# Risking Review and Potential Uplift for Walton-Morant Licence and Colibri Prospect Contingent Upon a Successful Piston Coring Campaign

## Report for United Oil and Gas plc

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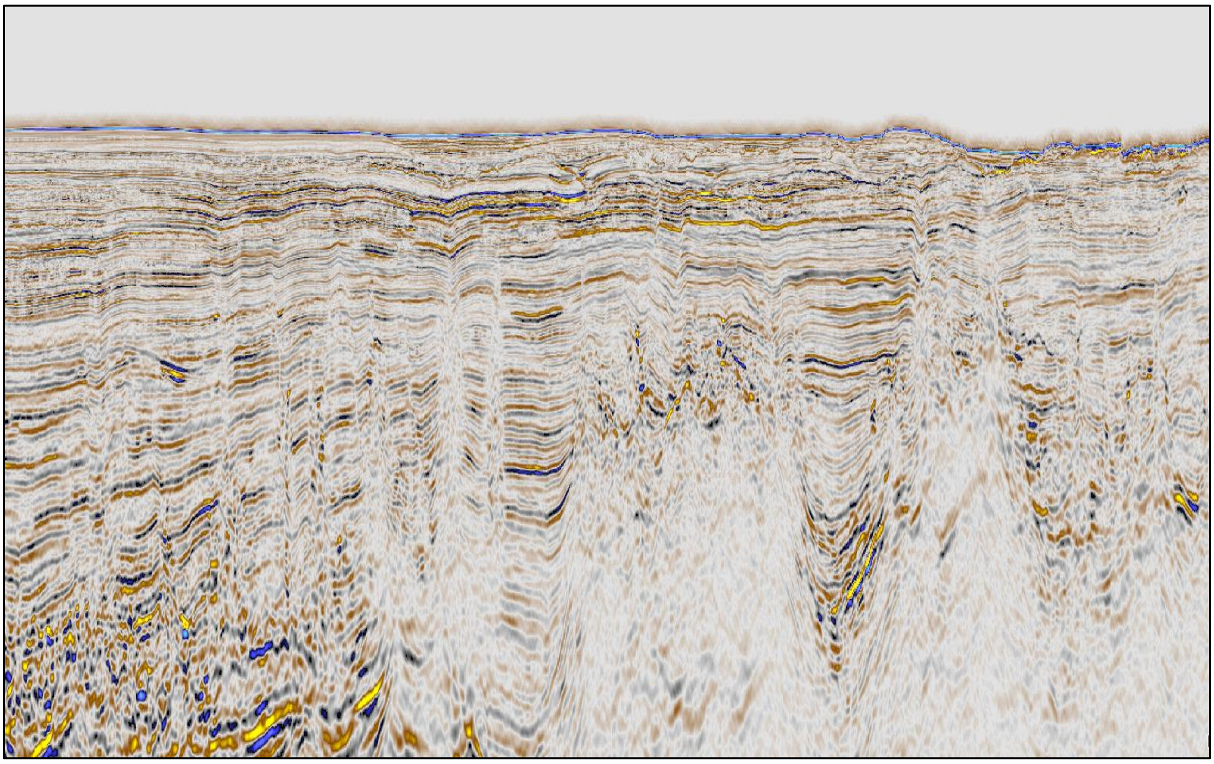

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# 1. Introduction

## Context and purpose of evaluation

United Oil and Gas plc (UOG) has included a surface geochemical exploration piston coring survey as part of the work program under the extension in the Walton and Morant Basins to the 3rd sub-period of the initial exploration period in the PSA for the Walton Morant Licence in Jamaica (Fig. 1). The aim of this survey is to de-risk the petroleum system, especially the hydrocarbon source and migration needed to charge the prospects. This is done through the geochemical detection of naturally occurring hydrocarbons seeping through the seabed. Seepage of deep-sourced hydrocarbons is controlled by the “plumbing system” of the basin and is only expected where migration routes to the surface exist. These can be marked by seabed features such as pockmarks or carbonate mounds but are much more rigorously identified when seismic data are integrated such that surface features can be linked to faults and other evidence for focused vertical or lateral fluid movement such as “pipes” and seismic amplitude anomalies.

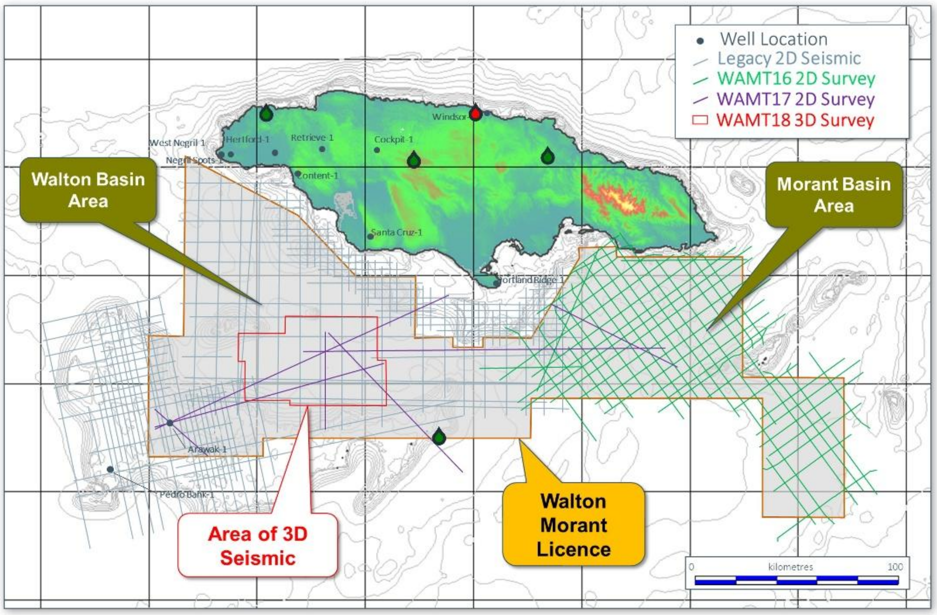


*Figure 1: Map showing location of Walton and Morant Basins relative to the island of Jamaica, UOG 2016 - 2018 seismic data, and historical exploration wells (i) onshore, (ii) on the shallow Pedro Bank limestone platform that forms the southern margin of the Walton Basin. Green markers = proven oil seeps, red marker = proven gas seep*

A previous piston coring survey was carried out by the former operator in 2015 but with limited legacy seismic data available to target the coring sites. No evidence of natural thermogenic hydrocarbons was detected. Since then, new 2D (2016, 2017) and 3D (2018) seismic data were obtained and interpreted, along with details of naturally occurring seeps and slicks, a new conceptual understanding of regional source rock distribution, revisions to basin models, and a new understanding of the geological history of the basin. These results suggest that few of the 2015 coring sites were appropriately located to be able to detect a working petroleum system, and so the results of that survey can not be considered a valid test.

Prospects identified by UOG in the Walton and Morant Basins were summarised in the Gaffney, Cline and Associates Limited (GaffneyCline) Prospective Resources Audit, 04 December 2020, with associated chance of geological discovery (Pg) values for each, ranging between 19% for the preferred drill candidate Colibri to 6% for some of the Morant Basin prospects.

UOG requested Iapetus Geoscience Limited to undertake a review of the risking in light of work carried out on the licence since the GaffneyCline (2020) audit, and also to consider how the risking would be uplifted in a “success case” piston coring campaign – in other words in the scenario that the piston coring revealed direct evidence of a working thermogenic petroleum system in the basins. The review concentrates on those elements of the petroleum system that can be impacted by the piston coring results, namely source rock presence, maturity, migration and containment.

Iapetus Geoscience Limited also advised on the potential piston coring sites to help select those that stood the best chance of testing for the presence of an active petroleum system.

### Relevant experience

Iapetus Geoscience Limited is qualified to undertake this review owing to its extensive experience of the Walton Morant licence and of the regional geology of Jamaica and the western Caribbean. Dr James Hendry worked on the Walton Morant Licence for Tullow Oil between 2015 – 2020 as Lead and Principal Geoscientist and was deeply involved in the integration and interpretation of different onshore and offshore data sets. He has previously consulted for United Oil and Gas on the reservoir potential in the Walton Basin, Jamaica onshore geology and source rock potential, and on the tectonic history of the Jamaica region. He is a geologist with a breadth and depth of experience gained over 35 years professional practice in senior positions in both academia and industry and holds a PhD in Sedimentology and Geochemistry from the University of Liverpool.

## 2. Disclaimer

Risking is an imprecise science open to a range of subjectivities and psychological biases (Polson and Curtis, 2010). There is no "standard" approach within the industry and no widely accepted benchmarking. There is also no "correct" answer. A drilled prospect will either be a discovery (Pg = 1.0) or a failure (Pg = 0.0). Risking is the best attempt to summarise all the available evidence and understanding of an exploration play or prospect to estimate chance of geological success in a probabilistic manner. Most approaches estimate a probability for each of the independent fundamental components in the petroleum system and multiply these together to give an overall Pg (e.g. Rose, 2001). The definition and number of the components vary between operators, but they are always weighted equally because the failure of any one of them results in a failure of the prospect.

Iapetus Geoscience Limited is an independent consultancy that has no commercial interest in the Walton-Morant Licence, and it has carried out the risking as objectively as possible. The contents of this document reflect its professional judgement based on latest geological studies and relevant licence information provided by UOG, which it assumes to be comprehensive and accurate, and on its own technical experience and expertise. Nothing in this document can be considered a guarantee of success or failure. The Pg values proposed are not linked to any quantified recoverable volume of hydrocarbons. Iapetus Geoscience Limited does not make any recommendations for or against any course of action on the basis of its assessment and is not accountable for any commercial or strategic decisions arising from the use of this document by UOG or any other party.

## 3. Aims and objectives of piston coring

The primary aim of the piston coring programme is to test for the geochemical expression of migrated natural hydrocarbons at the seabed by collecting a sediment sample from which liquid hydrocarbons and interstitial gasses, if present, are extracted and analysed. In a success case this will demonstrate active generation and migration in the basin, or remigration of previously generated hydrocarbons (Fig. 2.).

By carefully targeting the piston coring sites with reference to seismic data a secondary aim is to investigate potential indicators of subsurface hydrocarbon flow. In a success case these can be more confidently interpreted in parts of the basin that have not been sampled.

