

# The Past and Future Development of Africa’s Play Systems: Why Regional Geology is More Important than Ever

This talk reviews the new plays that have been identified in onshore and offshore Africa in the past 15 years, the messages that these play breakers have for explorers in the region, and speculates on some of the themes which will categorize future new discoveries.

Historically, the oil and gas reserves of Africa have been found to be heavily concentrated in just five countries: Algeria, Libya, Egypt, Nigeria, and Angola, and these have been the focus of the majors’ exploration efforts. Many of the basins of these countries are now creaming, with the notable exception of the Eastern Mediterranean portions of Libya and Egypt, where there have been recent discoveries in “new” plays that have partial analogs to shelfal and onshore petroleum systems. Clearer play breakers, in comparison, have come from new countries such as Ghana, Israel (geologically Africa!), and Uganda, with the exploration effort led by independents such as Tullow, Kosmos, Hardman, Heritage, and Noble. These companies have seemed to be more willing to take on the risks of frontier exploration, often being willing to carry one significant technical risk into a drilling phase. Many of their results have challenged established geological paradigms on trap styles and reservoirs, though few of them are truly in new petroleum systems, most forming extensions of or strong analogs to the main source rock systems of the continent (Figure 1).

**Key learnings and themes from these play breakers include:**

1. the high stratigraphic-trapping potential of turbidite systems on slopes and bypass zones, as particularly seen in Ghana, Mauritania, and Equatorial Guinea. Such potential almost undoubtedly extends to other regions of the West African and other African margins. The most successful strategy appears to have been to use regional geology to focus on regions of former sand input close to kitchens on the main African source rocks and then conduct 3D seismic to look for subtle traps with DHI expression (e.g. Ghana, Figure 2).

2. exploration moving further out onto basin floors, as testified by Noble’s report of over 100 m of gas pay in the pre-salt on the Levantine basin floor. This and outcrop analogs from São Tomé challenge existing sedimentological models for such distal settings.
3. a surprisingly large contribution from non-marine systems amongst the new play breakers, especially if recent discoveries on the conjugate margin of Brazil and the Falklands are included. (Both were attached to Africa at the time of formation of their key elements.) This is accompanied by an untraditionally low contribution from shallow marine systems. Both Cretaceous and Neogene graben systems are contributing here, which show some striking similarities (Figure 3), from which explorers in both systems could benefit.
4. the impact of a highly dynamic petroleum system in the Albertine basin of Uganda in making effective trap styles that conventionally would be considered as very high risk.

HGS International Dinner continued on page 31

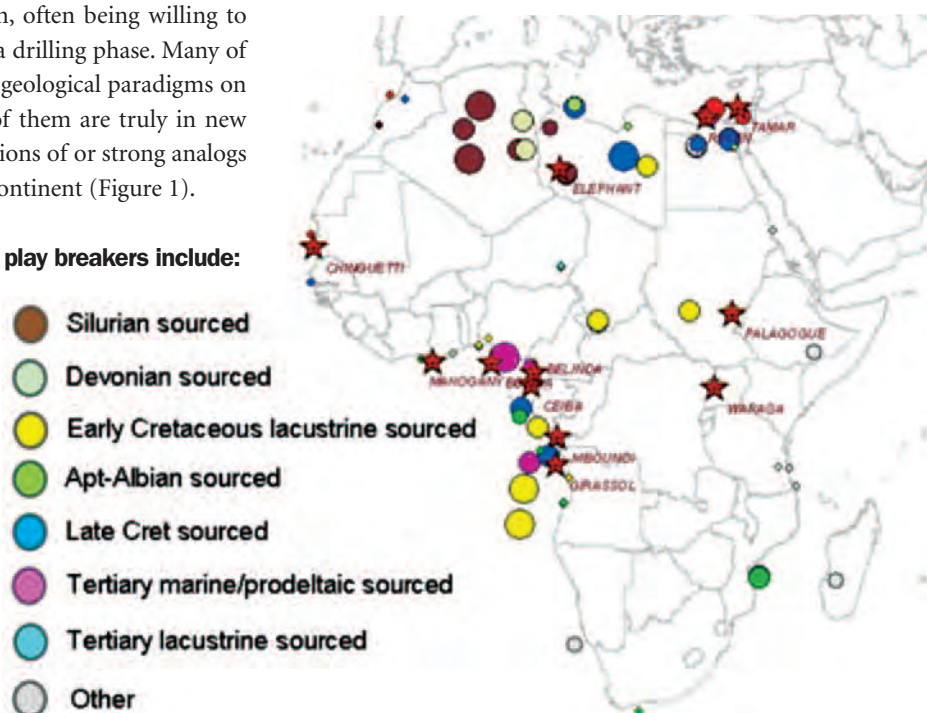


Figure 1. Main African petroleum systems and recent play-breakers. Source: Burke et al, 2003.

