STRATOS ENERGY ADVISORS
(Peter Woodroof and Peter Lunt)

Sirius Exploration Geochemistry Inc.
(Douglas Waples)

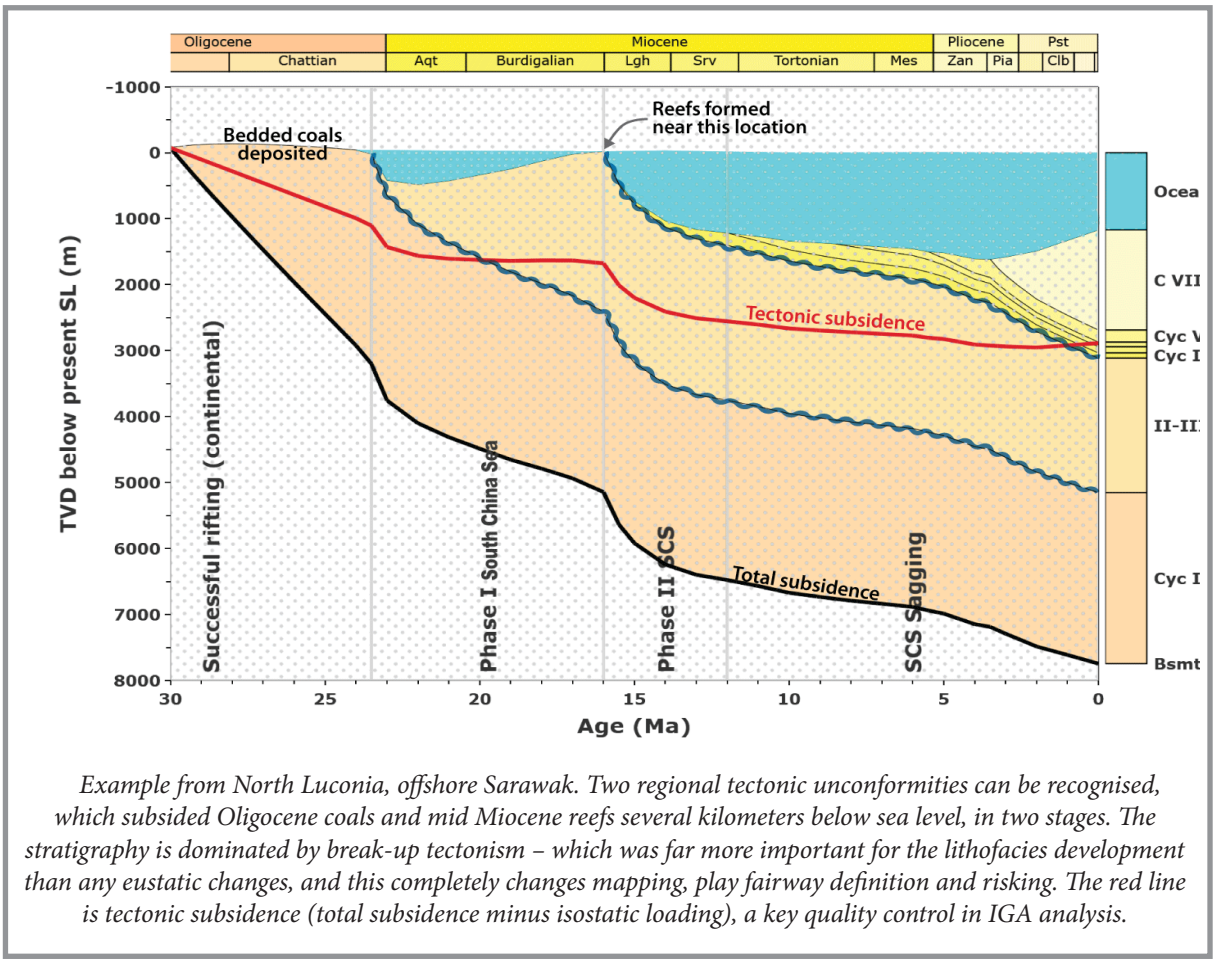
Times and Paradigms: They are a-changin'

— with apologies to Bob Dylan

Sirius and **Stratos** (https://siriusxgc.com, https://stratos-sea.com) have partnered in developing exciting and effective new ways of understanding the petroleum geology and plays of SE Asia. This new methodology is also applicable to other tectonically controlled and challenging regions of the world.

Geology requires integration within the context of data precision and reliability. Proper tools to carry out such integration and interpretation have been lacking, but now Sirius and Stratos have developed a game-changing approach based on Integrated Geohistory Analysis (IGA) (Endnote 1). The *Novva* software integrates a wide range of data with respect to depth and through time. As more data is added, the significance of this progress can be explored immediately.

Used this way *Novva* is more than just software, and the IGA method becomes a framework for thinking and developing new ideas. For example, we have used *Novva* and IGA to show that eustasy should be abandoned as the foundation of stratigraphy and facies predictions in SE Asian basins (Endnote 2), and IGA is a key tool in developing the new, dynamic stratigraphic framework. Through the IGA approach we gain a new understanding of the mechanisms of basin evolution, improve our facies and play concepts, lessen risks, and revitalize play-based exploration.