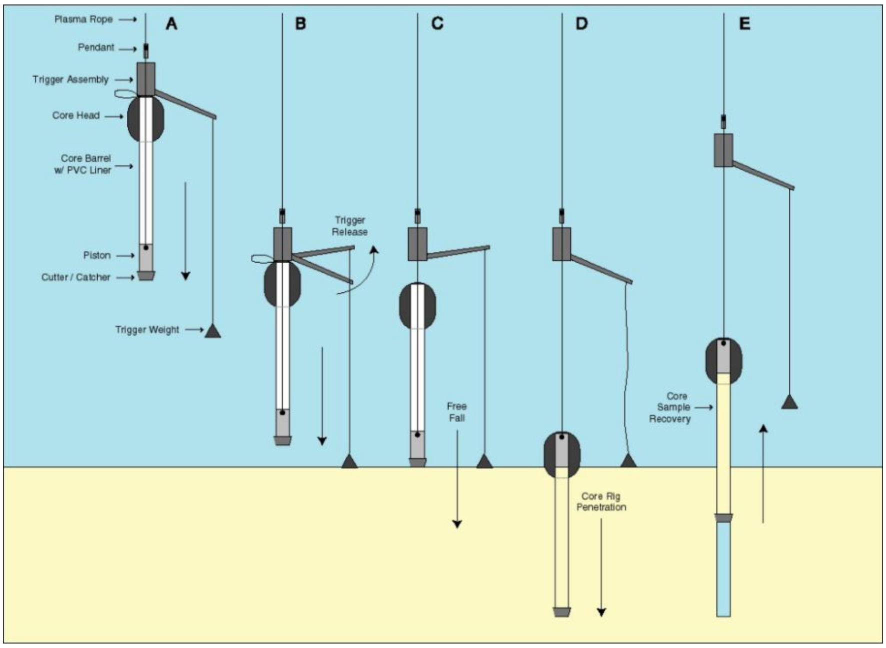


*Figure 2: Schematic of piston core recovery method.*

A third aim is to investigate containment of the identified prospects. Even if migration to seabed is demonstrated there remains a risk of leakage from the prospects. In a success case piston cores taken over the prospect crests or faults above them will fail to show any evidence of migrated hydrocarbons despite such evidence being present at targeted sites elsewhere in the basin.

Some multibeam bathymetry and thermal probes to collect heat flow and thermal conductivity data will be included in the campaign. Bathymetry can help pinpoint the piston core locations in / on surface features that have been linked to potential seismic evidence of fluid flow, given that its spatial resolution is much higher. Backscatter data from the survey can also help to avoid coring sites that are unsuitable owing to coral cover, boulders, or other features, and in ideal cases it can detect seepage plumes into the water column. Thermal data are important for validating the basin models that are used to predict the timing, amount and composition (phase) of hydrocarbon generation from the interpreted source rock kitchens.

## 4. Approach to risking

The GaffneyCline (2020) Prospective Resources Audit proposed Pg values for 5 prospects in the Walton Basin where 3D seismic is available and 6 leads in the Morant Basin where 2D seismic with a line spacing of approx. 10km is available. However, there was limited information as to the geological assumptions and deductions upon which the prognoses were based. In Appendix 1 of the Audit a probability was assigned for “*Trap and seal*”, “*Reservoir*”, “*HC Source*” and “*Geological Timing*”, and these were multiplied to give the ultimate Pg. The component probabilities were derived from a matrix of chance versus confidence (effectively data quality / data control) but specific reasons for selecting values were not given and so cannot be independently evaluated. There is a lack of industry consensus over which components to use, and as to which are truly independent. For example, GaffneyCline included migration as part of “HC source” but it is also inherently part of the “Geological Timing” factor.

Many different risking calculations exist with anything from four to nine components being multiplied, frequently employing sub-components where the least favourable sub-component is carried forward into the final calculation ("weakest link"). Various industry software packages for calculating volumetrics include a Pg module to capture the inputs (e.g. MMRA, GeoX). Some use detailed semiquantitative questionnaires to guide input values, but these are rarely reported. In a frontier scenario, the danger of an over-granular approach is that it generates a lower Pg than an equivalent prospect in a more mature province. The geology is not being risked so much as the data availability, yet a lack of data is not a predictor of ultimate failure. A complete lack of knowledge should equate to a 50:50 chance of success, but there is often circumstantial or conceptual evidence that can sway the risk to more or less favourable values.

Some companies prefer to risk the petroleum play and then risk the prospects within it on the basis that they share the same dependencies. However, with the exception of source rock and migration, the Walton Basin prospects are sufficiently different as to be considered as independent plays.

More important than the particulars of the calculation used is that the rationale for selection of the input values is **clear**, is as **objective** as realistically possible, and is **documented** and **auditable**. It is also vital that the components used are truly independent and do not omit any geological factor that can influence the chance of a successful discovery.

For the purposes of this exercise, Iapetus Geoscience Limited choose to employ the risk table approach of Milkov (2015). The advantages of this are that it is consistent, transparent (peer-reviewed, published in a leading academic journal), and incorporates both data-derived and model-derived geological evidence to avoid unduly "penalising" frontier basins. The components were carefully chosen by Milkov to be independent and comprehensive. Sometimes the table options do not precisely capture the geological conditions of the offshore Jamaica basins and prospects, so a rationale for the choice is provided that can be reviewed and adjusted when more data are available. This is more rigorous and "honest" than modifying the tables.

The six independent risking components are:

1. **Structure (closure, geometry, container)**
2. **Presence of reservoir facies**
3. **Reservoir deliverability**
4. **Seal (mechanism, quality)**
5. **Source rock (presence, maturity)**
6. **Migration from mature kitchen**

The primary Colibri prospect is risked according to the current state of geological knowledge, incorporating results of studies carried out since December 2020. The risking is then reiterated to include likely uplift from a successful piston coring campaign. Differences in the risking for the secondary Oriole prospect are briefly discussed.

# 5. Unique geological context of offshore Jamaica

Jamaica has had a complex geological and plate tectonic history, the specific details of which are beyond the scope of this report (Envoi, 2024; Iapetus Geoscience Limited, 2023). In simple terms it originated from several Early Cretaceous intra-oceanic volcanic arcs and a Middle Cretaceous oceanic plateau that accreted in the proto-Pacific Ocean at the beginning of the Late Cretaceous, moved eastwards and collided obliquely with the North American continent in the latter part of the Late Cretaceous and Palaeogene before progressively migrating to its current position by strike-slip along the Caribbean – North American plate boundary as the Cayman Trough opened through the Neogene.

The basement of Jamaica consists of different parts of this tectonic jigsaw, the largest part of which in western and Central Jamaica consists of deep but narrow intra- or back-arc basins filled by shallow to deep marine mudrocks, sandstones and limestones, separated by volcanic ridges. Shallowing during the Palaeogene collision led to a widespread unconformity then deposition of deep to shallow marine sandstones and shales in rift basins that opened as Jamaica began to be moved eastward along the plate boundary. These sediments were part locally derived and partly sourced from the adjacent continental landmass, but as Jamaica was separated from it, the Palaeogene rifts and underlying Cretaceous basins were blanketed by marine limestone deposition. Carbonate platforms with coarse shelly limestones developed on basement highs and adjacent deeper water carbonate basins accumulated carbonate muds. In the Late Miocene a complex rearrangement of the North Caribbean plate boundary initiated the vertical uplift of the island of Jamaica with coeval subsidence of the offshore areas. Uplift accelerated in the Quaternary, especially in the Blue Mountains area.

The Walton Basin offshore southern Jamaica is a Late Cretaceous to Palaeogene rift that underwent progressive post-rift subsidence throughout the Neogene, accelerating in the late Miocene and Quaternary. It is surrounded by Neogene carbonate platforms that have been drilled to the south (Arawak-1, Pedro Bank-1) providing a stratigraphic record back to the early Palaeogene, whilst the basin itself was filled by slope apron and pelagic limestones. The Morant Basin offshore SE Jamaica may contain Palaeogene or older sediment-filled rifts that can be linked to those mapped onshore but is strongly overprinted by Miocene extension and strike slip with some evidence for localised volcanism. It lacks a thick Neogene limestone section but received abundant sandy and muddy sediment from the uplift of the Blue Mountains to the north.

The uniqueness of Jamaica is that the Late Miocene to Quaternary uplift and associated tectonic movements, plus erosion, exposes large tracts of the Cretaceous and Palaeogene geology onshore that are in the subsurface offshore (Fig. 3). It offers a window into the adjacent basins that were, prior to the late Miocene, effectively contiguous with it. This onshore geological history has been studied in detail by academic and industry geoscientists, including present and past licence holders of the Walton Morant licence. It means that the onshore geology and onshore exploration wells can be directly related to the offshore basins. There are currently no exploration wells in the licence, but the proximity of the onshore data provides at least as much and arguably more geological control than would be the case in a frontier basin with a few existing wildcats.

Another key factor is that onshore Jamaica hosts a verified working petroleum system that is of the same age as that predicted in the correlative offshore. Ten out of eleven onshore wells drilled between 1955 – 1982 (Fig. 1) had hydrocarbon shows, and active seeps have been recorded in several locations. The oils have been typed to Cretaceous or Jurassic source rocks. Oil source potential has been proven in outcrop samples of the Cenomanian-Turonian Rio Nuevo Formation (type II marine source rock). High-porosity Cretaceous carbonate reservoirs were encountered in the Negril Spots-1 well and Palaeogene limestone and sandstone reservoir facies are widespread across the island. Most of the historical onshore exploration wells failed to target valid structures, and Late Miocene to Recent tectonic inversion breached onshore traps. This inversion is absent from the Walton Basin and localised in the Morant Basin. An offshore oil seep compatible with the onshore seeps was also sampled on the east of the Pedro Bank (Blower Rock). This is on structural trend with the Morant Basin.

