry out basin and maturity modelling to define areas of mature source rock and timings of hydrocarbon expulsion. This could be related to the structural evolution assessment of the basins to establish a petroleum systems chart per basin.
- ***Sedimentological analyses of conventional cores***. A detailed sedimentological analysis of all the core, combined with a focused and high resolution biostratigraphic analytical programme. This would be useful in helping to refine the palaeoenvironments of the various formations, members and beds, to better define reservoir facies and evaluate controls on reservoir quality.
- ***Reservoir distribution detailed mapping***. Similarly, now that the new stratigraphy is in place, reservoir intervals could be mapped beyond the known distribution according to all available wells, tied to a regional seismic grid.
- ***Reassess sandstone provenance***. With the new stratigraphy now in place, it would be advisable to reassess the sandstone provenance studies data, for instance for the Jurassic of the northern Porcupine Basin (provenance pilot study of Tyrrell *et al*., 2006) and the "Permo-Triassic and Middle Jurassic" sandstones of the 12/2-1Z well (Tyrrell *et al*., 2010).
- ***Update play fairway analysis***. Following from the above, it is recommended to carry out an updated play fairway analysis utilizing the new stratigraphy tied to source rock and reservoir mapping. This would update previous studies (for example, IS05/11, Ternan, 2006).
- ***Reassessment of well lithologies***. The lithological successions displayed on the operators' composite logs have been found to be of variable accuracy and it has been necessary to edit these in the light of new lithological data synthesized in this study. There are several instances whereby lithological data arising from first hand descriptions of samples analysed for biostratigraphy in this study, differ from those on the composite logs. In addition, there are cases where sidewall lithological descriptions are at odds with the lithologies shown on the composite logs. In general, it has been found that routine well biostratigraphic reports typically contain quite detailed lithological descriptions of intervals studied, including sidewall cores and core chips. Such descriptions have generally been found to be reliable, and often provide greater detail than the original composite log or mud log. This may be partially explained by the former being based on well site wet samples, whereas contractors' office-based descriptions are based on washed cuttings samples. These contractor reports in several cases differ from the operator's interpretation. While we have corrected the operators' lithological successions in such cases, it is beyond the remit of the current study to evaluate all lithological successions in all wells. It follows, therefore, that the lithologies shown on the composite logs, and on the summary logs in this study, may not be wholly accurate in all cases. A future avenue of work to address this issue may therefore be worth considering.
- ***Detrital zircon study of "26/28 basal conglomerate" in Connemara Discovery area***. A potential avenue of further investigation would be to attempt to source detrital zircons from the quartzite unit penetrated at TD in the 26/28-**1**, -2 and -3 wells in an attempt to date and characterize this rock unit.
- ***Seismic velocities***. Significant seismic velocity variations from basin to basin have been noted (see Appendix **A.7**). It would be worthwhile to follow up these observations with further study, possibly as part of a basin modelling exercise.

F.2 GENERAL RECOMMENDATIONS

- In general, the stratigraphy of all subsurface areas of offshore Ireland is complex. Many unconformities are present in the well successions which often render it difficult to synthesise the overall complete stratigraphic succession across a basin or region. It is therefore recommended that routine biostratigraphic analysis is carried out on all future exploration and appraisal wells to help address this.
- Several well sections drilled in the Porcupine Basin have proved difficult to date on the basis of biostratigraphy data due to drilling techniques used (combination of diamond bit with turbine) which are highly destructive to microfossil and palynomorph recovery. In certain circumstances it is necessary to use such techniques, however, it is recommended that in such cases, where the ditch cuttings samples are compromised by the drilling technique, that efforts are made to obtain samples (sidewall cores, cores) that will optimize biostratigraphic recovery, if at all possible.