Example from North Luconia, offshore Sarawak. Two regional tectonic unconformities can be recognised, which subsided Oligocene coals and mid Miocene reefs several kilometers below sea level, in two stages. The stratigraphy is dominated by break-up tectonism – which was far more important for the lithofacies development than any eustatic changes, and this completely changes mapping, play fairway definition and risking. The red line is tectonic subsidence (total subsidence minus isostatic loading), a key quality control in IGA analysis.

Sirius and Stratos are publishing examples of these advances in international peer-reviewed journals. This effort is a part of the phase of "*extraordinary research*" (Kuhn 1963) that drives paradigm shifts and provides compelling new concepts and discoveries worthy of investment.

The balanced and insight-rich IGA approach has been developed by leaders in their respective fields, to promote ideas for the emerging generation of explorers and geoscience researchers. We are keen to share and pass on our passion for science and new discovery; so please contact us for a discussion of your problems and our suggestions.

To help you, the Sirius-Stratos team are now available to:-

1) Organize and use your data to rationalize tectonic and sedimentary histories, in order to uncover new or undervalued plays and prospects (stand-alone **Consultancy** projects)
2) Work with your staff to understand and implement this new methodology and its exploration potential; to compile an audit trail for investors and partners; and to facilitate corporate adoption of this new paradigm (**Consultancy with mentoring/technology transfer**)
3) Provide training or workshops built around understanding and applying the new IGA and stratigraphic methods; and using neglected industry databases to inspire new investment (**Training**)
4) Provide the *Novva* software to enable you to work with us (or independently) on IGA projects that will form the core of a creative and cohesive exploration program that will attract attention and respect (**Software**)
5) Merge the new play concepts with appropriate business models to achieve optimal commerciality (**Commercial advice**)

To put these ideas and opportunities into action, please contact any or all of the Sirius-Stratos Team:

Douglas Waples: d.waples@siriusxgc.com

Peter Lunt: pl@stratos-sea.com

Peter Woodroof: pw@stratos-sea.com

Stratos is a Kuala Lumpur-based upstream consultancy that develops and provides new approaches to mastering the petroleum geology of SE Asia, especially in the disciplines of stratigraphy, tectonics, and basin analysis. Stratos has unmatched knowledge of every basin in SE Asia, especially at the levels of basin architecture, stratigraphy, petroleum plays and prospects.

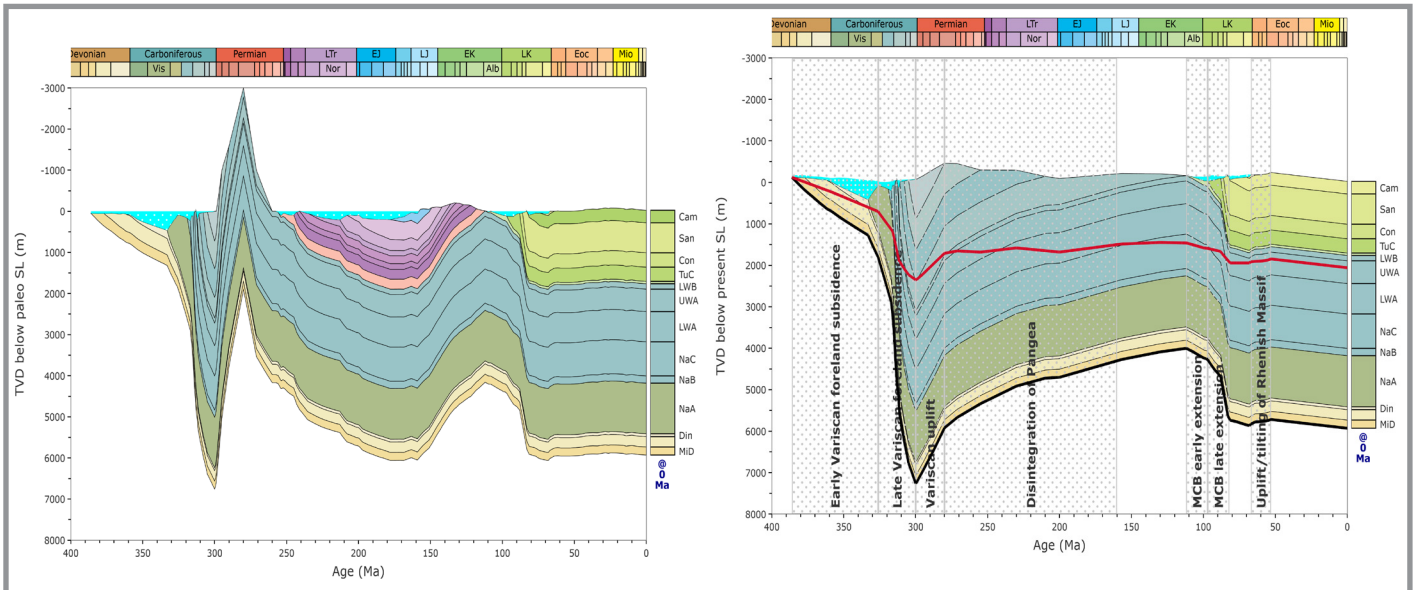
Sirius is a US-based international consultancy that initiated the IGA approach to provide new ideas for exploration applications. Sirius's unique and powerful Novva software is the key tool to implementing and making full use of IGA.