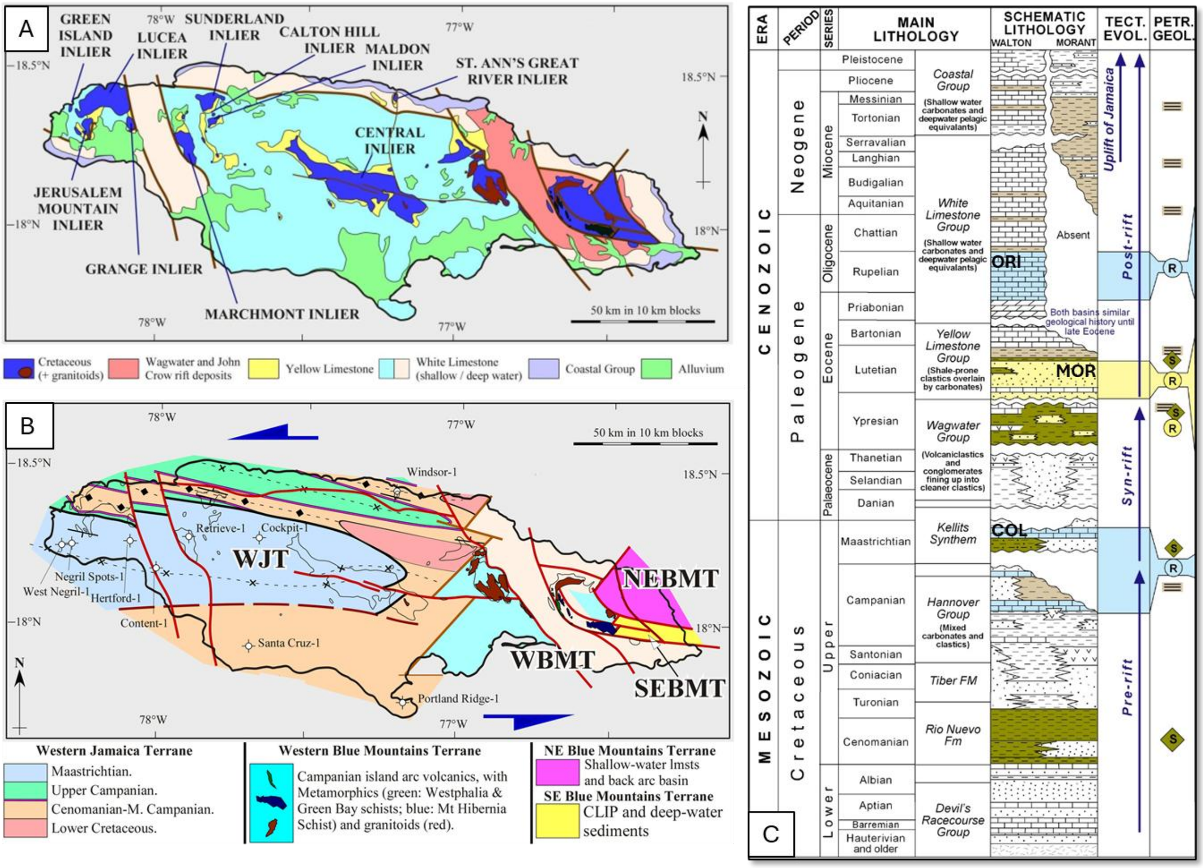


*Figure 3: A. Onshore geology of Jamaica. Dark blue = Cretaceous inliers, pink = Palaeocene to Early Eocene rift basin sediments, yellow = Middle Eocene shelf sediments, pale blue = Late Eocene to Late Miocene shallow marine limestones, beige = Oligocene to Late Miocene deep marine lime mudstones. B. Interpretation of Cretaceous basement. WJT consists of limestones, sandstones and mudrocks deposited in intra-arc rift basins and on adjacent shallow platforms. Due to plate tectonics, the Walton and Morant Basins will both have been adjacent to this terrane in the Cretaceous, and the Morant Basin will also have been positioned to receive sediments from the Palaeogene rift (beige). In the Neogene the Walton Basin was a site of deep marine lime mudstone deposition whilst the Morant Basin received sediment eroded from the rapidly uplifting Blue Mountains terranes. Modified from Mitchell (2013, 2020). C. Geological column showing extrapolation of onshore to offshore geology. Main source rock in Cretaceous Rio Nuevo Formation. Context of Colibri (COL), Oriole (ORI) and Morant Basin prospects (MOR) is also shown.*

The 3D seismic acquired in the Walton Basin revealed spectacular features that strongly suggest vertical fluid flow from mapped source kitchens to shallower strata, including numerous "pipes" (circular in plan view) and modified faults resulting from localised dissolution in the basinal limestones most probably from acidic pre-charge fluids (Figs. 4 - 7). There are also frequent "soft" (low acoustic impedance) seismic amplitude anomalies that are consistent with hydrocarbon presence - potential Direct Hydrocarbon Indicators or DHIs. Only a small proportion of the "pipes" reach seabed, and these are strong candidates for piston coring, especially where they are adjacent to amplitude anomalies. The 3D seismic also revealed a striking, structurally conformant, low velocity anomaly that coincides with the Colibri prospect and that is very difficult to explain as something other than a high porosity reservoir section. Finally, the seismic velocities suggested overpressure coincident with the mapped source kitchens, as would be expected as a result of hydrocarbon generation and expulsion.

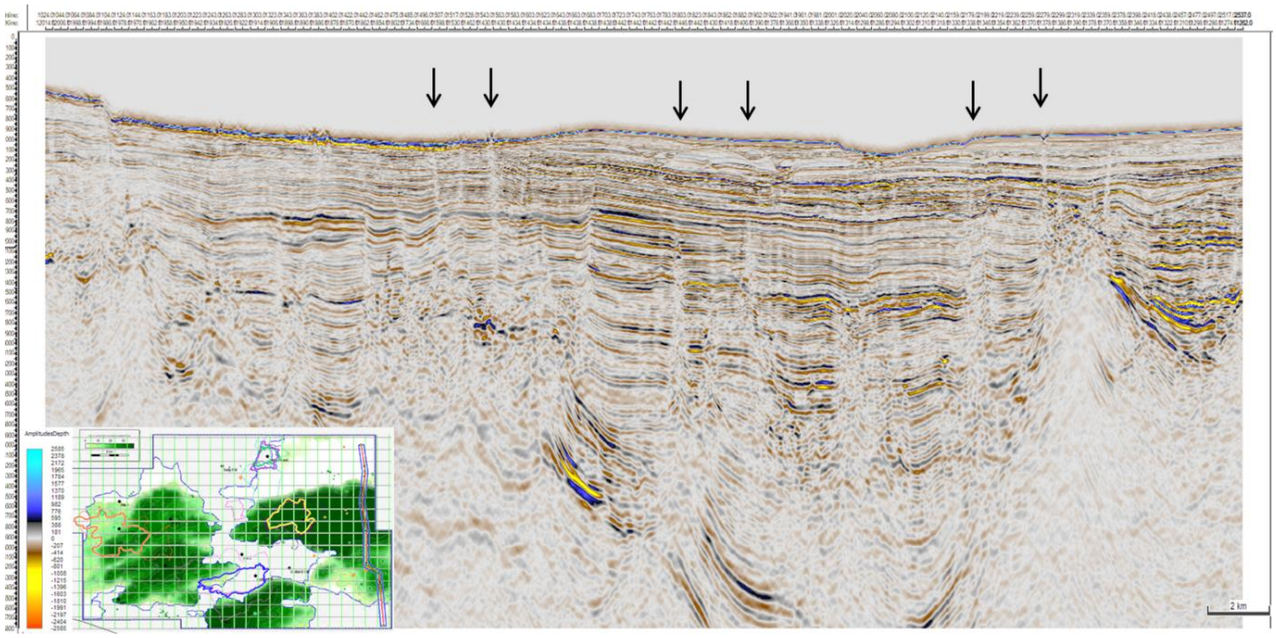

*Figure 4: N-S arbitrary 3D seismic line across eastern kitchen area with multiple examples of fluid "pipes" and modified faults (linear in plan view). Some correspond to seabed features; others terminate in the shallow subsurface. Anomalous "soft" amplitude reflectors show as yellow to orange colours. Inset map shows oil expulsion from Late Cretaceous source rock, prospect outlines and candidate piston coring sites.*

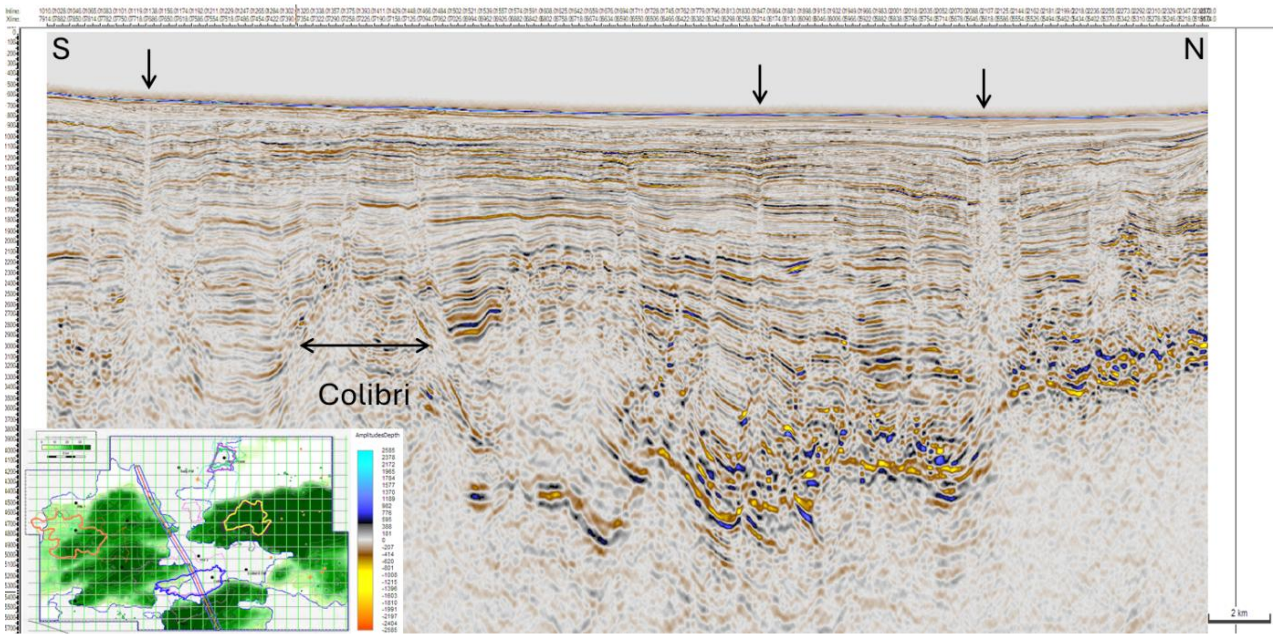


*Figure 5: N-S arbitrary 3D seismic line across Colibri and adjacent kitchen areas with deep-rooted fluid "pipes". Inset map as in Fig. 4.*

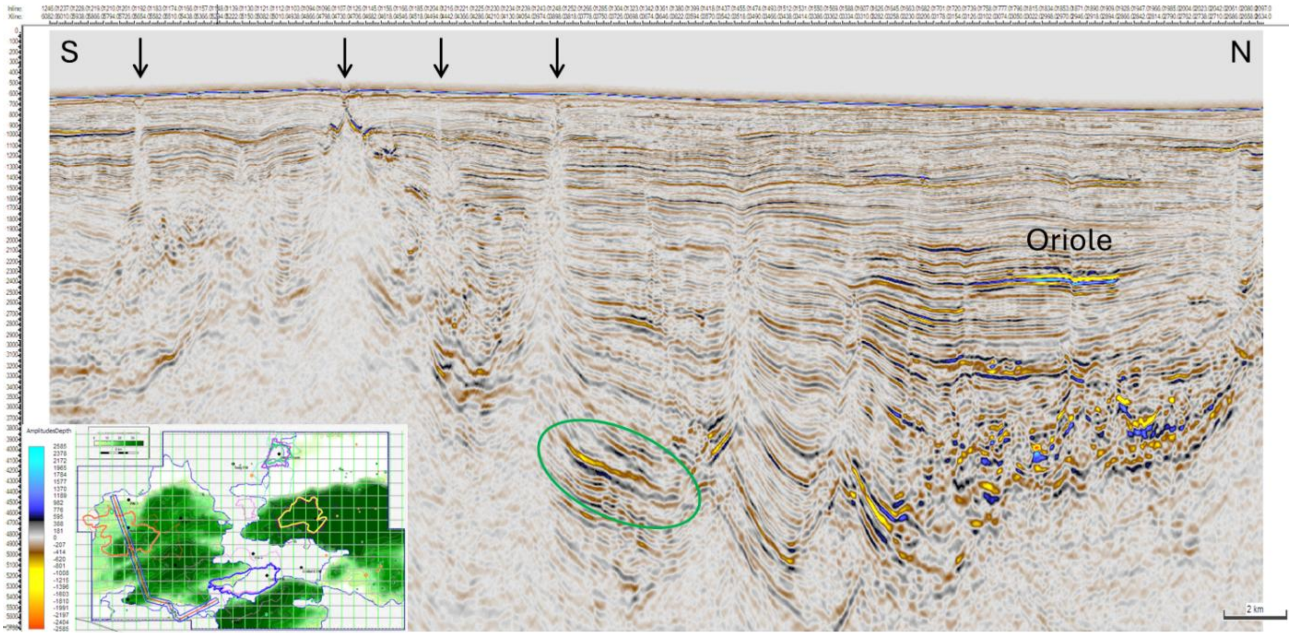


Figure 6: *N-S arbitrary 3D seismic line across Oriole and adjacent kitchen showing fluid "pipes", some of which correspond to seabed or very shallow pockmark features. Green oval highlights typical seismic response expected for source rock (more broken up by faulting elsewhere). Note Oriole is a prominent "soft" amplitude anomaly. Inset map as in Fig. 4.*