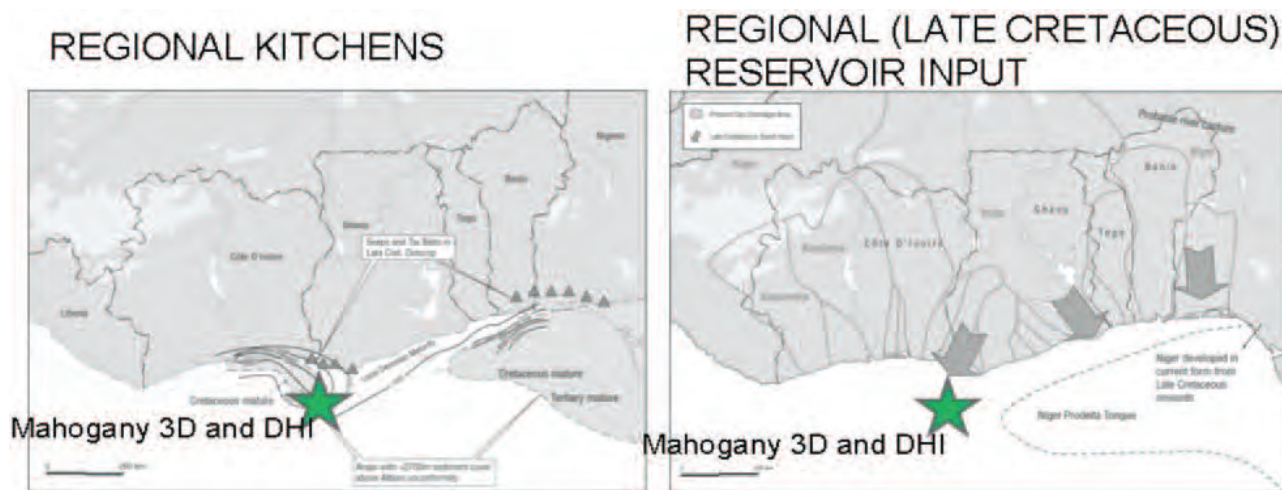


Figure 2. Play focusing on Kitchens, seeps and sediment input prior to 3D seismic and discovery, Ghana

5. learning from systems such as the Murzuk basin and onshore Congo that many, if not most, African onshore basins contain source rocks that underwent greater burial and maturation than is apparent from present-day burial depths. This conclusion, which opens up plays in relatively shallow basins, can be very much tied to Africa's recent tectonic history and the frequency of Miocene plume uplifts responsible for the 'basin and swell' topography of the continent.

So where will be the next new petroleum province of Africa? We can hazard a guess it will again lie along the trend of one of the major source rock systems and that there is one element of it that we do not fully understand and therefore currently over-risk. The new play breakers help us considerably, especially if we fit them to an ever-updating model of African tectonics, climate, drainage systems, and source rock distributions in order to accurately identify analogs. None of the five learnings and themes listed above are likely to be one-offs.

**Key challenges are to:**

1. reconstruct the palaeogeography of Africa as it influenced the regional supply of turbidites to Cretaceous margins and thus high-grade basins and regions for 3D/DHI risk reduction.
2. develop technologies for exploring for stratigraphic traps below the DHI floor.
3. identify additional "sweet spots" for exploration in the East African rift system with minimal direct data on these basins' sediment fills.
4. identify regions of maximum trap-preservation potential in basins with complex structural histories, particularly on the East African margin.

5. accurately reconstruct the burial history of onshore basins containing developments of the major African source rocks (Figure 1) to identify where maturity has been underestimated.

