Assessing and communicating risk in early stage exploration: embedding regional understanding within basin modelling workflows

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Assessing and Communicating Risk in Early Stage Exploration: Embedding Regional Understanding Within Basin Modelling Workflows

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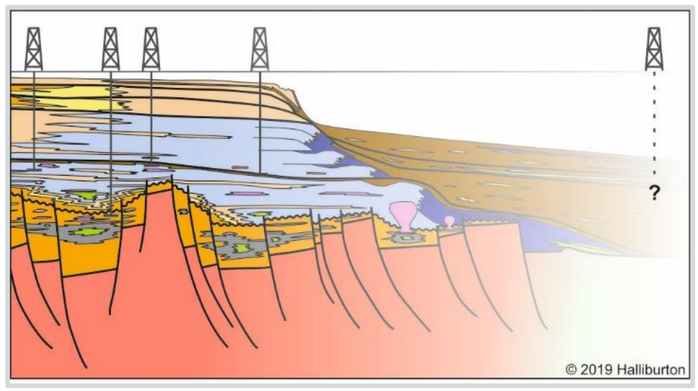
1. CHALLENGE AND WORKFLOW



During early exploration, **uncertainty** regarding the nature of petroleum system can be significant. **Charge** is a common cause of wildcat failure. **Basin modelling** is an essential tool for evaluating charge and assessing uncertainty, but **how can we model where there is little data to constrain predictions?**

BUILD PSEUDO MODEL USING REGIONAL INSIGHTS AND ANALOGUE DATA

ASSESS UNCERTAINTY AND IDENTIFY CRITICAL FACTORS

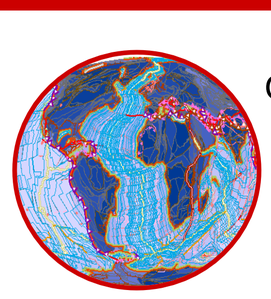
CALIBRATE ANALOGUE MODELS TO UNDERSTAND BOUNDARY CONDITIONS

USE SENSITIVITY ANALYSIS TO TEST MULTIPLE SCENARIOS

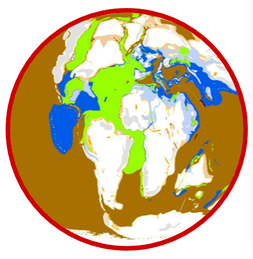
Uncertainty

Use of a **regional geological and tectonic framework** within the basin modelling workflow allows us to develop predictions away from data control, identify **critical factors,** and inform **uncertainty analysis** when exploring new frontiers.

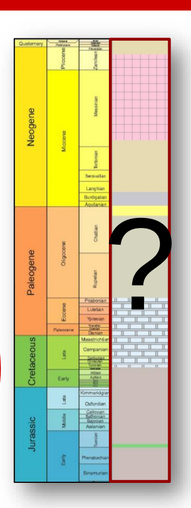
2. MODEL BUILD

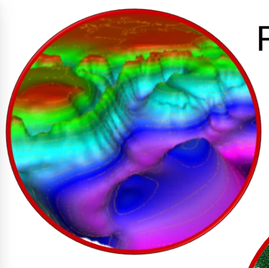


Global **plate model**

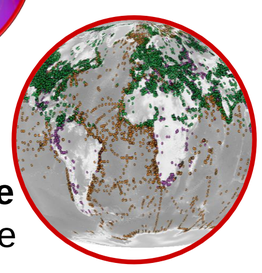


Regional **depositional patterns**





Regional **Depth** Frameworks



Global **source rock** database

A **global plate model** is used to understand tectonic setting and highlight appropriate analogues. **Regional depositional trends** are used to infer stratigraphy and depositional models aid extrapolation from analogues. Burial and erosion are predicted using basinal **structural trends** and regional **depth frameworks.** Petroleum elements are predicted using **global datasets**.

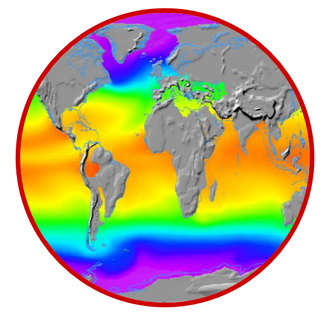
3. UNCERTAINTY AND CRITICAL FACTORS

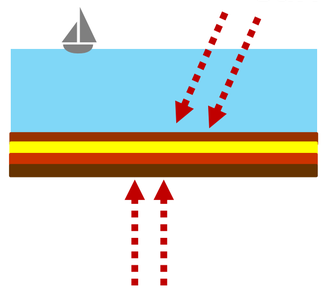
The **uncertainty** and impact of each data input is assessed. Inputs with high uncertainty and high impact on model outputs are **critical factors** on exploration risk.

	DATA QUALITY	POSSIBLE RANGE	SENSITIVITY ANALYSIS
DATA INPUT	High quality/resolution data Multiple supporting data High data distribution	Known values	Low impact on model outputs
	Moderate quality/resolution data Low data distribution Inferred using data	Narrow possible range	Some impact on model outputs
	No supporting data Poor data distribution Inferred using models	Large possible range	High impact on model outputs

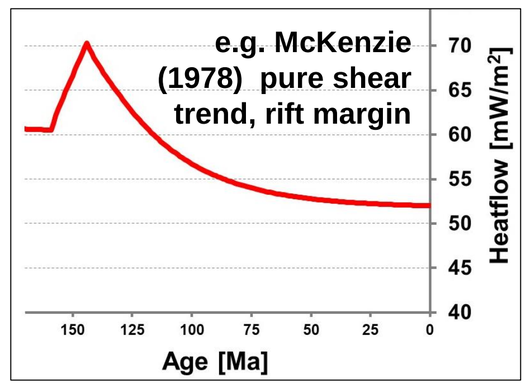
4. BOUNDARY CONDITIONS

Paleoclimate models can be used to infer **paleo-sediment surface temperature.**





Basal heat flow can be derived from tectonic setting and may follow predictable trends.