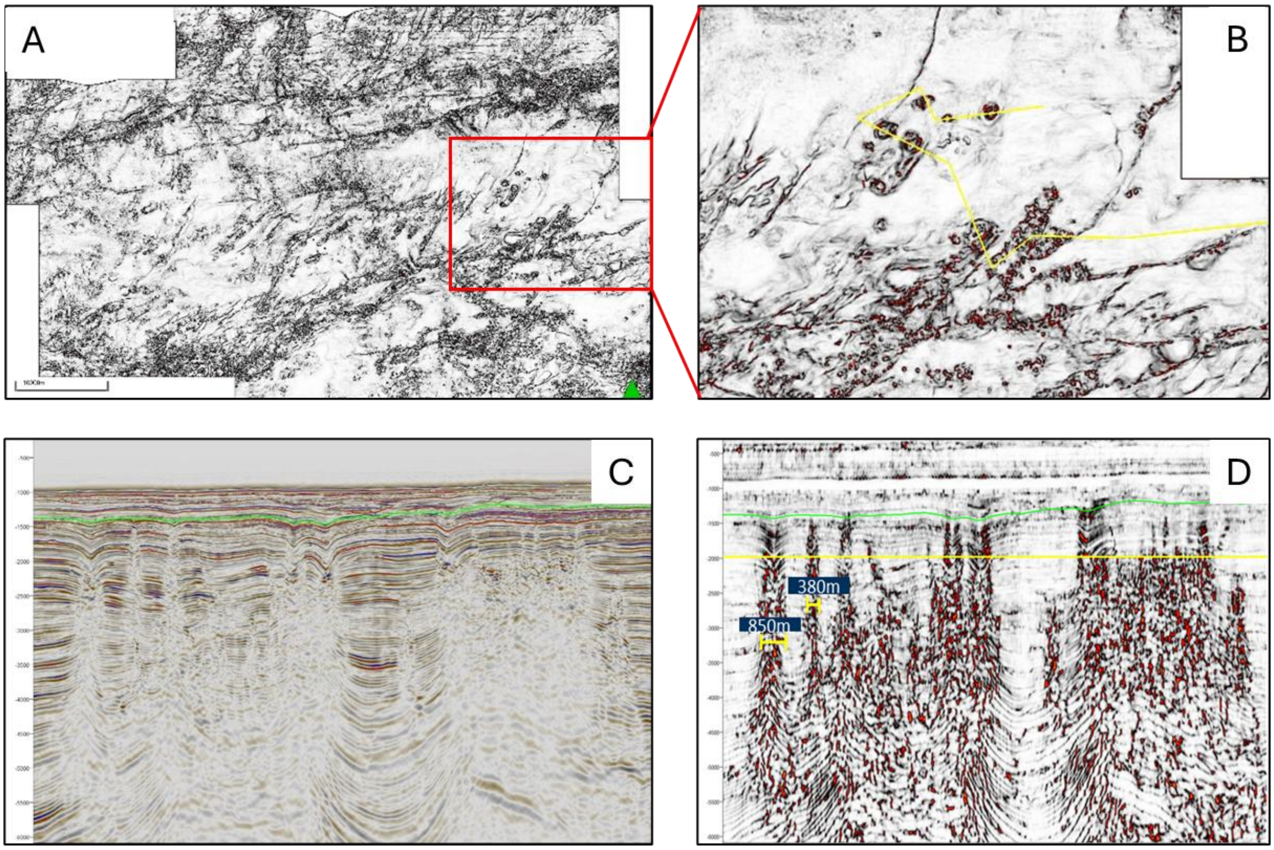


*Figure 7: A and B. 3D seismic variance attribute depth slice showing detail of modified faults and fluid "pipes". C and D. Arbitrary 3D seismic line and variance attribute through fluid "pipes". Green horizon shows local termination of pipes at about 400 m below sea floor; others extend to seabed (Figs. 4 – 6).*

# 6. Geological work undertaken since 2020

A significant amount of geological and geophysical work has been carried out by UOG since the GaffneyCline (2020) Prospective Resources Audit and can inform the new risking. This is summarised below:

- Revised mapping of seismic horizons and validation of prospects on the 3D seismic data in the Walton Basin, including consistent mapping of the proposed Late Cretaceous (Cenomanian – Turonian) source kitchens and identification of appropriate source rock seismic facies with high amplitudes that brighten from far to near angle stacks (Fig. 8) (Løseth et al., 2011).
- A completely new horizon and fault interpretation of the Morant Basin 2D seismic grid incorporating the new understanding of its history based on regional tectonics and differences from the Walton Basin (e.g. Iapetus Geoscience Limited, 2023).
- A new satellite slick study of offshore Jamaica with 18-year repeatability data window that revealed a significant and repeatable anomaly in the east of the Walton Basin that can be related to seismic evidence for localised seabed erosion and potential fluid leakage (Fig. 9).
- A new palaeo-geographic model for Late Cretaceous source rock distribution that shows Jamaica to have been in the middle of a discrete fairway of prospectivity which includes basins that are now distributed across the northern Caribbean due to subsequent plate tectonics (Fig. 10).
- Incorporation of the newly mapped source rock horizons into the Walton Basin petroleum systems model, testing and validation of thermal data, reiteration of maturation and expulsion histories, fetch areas and migration pathways, and reservoir temperatures. Results showed a heat flow of 55 mW/m$^2$ best fit the available calibration data. This work verified the presence of major source kitchens close to the main prospects allowing for short-distance migration and sufficient charge to fill the prospects accounting for realistic migration losses (Fig. 11). It also demonstrated that charge timing allowed for the deposition of adequate top seal strata.
- Creation of an independent petroleum systems model for the Morant Basin using the new seismic interpretation and including both Late Cretaceous and Eocene source rock intervals (a viable Eocene source rock is documented onshore but is immature there and also in the Walton Basin). Results showed the prospects to be surrounded by viable source kitchens and favourably located to receive charge from both source rocks (Fig. 12).
- Review of those 2015 piston coring locations that lie on the 2018 seismic 3D survey in the Walton Basin or on lines of the 2016 seismic 2D survey in the Morant Basin to determine whether they were valid tests using criteria explained in Section 8 below. Of six within the Walton Basin 3D survey area only one could be considered a potential candidate for fluid seepage although it was not located over a kitchen area. This site recorded one of the most positive results for $C_{2+}$ alkanes, albeit still within the contractor's "background" range. None of the sites on or close to 2D lines in the Morant Basin corresponded to seismic evidence that would indicate the potential for a positive result.

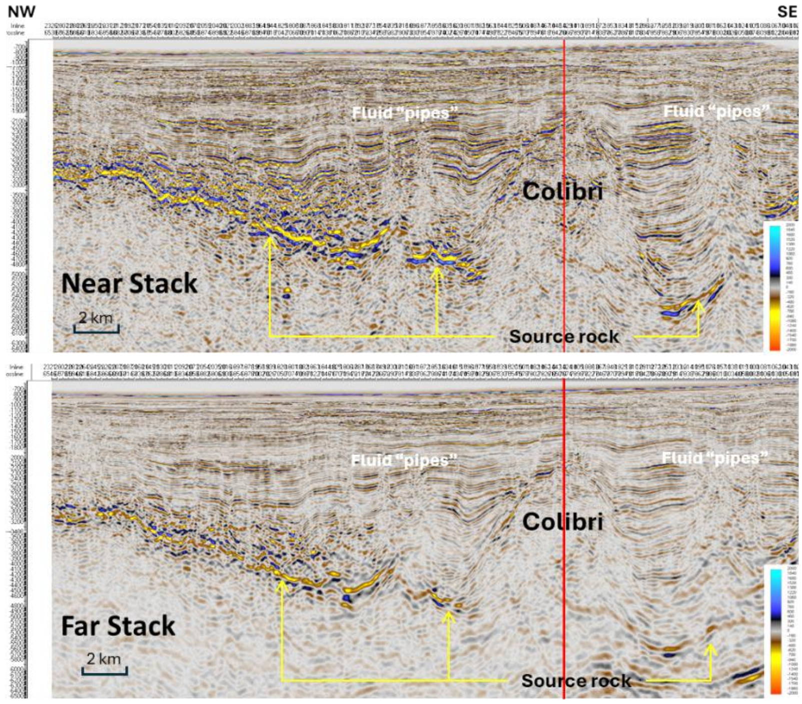


*Figure 8: Arbitrary 3D seismic line through Colibri and source kitchens on ether side. Interpreted source rock amplitude increases from far to near stack (brown to yellow). Note fluid "pipes" above kitchen areas and short migration distance up into the Colibri prospect.*