*Africa's petroleum geology has surprised us on many aspects of these recent play breakers and will continue in future to challenge the paradigms*

A final challenge is to acknowledge that Africa's petroleum geology has surprised us on many aspects of these recent play breakers and will continue in future to challenge the paradigms we have established from the basins we are most familiar with. Success may, however, come to those who best integrate the regional geology to reduce their exposure to risk, but still make allowance for Africa's petroleum geology to surprise them, positively or otherwise. ■

**Biographical Sketch**

DUNCAN MACGREGOR is a regional petroleum geologist specializing in the African continent. Following a 20-year career with BP, working largely in the Far East, he has worked and consulted for a number of independent companies and consultancies, including PGS, Mossgas, Sasol, Neflex, Noble, Richmond, and BG, mainly on new ventures and play-fairway-scale studies in Africa. His current main role is working frontier plays in the East African Rift System for Surestream Petroleum. He also has extensive research interests on the evolution of the African continent, as presented in this paper. Duncan has been the technical chair of the London PESGB/HGS African conferences for some years, has written over 20 papers, presents a number of courses, and has edited two books on African petroleum geology.



HGS International Dinner *continued on page 33*

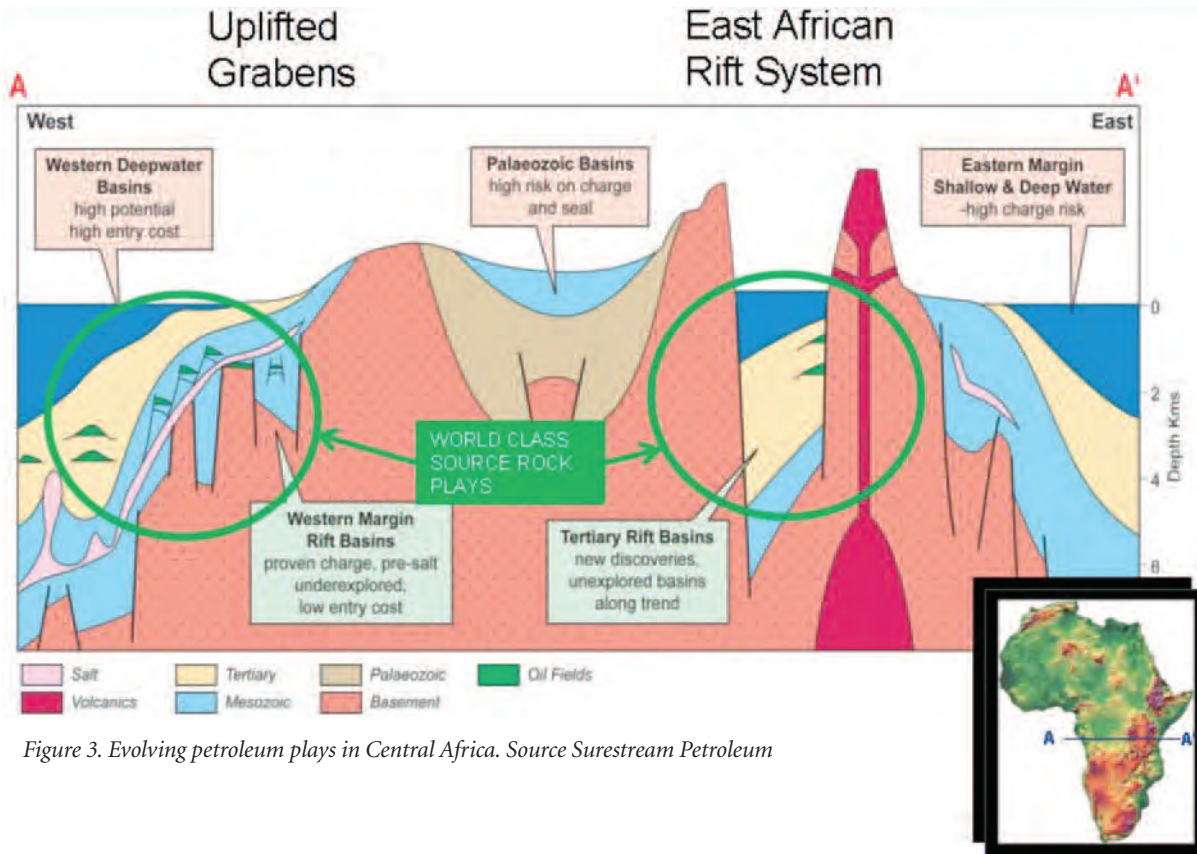


Figure 3. Evolving petroleum plays in Central Africa. Source Surestream Petroleum