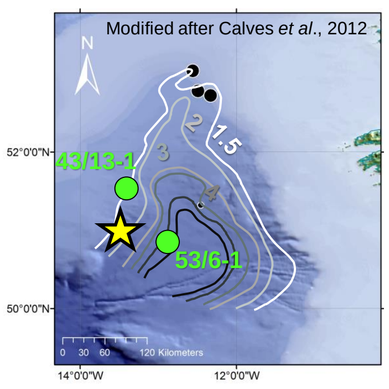
The build and **calibration of analogue models** improves confidence in boundary condition predictions. For example, vitrinite reflectance data for an analogue model may highlight post-rift thermal events such as igneous activity.

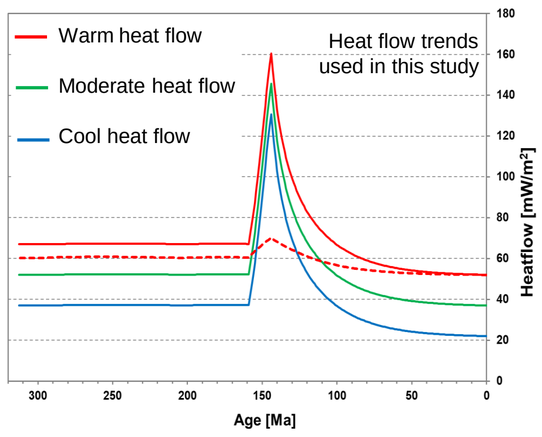
5. MULTIPLE SCENARIOS: CASE STUDY

Analogue calibration can be used to define **multiple scenarios** for critical factors such as heat flow. Regional knowledge is used to assess the likelihood of each. Results for each scenario are analyzed to inform understanding of **charge, timing and phase risk.**

Porcupine Basin Case Study

Discoveries have been made in the Northern Porcupine Basin (black circles on map) but so far this success has not been replicated in the southern sector of the basin. A new exploration well is to be drilled in Summer 2019 (star on map). **What can modelling tell us about charge risk across the Southern Porcupine Basin?**

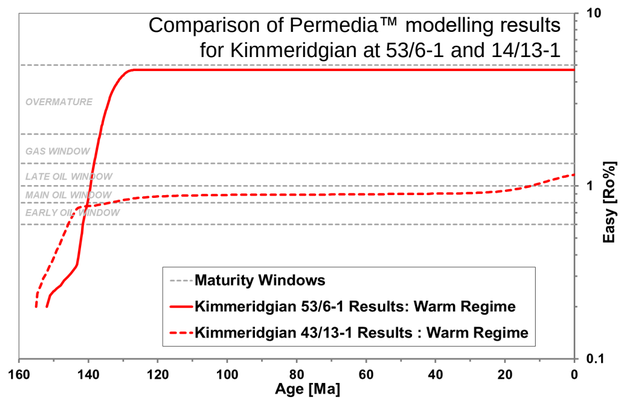


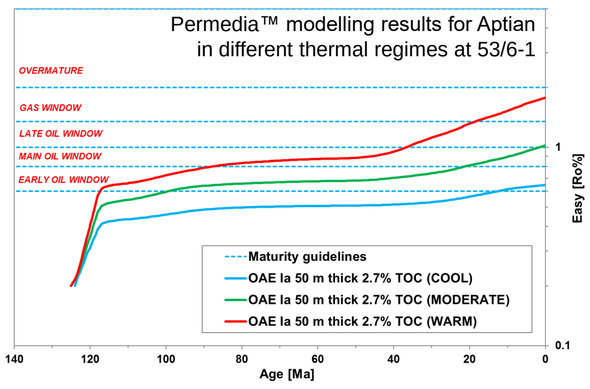


Publicly-available data was used to create an analogue model at well 43/13-1 and a pseudo model at 53/6-1 (green circles on map). A McKenzie pure shear calculation and calibration of the analogue model was used to develop three thermal scenarios for the 53/6-1 pseudo model. Hyperextension (beta factor, greyscale lines on map) causes peak heat flow to be higher at basin centre (solid lines) than at flank (dashed).

Jurassic Charge Risk at Basin Flank

- Potential Kimmeridgian source rocks are overmature at basin centre (53/6-1) due to high beta factor and high heat flow at rifting.
- Kimmeridgian is viable oil charge at basin flank (43/13-1; right graph).
- The planned 2019 exploration well on Southern Porcupine Basin flank has low Jurassic charge risk.





Cretaceous Charge Risk at Basin Centre

- **Cool** scenario = potential OAE Ia Aptian source rocks are immature (left graph).
- **Warm** scenario = gas mature.
- **Moderate** scenario = oil mature
- Cretaceous source rock presence and thermal regime are critical factors on charge risk in central Southern Porcupine Basin.

CONCLUSION

Use of a regional geological and tectonic framework to predict and analyse pseudo models in early stage exploration allows for evaluation of multiple thermal scenarios and meaningful analysis of charge risk.

References

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