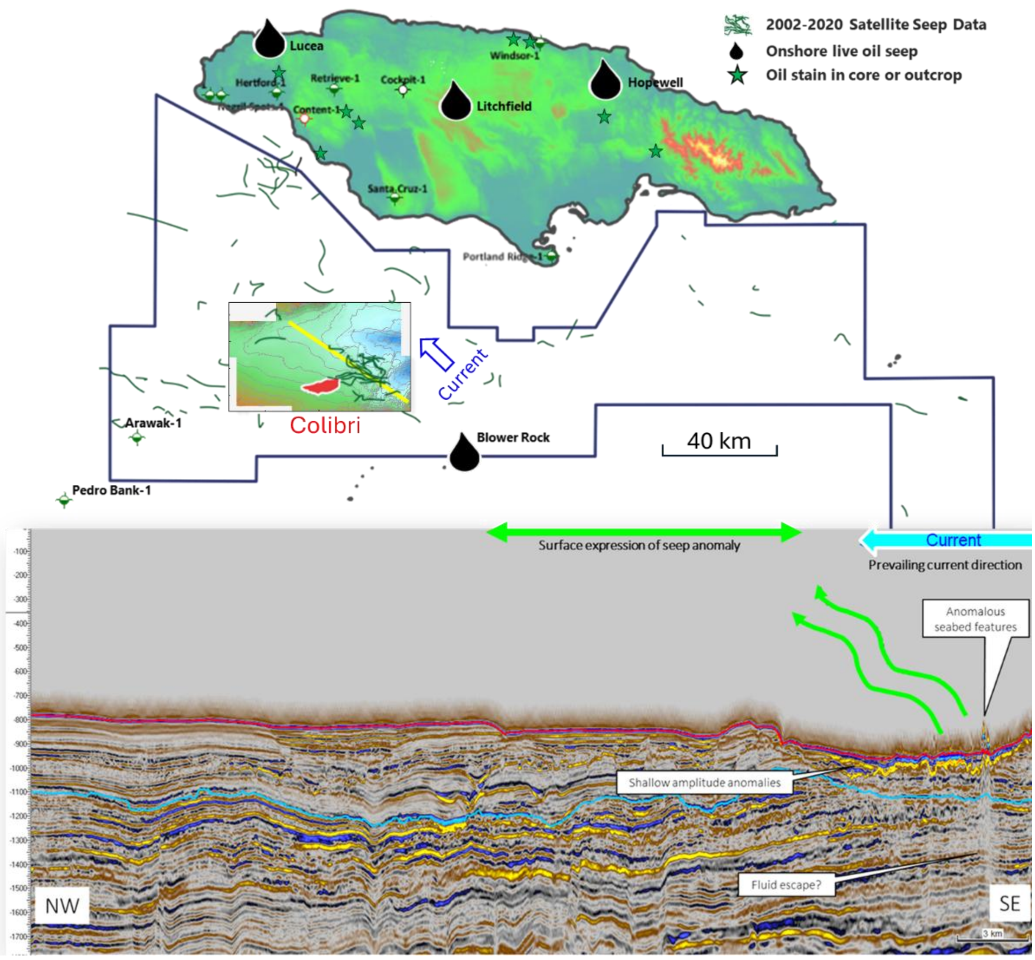


*Figure 9: Satellite seep data plus location of onshore and offshore seeps. 3D seismic line through area of seabed erosion and shallow amplitude anomalies corresponding to slick east of Colibri.*

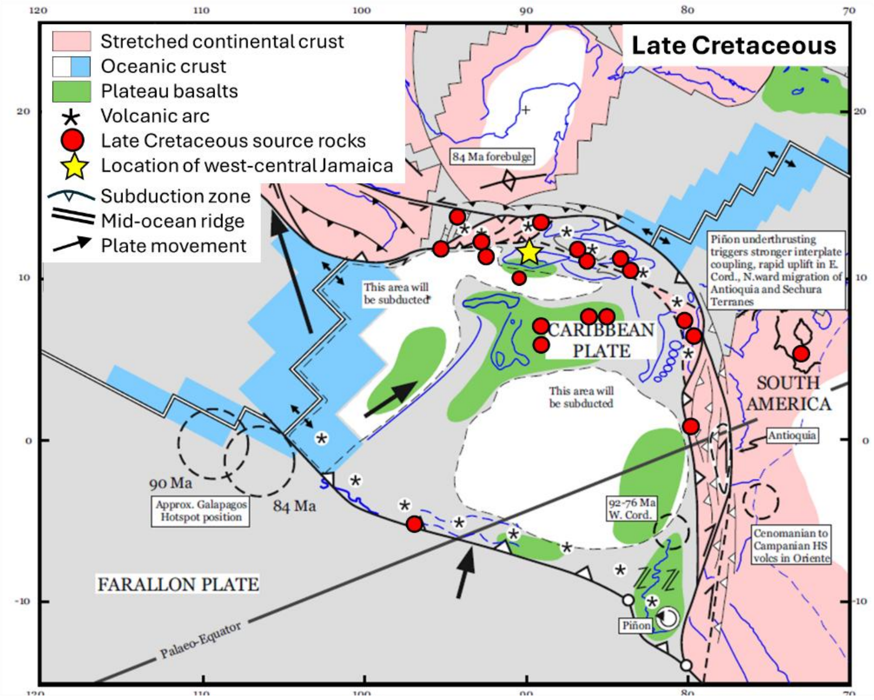


*Figure 10: Plate tectonic reconstruction of Caribbean in Late Cretaceous showing how the restored locations of known source rocks from different parts of the present-day Caribbean formed a fairway of intra-arc basins that includes Jamaica. Base map modified from Pindell and Kennan (2001).*

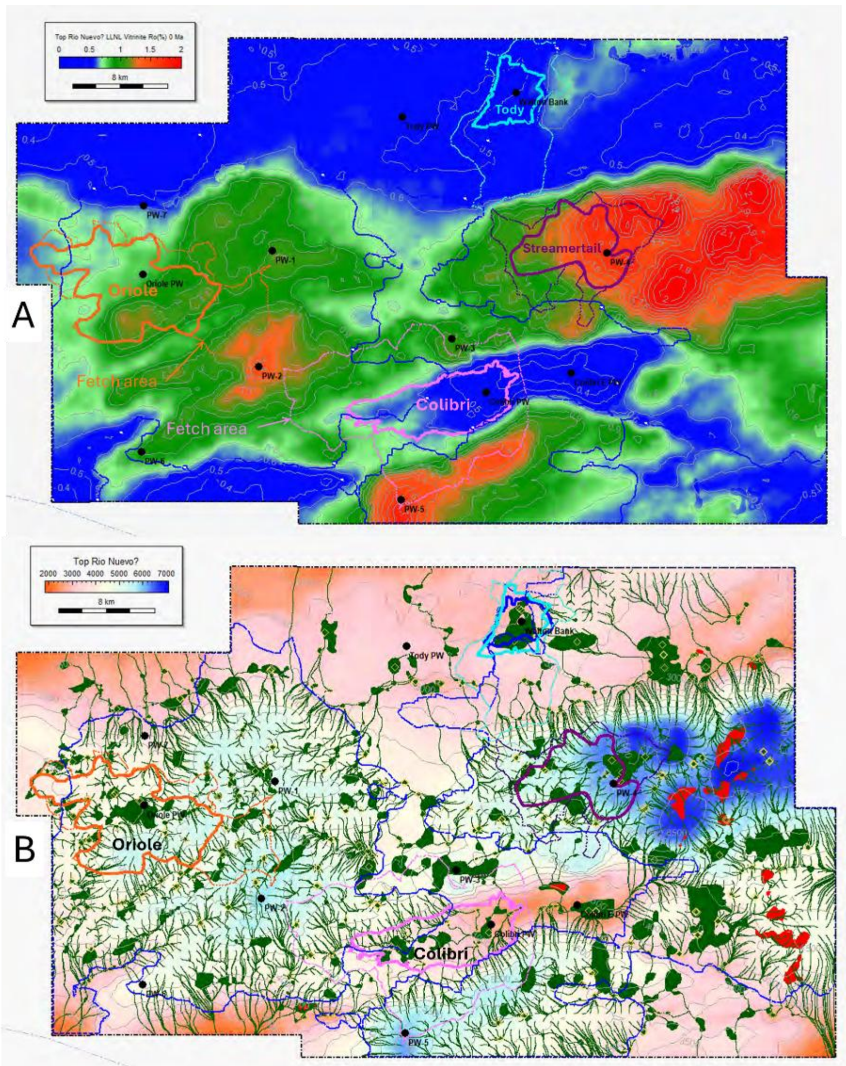


*Figure 11: A. Modelled maturity of the mapped Cretaceous type II source rock kitchen in the Walton Basin. Green = mid oil mature, orange = late oil mature, red = oil over-mature / gas mature. B. Migration modelling from the Upper Cretaceous source rock kitchens superimposed on depth map. Colibri is at a migration focus. Oriole and the other prospects are at a shallower level but above migration foci and linked to them by faults that show evidence for fluid modification.*



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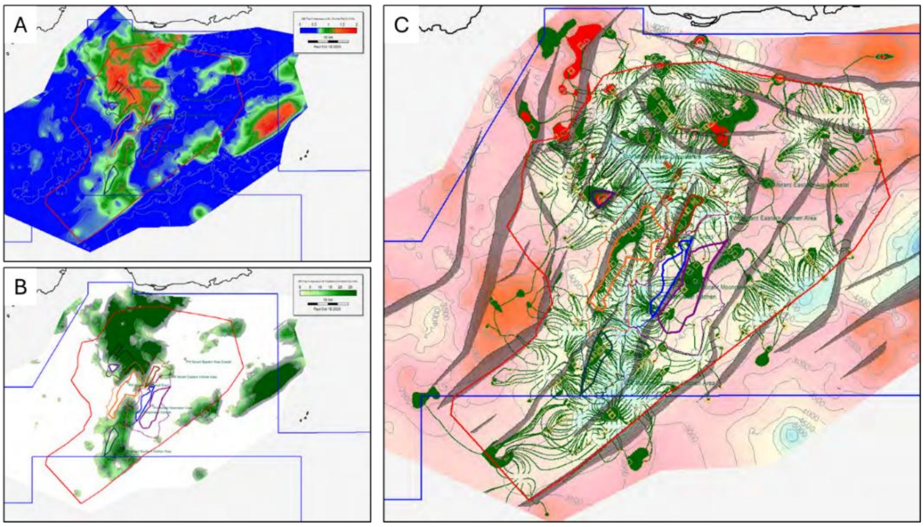

*Figure 12: A. Maturity map for Cretaceous source kitchens in the Morant Basin. Green = mid oil mature, orange = late oil mature, red = oil over-mature / gas mature. B. Oil expulsion map. C. Migration map showing that all the prospects (coloured polygons) are able to receive charge.*

# 7. Colibri prospect risking based on work since 2020

The risking tables from Milkov (2015) are reproduced below. In each case the green rectangles highlight the proposed risking for Colibri. The rationale for the selections is given below.

- **Structure: 0.85.** Mapped on 3D seismic, high relief structure (Fig. 13), no wells in basin so model developed using geologically appropriate analogues.
- **Presence of reservoir facies: 0.95**. No wells in basin but shallow marine carbonate reservoir suggested by seismic data analysis and mapping, including seismic facies, low velocity anomaly (Fig. 14), encouraging pilot ADF dispersion study.
- **Reservoir deliverability: 0.75**. Modelled reservoir temperature 60 - 80°C, anticipated rudist reef and associated skeletal facies. No wells *currently* in basin but Negril Spots-1 was in the basin at the time of reservoir deposition, in a similar structural context, and vuggy fractured dolomite was reported from the correlative section.
- **Seal: 0.65**. Top seal is inferred from seismic data including seismic facies, horizon onlap, and conformance of the low velocity anomaly to the Colibri prospect. It is also supported by conceptual models that predict blanketing of syn-rift Colibri by post-rift deep-water mudstone deposits that have correlatives exposed onshore, as well as by a lack of seabed pockmarks or fluid "pipes" over the crest of the structure; however, some faults do cut the top reservoir surface, and some lateral sealing may be fault-controlled (Fig. 13). The context is between a faulted horst block and a "buried hill".
- **Source rock presence and maturity: 0.80**. Basin model confirms fetch area experienced maximum temperature ≥ 150°C and majority currently in late mature window. No seeps sampled in the *current* basin, but correlative onshore seeps and source rocks indicate a type II source. Source kitchen distribution based on seismic mapping (Fig. 11).
- **Migration from mature kitchen: 0.70**. Basin model predicts Colibri to be a migration focus, with 2 – 10 km lateral and ≤ 2,000 m vertical migration distance from fetch area to prospect (Fig. 11). Potential DHIs are present in the basin but the limestone lithology, complex shallow overburden and lack of well calibration means that they can not be geophysically verified.