Endnote 1: Integrated Geohistory Analysis (IGA) and *Novva*

IGA focuses on making full use of the amazing capabilities of geohistory plots. IGA brings together, integrates, and creates scientific and monetary value from a wide variety of geologic information. The IGA process links facts and ideas from all the major areas of petroleum geoscience; including tectonics, stratigraphy, sedimentology, geothermics and geochemistry. It accomplishes this objective with its intuitive interview format for data entry, its capability to display input and output data in the time and depth dimensions and its many built-in defaults and help screens for non-expert users, including all exploration geoscientists.

Basin-scale IGA becomes a quantitative regional knowledge-base that not only rationalizes stratigraphy, but links directly into thermal basin models and larger-scale tectonic frameworks. Archaic basin classifications and their proposed correlation with exploration risk can then be replaced by a new understanding of integrated geology and the petroleum systems within this new context. IGA is thus a scientific method that leverages cross-discipline data-evaluation skills and becomes much more than ordinary basin modeling or petroleum systems modeling. IGA is applicable to any basin, especially the troublesome ones that are tectonically controlled.

Novva software provides an instructive IGA workflow that can carry out complex geological investigations on a multi-location basis. *Novva* is a forensic investigation tool based on scientific testing. Its approach allows for the evaluation of data accuracy and reliability, an advantage that is especially important for geological data, often from different generations and sources. For example, in passive basins various eustatic sea-level changes are built into *Novva* and available as tools for assessments. As a second example, geothermics in *Novva* is linked to tectonics and to other geological phenomena and events, and is thus not simply a tool for calculating maturity.



These plots show the benefit of using geohistory for analysis. The left-hand figure shows a published geohistory for the Münsterland-1 well in NW Germany, an area strongly affected by the Late Paleozoic Hercynian Orogeny. It shows the development and infilling of a deep foreland basin that developed prior to continental collision; uplift of a high mountain range; and then a necessarily rapid erosion of the mountains in time to deposit a thick Tr-Jur section in the Lower Saxony Basin. The right-hand plot shows a re-interpretation using IGA methodology. The foreland basin was just as deep, but a lesser amount of uplift, coupled with synorogenic erosion, prevented development of high mountains, which in concert with lack of deposition during the Tr-Jur, kept topography consistently low. Both models fit measured Ro data equally well, but the revised model has a more balanced and less extreme geological framework. The red line represents tectonic subsidence, which is a valuable part of IGA analysis. The various overlays allow us to match our geologic concepts to the proposed geohistory.

Endnote 2: Tectono-stratigraphy in SE Asian Basins

During the Cenozoic tectonic movements were hugely important in SE Asia – rapid, and invariably much greater in magnitude than eustatic sea-level (ESL) events. Basin architecture was frequently altered through time, with distal-to-proximal sedimentary directions changing in ways well beyond the assumptions required for applying an ESL model. Tectonics thus exerted the major control on erosion and deposition, transgression and regression, water depth and elevation; and was of such overriding importance that eustatic effects are often difficult or impossible to detect. Variations in facies and petroleum systems in these basins are far more extreme than expected in conventional ESL models. **Even today, these important variations are still seldom studied in most SE Asian basins, as we have lacked the tools.**

The quantitative IGA approach is revolutionising sedimentary geology in tectonically active basins, beyond providing a new sequence stratigraphy. There is much we are mistaken about in SE Asia, and much we still do not know at all. For example, the power of the self-checking, quantitative approach has changed many basic stratigraphic concepts in Sabah, one of which strongly challenges the widely cited Proto-South China Sea subduction model of tectonic evolution, and then highlights an overlooked shallow water oil play (*papers in press, pre-prints available*). Around eastern Java the entire model of basin development and facies distribution is undergoing transformation, and several new plays are coming to light. Eastern Java is remarkable in having a reverse creaming curve, with more oil and gas found in the past two decades that in the entire century before. IGA and quantitative stratigraphy will provide the method to find new creaming curves in areas we have previously side-lined as marginal, or "too difficult". From North Sumatra to Mangkalihat, new geological concepts are developing. The more complex area from Sulawesi to Papua absolutely requires new geological methods to understand tectonism and hydrocarbons. SE Asia may become the laboratory for new methods applicable for complex basins around the world.

Such inter-linked and cross-referencing geological frameworks are hard to reduce to simple, eye-catching images or a few words of text. ***Please contact us to learn more, and dig deeper into this fascinating, valuable and timely subject***.

On-line talks:

Waples, D., Integrated Geohistory Analysis, June 2020

Lunt, P., SE Asian stratigraphy at a large scale, July 2020

Waples, D., Building Better 1-D Maturity Models. A detailed example: the famous Münsterland-1 well, August 2018