Title: The Future is Now

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Introduction

Since 2014 some 70% of new potential resources discovered globally have been found in deep water. Whilst deep water drilling is no longer the domain of just the super-majors, development and production has often seemed futuristic. Re-thinking the way discoveries are appraised and commercialized, has recently made deep water accessible and commercial. The industry has begun to explore play systems in deep water where a revolution in subsurface imaging technology yields the observations which provide the feedstock for exploration innovation.

Yet, as industry pushes down slope on passive margins, surprises are occurring that are as interesting as the successes. Unexpected heat-flow distribution across varied crustal structural architectures, unexpected source rocks and petroleum systems and the recognition of the dominant role that previously esoteric sedimentology might be exerting on reservoir and traps – all these are bringing new opportunity and challenge in equal measure.

Deep Water Clastics.

In North West Africa a series of stunning successes Tortue-1, Marsouin-1, Taranga-1 and Yakaar-1 has extended understanding of the petroleum system from the previous discoveries in the near shore shelf and diapir play (Banda, Chinguetii, Tiof) taking industry to the Cretaceous basin floor domain. Here, geothermal gradients have surprised and the turbidite reservoirs are strongly influenced by contourite currents. Such "mixed" systems have only been infrequently penetrated in the past, yet in deep basins they are now being recognised more and more. Vast quantities of gas have been found in reservoirs of this type in the Rovuma Basin of Mozambique, and they are starting to be understood in the South Atlantic from Argentina to Brazil. Understanding the seismic expression of mixed systems, how they can be read and how these varied spatially up-down slope and through time, how turbidites are "de-silted", and then traps created is a new challenge for explorationists globally (examples from Argentina, Uruguay, North East Brazil and Mozambique are presented).

Deep Water Carbonates.

Of the major discoveries of the last few years Exxon's Guyanan Ranger-1 discovery and ENI's Zohr-1 discovery in Egypt stand out. The chase for more Zohr look-alikes is on in the deep water of the East Mediterranean, where the Eratosthenes plateau displays many analogues to Zohr. Calypso-1 offshore Cyprus, was the world's biggest discovery in 2018, and exploration will focus on these structures as the huge potential resources offer to change the geopolitics of gas in the Eastern Mediterranean. To further remind us that carbonates provide a significant proportion of the world's hydrocarbon resource, the giant Ranger-1 carbonate build-up discovery on a volcanic guyot in Guyanan deep water is seen potentially replicated repeatedly along the South American transform margin (examples from Foz Do Amazonas, Para-Maranhao, Camamu basins are presented). This play is very little explored because such guyots, with associated source rocks, on passive margins are normally found in water depths that were previously inaccessible. Key to evaluation of this play is the seismic characteristics of the carbonate, and the identification of a source rock.

Deep Water Petroleum systems.

Seismic imaging has seen the most dramatic changes in the last decades and whilst there has been a focus on reservoir, structure and fluids, relatively little work has addressed source rock characterization. However, seismic in deep water settings responds well to such enquiry which is extremely pertinent, as this is where very few wells have been drilled and so few source rock sections

are penetrated. Four main seismic observations are used in a standard workflow to identify and characterize source rocks offshore The Gambia, Guinea Bissau, Argentine, Brazil, Mozambique and Somalia. In most situations multiple source rocks are identified, that can explain some curious hydrocarbon occurrences and when combined with new models and understandings of heat-flow in various crustal architectures and mantle dynamic topography settings, a variety of new exciting petroleum systems are revealed. An example of how demonstration of source rock in one margin may be extrapolated to its unexplored frontier conjugate margin is presented between The Gambia/Senegal and East Coast USA.

Conclusions

The demand for clean fossil fuel (i.e. oil and gas rather than coal and peat) continues to grow across the world feeding an ever increasing energy market. To meet future production our search for new giant reserves is taking us to ever deeper water locations, where risk reduction through application of geoscience takes an ever more important role. Yet this journey is uncovering surprises that requires agility and innovation to understand and master. Identifying and understanding the play characteristics of contourite systems in base-of-slope and basin floor settings, carbonate build-ups (on intra-basin carbonate platforms, extensional post rift settings to source rock surrounded guyots) and identifying and characterizing source rocks on seismic data, can be seen to be key to future exploration initiatives. Yet much to our surprise, in recent discoveries around the world, the future has already arrived.