| Structure (closure, geometry, container) | | | | Data (existence and reliability) | | | |
|---|---|---|---|---|---|---|---|
| | | | | 3D seismic | 2D seismic<br>Number of lines per structure (with obligatory availability of in-line and cross lines) | | |
| | | | | | Dense (7 lines and more) | Sparse (3-6 lines) | Very sparse (2 lines) (Lead) |
| Models (existence and reliability) | Seismic mapping and correlation | High-relief structure (≥3 times higher than seismic accuracy) AND low structural complexity (4-way) | Easy to interpret, reliable correlation based on nearby (<50 km) wells | 1.00 | 0.90 | 0.80 | 0.60 |
| | | | Uncertain correlation (horizons are interrupted laterally) or based on remote (> 50 km) wells | 0.95 | 0.85 | 0.75 | 0.55 |
| | | | Difficult to interpret, unreliable correlation (horizons are interrupted by thrust faults, diapirs, etc.) or model developed using analogues without wells in the basin | 0.85 | 0.75 | 0.70 | 0.45 |
| | | Medium-relief structure (1-3 times higher than seismic accuracy) OR high-relief structure with high structural complexity (3-way, stratigraphic) | Easy to interpret, reliable correlation based on nearby (<50 km) wells | 0.80 | 0.70 | 0.60 | 0.35 |
| | | | Uncertain correlation (horizons are interrupted laterally) or based on remote (> 50 km) wells | 0.75 | 0.65 | 0.50 | 0.25 |
| | | | Difficult to interpret, unreliable correlation (horizons are interrupted by thrust faults, diapirs, etc.) or model developed using analogues without wells in the basin | 0.70 | 0.55 | 0.45 | 0.20 |
| | | Low-relief structure (lower than seismic accuracy) OR high uncertainty of depth conversion (subsalt, below lava flows) OR areas with rapidly changing lateral velocities in the overburden | Easy to interpret, reliable correlation based on nearby (<50 km) wells | 0.55 | 0.45 | 0.35 | 0.15 |
| | | | Uncertain correlation (horizons are interrupted laterally) or based on remote (> 50 km) wells | 0.50 | 0.40 | 0.25 | 0.10 |
| | | | Difficult to interpret, unreliable correlation (horizons are interrupted by thrust faults, diapirs, etc.) or model developed using analogues without wells in the basin | 0.40 | 0.30 | 0.20 | 0.05 |
| | | Low-relief structure (lower than seismic accuracy) AND EITHER high uncertainty of depth conversion (subsalt, below lava flows) OR areas with rapidly changing lateral velocities in the overburden | | 0.35 | 0.25 | 0.15 | 0.05 |

| Presence of Reservoir Facies | | | | Data (existence and reliability) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | There are wells <100 km away in the play. GDE / reservoir maps suggest that reservoir facies are present based on outcrop, core/cuttings, well-logs and seismic data OR reservoir facies appear on seismic data (amplitudes, coherence, AVO, DHI etc.) | | | | No wells <100 km away in the play. GDE maps suggest reservoir facies based on seismic data analysis. | |
| | | | | All wells <50 km away have reservoir | All wells 50-100 km away have reservoir | Not all wells <100 km away have reservoir | All wells <100 km away lack reservoir | Reservoir facies appear on seismic data (amplitudes, coherence, AVO, DHI etc.) | Reservoir facies are not visible on seismic data |
| Models (existence and reliability) | Interpreted Gross Depositional Environment (GDE) | Marine | Shallow marine blanket deposits, carbonates | 1.00 | 0.95 | 0.85 | 0.60 | 0.95 | 0.85 |
| | | | Coastal, fluvio-deltaic, deltaic, tidal | 1.00 | 0.90 | 0.80 | 0.55 | 0.90 | 0.80 |
| | | | Deep-water turbidites (channels, fans) | 0.75 | 0.65 | 0.45 | 0.20 | 0.65 | 0.45 |
| | | Continental | Eolian | 0.95 | 0.85 | 0.70 | 0.45 | 0.85 | 0.70 |
| | | | Lacustrine | 0.90 | 0.80 | 0.70 | 0.45 | 0.80 | 0.70 |
| | | | Alluvial fan, braided stream | 0.85 | 0.75 | 0.60 | 0.35 | 0.75 | 0.60 |
| | | | Meandering channels | 0.80 | 0.70 | 0.50 | 0.25 | 0.70 | 0.50 |
| | | Other | Fractured basement or porous lava | 0.55 | 0.45 | 0.25 | 0.05 | 0.45 | 0.25 |

| Reservoir Deliverability (carbonate reservoirs) | | | | Data (existence and reliability) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | RD trends (poro / perm, flow rates, viscosity) trends for the play are available from well data | | | | No wells in the play, seismic data only |
| | | | | All wells <50 km away have good RD | All wells 50-100 km away have good RD | Not all wells <100 km away have good RD | All wells <100 km away have poor RD | |
| Models (existence and reliability) | Numerical model (e.g., Touchstone) suggests good RD | 35-80°C for oil or <100°C for gas | Grainstone (packstone, oolite skeletal) or fore-reef facies | 1.00 | 0.95 | 0.80 | 0.55 | 0.75 |
| | No numerical model available / Maximum reservoir burial temperature | | Carbonate mud, chalk or core-reef facies | 0.95 | 0.80 | 0.70 | 0.45 | 0.65 |
| | | 80-130°C for oil or 100-150°C for gas | Grainstone (packstone, oolite skeletal) or fore-reef facies | 0.85 | 0.75 | 0.55 | 0.30 | 0.50 |
| | | | Carbonate mud, chalk or core-reef facies | 0.75 | 0.60 | 0.45 | 0.20 | 0.40 |
| | | >130°C for oil or >150°C for gas OR oil at <35°C at present | Early petroleum migration (before burial to >80-130°C) | 0.65 | 0.55 | 0.35 | 0.15 | 0.30 |
| | | | Grainstone (packstone, oolite skeletal) or fore-reef facies OR T<35°C and the product is oil (biodegradation) | 0.55 | 0.45 | 0.25 | 0.10 | 0.20 |
| | Numerical model (e.g., Touchstone) suggests poor RD | | Carbonate mud, chalk or core-reef facies | 0.50 | 0.40 | 0.20 | 0.05 | 0.15 |

Hatched rectangle based on onshore correlatives

| Seal | | | | | Data (existence and reliability) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Top seal is proven by nearby (<100 km away) wells | | | | Top seal is inferred from the analysis of seismic data |
| Models (existence and reliability) | | Sealing mechanism | | | Sealing quality | | | | |
| | | Top seal | Bottom or lateral seal | Structural style | Very good (salt, anhydride) | Good (thick (>10 m) soft shales, basalt, carbonates) | Acceptable (shale of average thickness (5-10 m)) OR faults cutting top surface | Poor (thin (<5 m, or sand-rich) OR brittle shale | |
| | One-seal traps | Conformable or unconformable | none | Anticlines, buried fans, reefs, banks, topography (hill, erosional remnant) | 1.00 | 0.95 | 0.80 | 0.55 | 0.75 |
| | | Unconformable, fault plane is part of top seal | none | Faulted structures (horst blocks) | 0.95 | 0.85 | 0.70 | 0.45 | 0.65 |
| | Poly-seal traps | Conformable or unconformable | Tectonic surface (faults) | Juxtaposition seal | 0.95 | 0.85 | 0.70 | 0.45 | 0.65 |
| | | | | Clay-shale smear, SSF<4 | 0.85 | 0.75 | 0.55 | 0.30 | 0.50 |
| | | | | No juxtaposition / smear analysis done | 0.80 | 0.70 | 0.50 | 0.25 | 0.45 |
| | | | | More than one fault planes OR Leak windows caused by sand-sand juxtaposition OR Self-juxtaposed reservoir at >2500 m burial, SGR>0.25, SSF<5 | 0.75 | 0.65 | 0.45 | 0.20 | 0.40 |
| | | | | Self-juxtaposed reservoir at <2500 m burial, SGR<0.2, SSF>5 | 0.50 | 0.35 | 0.20 | 0.05 | 0.15 |
| | | Conformable | Tectonic surface (diapirs) | Traps formed by salt or shale diapirism | 0.95 | 0.85 | 0.70 | 0.45 | 0.65 |
| | | Conformable | Facies change, cataclasis, change in pore fluid (tar, hydrate) | Stratigraphic traps ("shale out", postdepositional facies change) | 0.75 | 0.65 | 0.45 | 0.20 | 0.40 |
| | | Conformable | Unconformable | Onlap, lowstand wedge | 0.65 | 0.50 | 0.30 | 0.10 | 0.25 |
| | | Unconformable (erosional contact) | Conformable | Subcrop structures | 0.50 | 0.35 | 0.20 | 0.05 | 0.15 |

Hatched rectangle based on onshore correlatives


Iapetus Geoscience

| **Source Rock Presence and Maturity** | | | **Data (existence and reliability)** | | | | |
|---|---|---|---|---|---|---|---|
| | | | Direct evidence for/against mature source rocks in the basin | | | | Inferred source rocks: GDE maps are based only on seismic data |
| **Models (existence and reliability)** | Numerical model available | No numerical model available | Pools, seeps, penetrated SR in the basin | Shows in the drilled basin, reliable / valid DHI in prospects | Lack of pools, seeps and shows in the drilled basin | Source intervals outcrop on basin margins | |
| | 1D-3D numerical models suggest that the fetch area is largely within late maturity window or over-mature | Fetch area of Type I-II (Class A, B, C) source experienced maximum burial temperature >140°C.<br>Fetch area of Type III-IV (Class D\E, F) source experienced maximum burial temperature >200°C. | 1.00 | 0.90 | 0.50 | 0.80 | 0.70 |
| | 1D-3D numerical models suggest that the fetch area is largely within early maturity window | Fetch area of Type I-II (Class A, B, C) source experienced maximum burial temperature 115-140°C.<br>Fetch area of Type III-IV (Class D\E, F) source experienced maximum burial temperature 160-200°C. | 0.80 | 0.70 | 0.25 | 0.55 | 0.45 |
| | 1D-3D numerical models suggest that the fetch area is immature | Fetch area of Type I-II (Class A, B, C) source experienced maximum burial temperature <115°C.<br>Fetch area of Type III-IV (Class D\E, F) source experienced maximum burial temperature <160°C. | 0.55 | 0.45 | 0.05 | 0.30 | 0.20 |

| **Migration from Mature Kitchen** | | | **Data (existence and reliability)** | | | | |
|---|---|---|---|---|---|---|---|
| | | | There are wells within the fetch area | | No well information within the fetch area, seismic data only | | |
| | | | Pools / shows / thermogenic front within migration pathways | Lack of pools / shows / thermogenic front within migration pathway | "Should See" DHI environment | | "Should Not See" DHI environment |
| **Models (existence and reliability)** | | | | | DHI present | DHI absent | |
| | 3D numerical model (Trinity, Temis, PetroMod) suggests migration | Local upward or downward migration (source and reservoir are adjacent) | 1.00 | 0.55 | 1.00 | 0.55 | 0.80 |
| | No numerical model available | Short <2 km vertical AND short <50 km lateral migration | 0.90 | 0.45 | 0.90 | 0.45 | 0.70 |
| | | Short <2 km vertical AND long >50 km lateral migration | 0.80 | 0.30 | 0.80 | 0.30 | 0.55 |
| | | Long >2 km vertical AND short <50 km lateral migration | 0.70 | 0.20 | 0.70 | 0.20 | 0.45 |
| | | Long >2 km vertical AND long >50 km lateral migration | 0.55 | 0.10 | 0.55 | 0.10 | 0.30 |
| | 3D numerical model (Trinity, Temis, PetroMod) suggests lack of migration | Migration shadow / barriers OR the trap formed after the source rock over-matured | 0.45 | 0.05 | 0.45 | 0.05 | 0.20 |

The overall **current** risking for Colibri is therefore proposed as 22%:

| | |
|---|---|
| Structure | 0.85 |
| Reservoir presence | 0.95 |
| Reservoir deliverability | 0.75 |
| Seal | 0.65 |
| Source | 0.80 |
| Migration | 0.70 |
| **Pg %** | **22%** |

This compares to 19% suggested by GaffneyCline (2020) from four components (trap and seal 0.60, reservoir 0.65, source 0.70, timing 0.70).

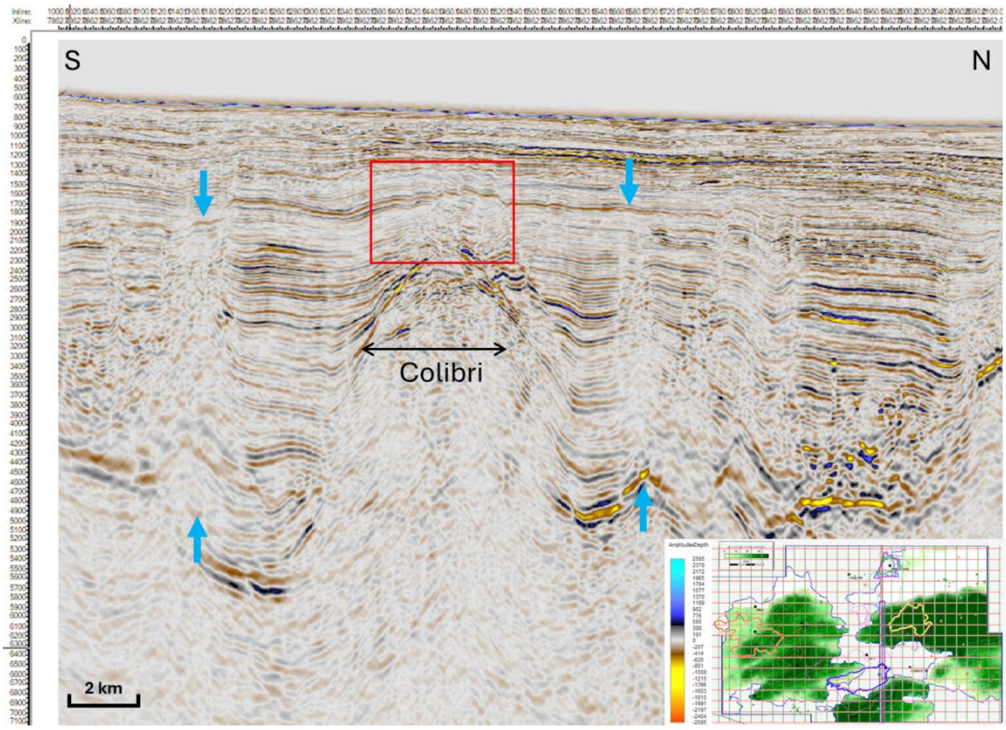


*Figure 13: 3D seismic cross line over crest of Colibri showing minor faulting that does not reach seabed (red box) but no fluid "pipes", in contrast to adjacent kitchens (blue arrows). Inset map as in Fig. 4.*

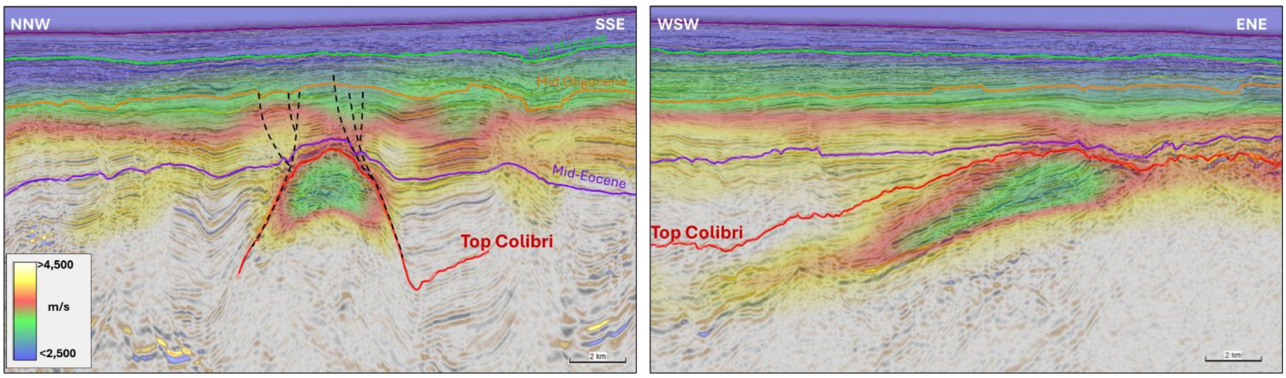


*Figure 14: Arbitrary 3D seismic axial and cross lines through Colibri overlaid with seismic velocity, showing anomalous low velocities indicative of high porosity within the prospect.*

# 8. Piston coring campaign site selection

A piston coring campaign success case will record evidence of thermogenic hydrocarbons at seabed in locations where subsurface evidence suggests that they should be anticipated. A ranking of sites is proposed based on five criteria:

1. Presence over a kitchen with oil expulsion based on seismic mapping and basin modelling.
2. A vertical "pipe" feature on 3D seismic that can be traced down to root at or above the interpreted source rock (e.g., Figs 4 - 7).
3. A location that is above or close to a migration focus from the basin modelling (Fig. 11).
4. A subsurface "soft" seismic amplitude anomaly (candidate DHI) especially in the upper ca. 500 m of section (Fig. 15).
5. Seabed surface feature identified on seismic ± multibeam bathymetry. Pockmarks are preferred to mounds because the latter are likely to be lithified and difficult to sample.

It is suggested that sites should ideally rank at least 3/5 to be viable sampling candidates, with criteria 1-3 being relatively more important. If water column plumes are detected during multibeam bathymetry they can be additional positive evidence provided some of the other criteria are met.

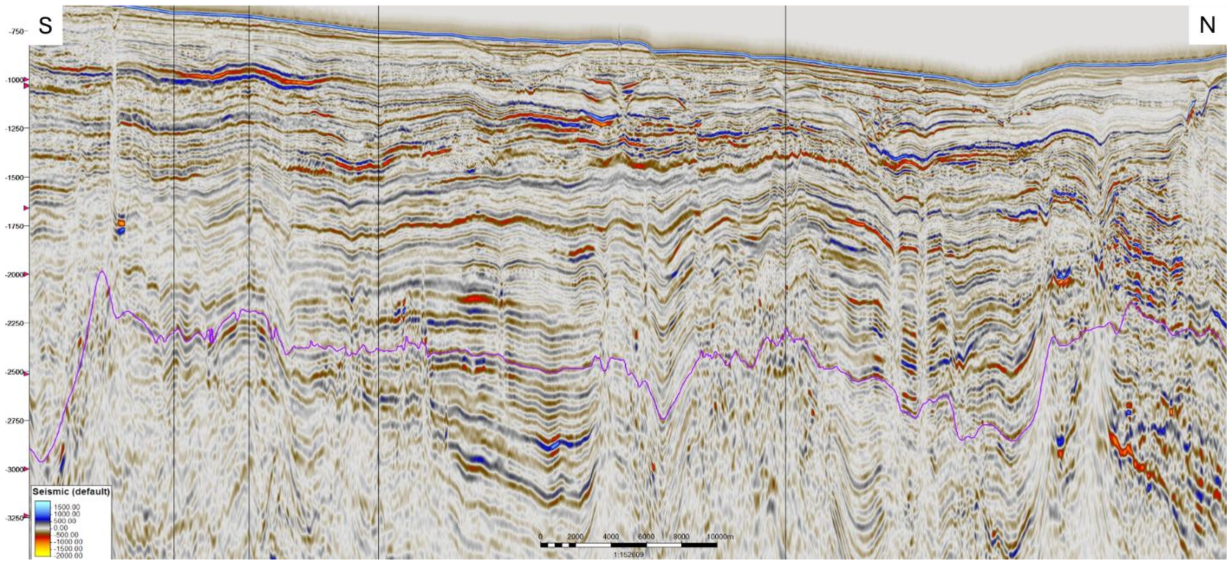


*Figure 15: Arbitrary dog-leg 3D seismic line across the Walton Basin. Purple marker is base of the post rift section. Note abundant "soft" (bright red) amplitude anomalies and fluid "pipes".*

Key area of interest for the piston coring in the Walton Basin are suggested to be as follows:

- Eastern part of the 3D survey where surface slicks correspond to high amplitudes near seabed and erosion down to the level that many subsurface "pipes" terminate at.
- Southwestern part of the 3D survey which is a migration focus from the southern and western kitchens.
- Northeastern part of the 3D survey above and up dip from the eastern kitchen.
- Central northern part of the 3D survey where some seabed pockmarks and underlying "pipes" are present.

- Central southern part of the 3D survey where some seabed pockmarks and underlying "pipes" are present.
- Over the faulted crest of Colibri (looking for negative result).
- Over the faulted centre of Oriole (looking for negative result).

The Morant Basin lacks prominent fluid "pipes", possibly due to a non-limestone fill, and has fewer amplitude anomalies than the Walton Basin. It is worth remembering that the Morant Basin does not benefit from the presence of 3D seismic and the uplift in data density and image quality that 3D data provide. Site selection is still recommended to follow the ranking criteria and to focus on:

- Basin margin faults adjacent to source kitchens where the faults show shallow amplitude anomalies and/or seabed pockmarks (at least one of these sites is coincident with a slick location reported by JEBCO in 2004).
- Above shallow subsurface amplitude anomalies provided these are over kitchen areas and can be linked to faults or horizon subcrop at Miocene – Pliocene unconformities.
- Sites with additional multibeam evidence for seabed features or water column plumes. However, the seabed over inverted parts of the basin is very rugose and these areas lack source kitchens so are best avoided unless there is compelling seismic support.

# 9. Colibri risking uplift in piston coring success case

A successful piston coring campaign will demonstrate a working petroleum system in one or both of the offshore basins. However, the basins have a different tectonic history and different play concepts, so success in one does not de-risk the other to a significant extent (only in terms of conceptual presence of a source rock).

In the Walton Basin, the risk in the **source rock presence and maturity** table would improve to **0.90** on the basis that the piston cores would prove hydrocarbon shows in the drilled basin and/or validation of potential DHIs. The risking for **migration from mature kitchen** would also rise to **0.90** for shows that are on a valid migration pathway as predicted by the basin model and/or by validation of potential seismic DHIs. This is shown by the orange rectangles in the tables below.

In an ideal scenario, the surface seeps would record liquid hydrocarbons that can be geochemically tied to a Late Cretaceous source rock but that depends on amounts recovered and any surface alteration so is not a prerequisite. The situation is more complicated if the piston coring records gas. Basin modelling predicts limited thermogenic gas generation, mostly from the eastern kitchen and to a minor extent from the deepest part of the southern kitchen. Therefore, the location of the piston cores recovering interstitial gas, as well as the gas composition, will be important. The gas composition will need to be sufficiently "wet" (propane and butane versus methane and ethane) to rule out shallow biogenic gas generation. Hydrocarbon gas definitely can de-risk source and migration, but the results will need careful evaluation.

The piston coring would not materially impact the risking for structure, reservoir presence or reservoir deliverability. If the piston coring demonstrates surface seepage of thermogenic hydrocarbons along predicted migration routes and/or via vertical pathways imaged by seismic data, a **lack** of shows over the crest of Colibri will reinforce the containment case (top seal quality) although it can not resolve residual uncertainties over lateral sealing. A lack of surface seepage above Colibri is **inconclusive** if the other sites anticipated to show positive results do not contain any hydrocarbon shows.

| Source Rock Presence and Maturity | | | Data (existence and reliability) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Direct evidence for/against mature source rocks in the basin | | | | Inferred source rocks: GDE maps are based only on seismic data |
| | | | Pools, seeps, penetrated SR in the basin | Shows in the drilled basin, reliable / valid DHI in prospects | Lack of pools, seeps and shows in the drilled basin | Source intervals outcrop on basin margins | |
| Models (existence and reliability) | Numerical model available | No numerical model available | | | | | |
| | 1D-3D numerical models suggest that the fetch area is largely within late maturity window or over-mature | Fetch area of Type I-II (Class A, B, C) source experienced maximum burial temperature >140°C.<br>Fetch area of Type III-IV (Class D\E, F) source experienced maximum burial temperature >200°C. | 1.00 | 0.90 | 0.50 | 0.80 | 0.70 |
| | 1D-3D numerical models suggest that the fetch area is largely within early maturity window | Fetch area of Type I-II (Class A, B, C) source experienced maximum burial temperature 115-140°C.<br>Fetch area of Type III-IV (Class D\E, F) source experienced maximum burial temperature 160-200°C. | 0.80 | 0.70 | 0.25 | 0.55 | 0.45 |
| | 1D-3D numerical models suggest that the fetch area is immature | Fetch area of Type I-II (Class A, B, C) source experienced maximum burial temperature <115°C.<br>Fetch area of Type III-IV (Class D\E, F) source experienced maximum burial temperature <160°C. | 0.55 | 0.45 | 0.05 | 0.30 | 0.20 |

Orange rectangle based on potential uplift from success case piston coring campaign.

| Migration from Mature Kitchen | | | Data (existence and reliability) | | | | |
|---|---|---|---|---|---|---|---|
| | | | There are wells within the fetch area | | No well information within the fetch area, seismic data only | | |
| | | | Pools / shows / thermogenic front within migration pathways | Lack of pools / shows / thermogenic front within migration pathway | "Should See" DHI environment | | "Should Not See" DHI environment |
| | | | | | DHI present | DHI absent | |
| Models (existence and reliability) | 3D numerical model (Trinity, Temis, PetroMod) suggests migration | Local upward or downward migration (source and reservoir are adjacent) | 1.00 | 0.55 | 1.00 | 0.55 | 0.80 |
| | No numerical model available | Short <2 km vertical AND short <50 km lateral migration | 0.90 | 0.45 | 0.90 | 0.45 | 0.70 |
| | | Short <2 km vertical AND long >50 km lateral migration | 0.80 | 0.30 | 0.80 | 0.30 | 0.55 |
| | | Long >2 km vertical AND short <50 km lateral migration | 0.70 | 0.20 | 0.70 | 0.20 | 0.45 |
| | | Long >2 km vertical AND long >50 km lateral migration | 0.55 | 0.10 | 0.55 | 0.10 | 0.30 |
| | 3D numerical model (Trinity, Temis, PetroMod) suggests lack of migration | Migration shadow / barriers OR the trap formed after the source rock over-matured | 0.45 | 0.05 | 0.45 | 0.05 | 0.20 |

Orange rectangle based on potential uplift from success case piston coring campaign.

In summary, the risking uplift for Colibri after a success case piston coring campaign would be 32%:

| COLIBRI | Current | Uplift |
|---|---|---|
| Structure | 0.85 | **0.85** |
| Reservoir presence | 0.95 | **0.95** |
| Reservoir deliverability | 0.75 | **0.75** |
| Seal | 0.65 | **0.65** |
| Source | 0.80 | **0.90** |
| Migration | 0.70 | **0.90** |
| **Pg %** | 22% | **32%** |

## 10. Oriole risking

The risking tables can be used to suggest current and uplifted risking for the other prospects in the Walton Basin. Oriole and Colibri have the same source and migration dependency based on the risking tables, but Oriole is a low to medium relief structure (about 1.5 x seismic resolution) that is easy to interpret owing to its high seismic amplitude (Fig. 16). However, it is challenging to correlate to the wells on the Pedro Bank and lacking a direct analogue in the basin. This would give it a structure risk of 0.70. It is mapped on 3D seismic as a limestone fan sourced from an adjacent steep platform margin. Analogues for the redeposited platform margin onshore demonstrate grainy shallow marine limestones. Oriole has a very strong soft seismic amplitude anomaly that indicates much higher porosity than the surrounding pelagic limestones. Reservoir facies presence is therefore risked at a compromise 0.75. Reservoir deliverability is based on a predicted reservoir temperature of 52 - 56°C, and a robust conceptual model that predicts grainy limestones. It is risked at 0.75. The top seal for Oriole is conformable and marked by a strong seismic impedance contrast with minor faulting but there is a lateral facies change / lateral pinch out element. Sealing facies are thick lime mudstones. Weighing these factors a value of 0.65 is appropriate. Along with the source and migration risking of 0.80 and 0.70 this gives a Pg of 14% compared to 13% from GaffneyCline (2020).

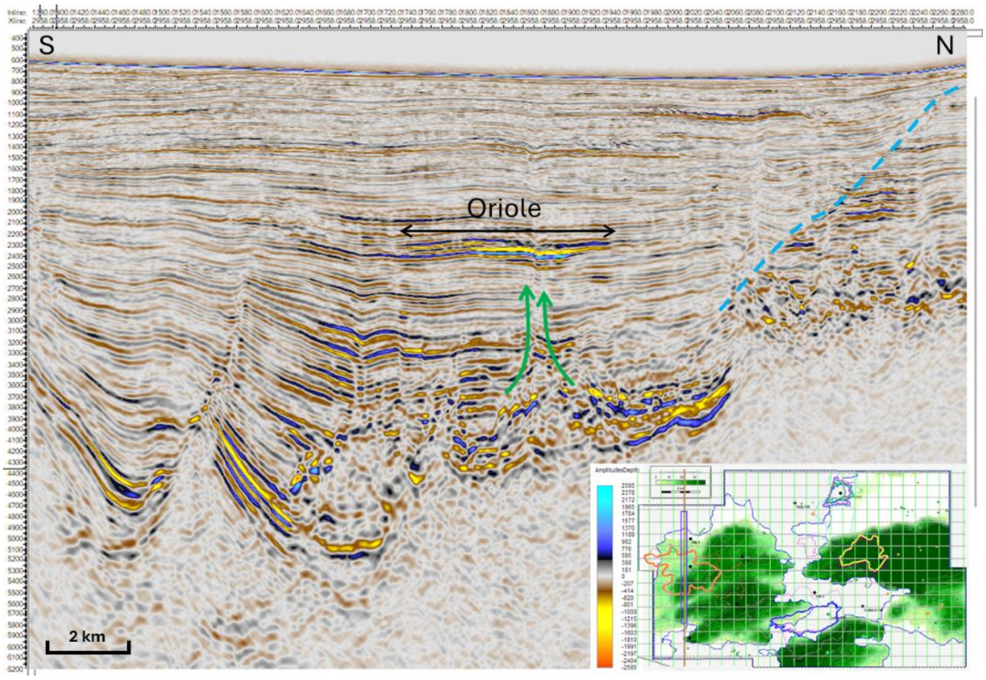


*Figure 16: 3D seismic cross line through centre of Oriole showing its strong "soft" amplitude anomaly and the vertical migration concept from the source rock kitchen below. Blue hatched line marks edge of shallow limestone bank from which Oriole reservoir facies was derived. Inset map as in Fig 4.*

In a piston coring success case, the source and migration risks would be uplifted as for Colibri and the new Pg would be 21%.

| ORIOLE | Current | Uplift |
|---|---|---|
| Structure | 0.70 | **0.70** |
| Reservoir presence | 0.75 | **0.75** |
| Reservoir deliverability | 0.75 | **0.75** |
| Seal | 0.65 | **0.65** |
| Source | 0.80 | **0.90** |
| Migration | 0.70 | **0.90** |
| **Pg %** | 14% | **21%** |

Re-risking has not been carried out on all the prospects and leads included in GaffneyCline (2020), but the uplift envisaged for Colibri and Oriole is indicative of what would be anticipated across the Walton Morant licence where piston coring demonstrates the presence of a mature source rock and migrated hydrocarbon.

# 11. Conclusions

- United Oil and Gas plan to undertake a piston coring (surface geochemical exploration) campaign in the Walton and Morant Basins offshore Jamaica to further de-risk a working petroleum system that is already known to be present onshore.
- In advance of this campaign, Iapetus Geoscience Limited has carried out an independent review of the chance of geological success (Pg) for the primary Colibri prospect. This assessment uses a risking table approach to maximise objectivity and to provide a clearly documented rationale that can be adjusted as new data become available. The review considers the impact of geological work carried out by UOG since the Walton Morant licence prospects were last risked and arrives at a Pg of 22%. This compares to 19% previously proposed by GaffneyCline (2020).
- The risking was then reiterated to consider what the impact of a successful piston coring campaign would be. Success in this case would be the detection of thermogenic hydrocarbons at specific seabed locations where the subsurface geology suggests they are most likely to be encountered. By reducing the risk on presence of a mature source rock and migration from it into and through the overlying strata the overall Pg is increased to 32%.
- Following the same approach the secondary Oriole prospect is assigned a current Pg of 14% and an uplift to 21% after a successful piston coring campaign.
- A ranking scheme based on five criteria is proposed to aid in the selection of piston coring sites with 4 of the criteria based on seismic data. A previous piston coring campaign undertaken in 2015 lacked 3D seismic data for the Walton Basin that show much potential evidence of focused vertical fluid migration, and it also pre-dated acquisition of any seismic data in the Morant Basin. Most of the sites from that 2015 exercise were not appropriately located to have a good chance of encountering migrated hydrocarbons.

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