

# Meandering Miocene Deep Sea Channel Systems Offshore Congo, West Africa

S. Baer\* (PGS), J. E. Comstock (PGS), K. Vrålstad (PGS), R. Borsato (PGS), M. Martin (PGS), J.P. Saba (SNPC), B. Débi-Obambé (SNPC) & A.R. Ngouala-Nzoussi (SNPC)

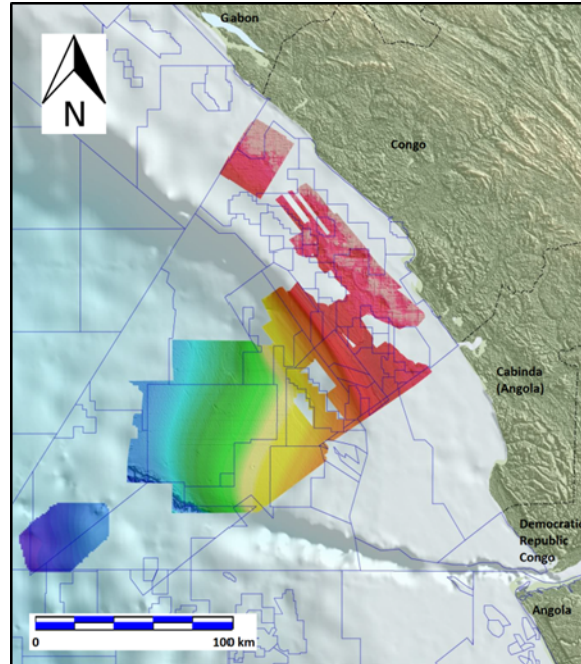
## SUMMARY

---

The recently completed Congo regional seismic survey shows regional scale features in high detail. Individual channel systems have been recognized and exploited but now the regional scale extent of these systems can be clearly visualized. The hydrocarbon bearing formations of the Congo Basin were formed by the rifting of the African and South American plates during the Late Jurassic. Four distinct phases of deposition and deformation are recognized in the Congo Basin; Pre-Rift, Syn-Rift, Post-Rift deposition, and Salt Tectonic deformation and while petroleum systems are found in all phases this paper focuses on the Upper Miocene sequence comprising deeper marine turbidite systems with sediment sourced via the Congo River. Extractions of amplitude anomalies within different time intervals show the details of multiple “meander-form” channel systems traversing the deep basin and terminating in fan shaped topography. These channels systems are 1 to 2km wide and trend generally from SE to NW. The source of the sediments carried in the channels is the Congo River Delta. Viewed regionally these features may be interpreted to provide information on paleocurrent direction, flow changes over time as well as displacement of channel systems due to offset by faulting and salt domes.

## Introduction

The recently completed Congo regional seismic survey provides an opportunity to see regional scale features in high detail. Individual channel systems have been recognized and exploited but now the regional scale extent of these systems can be clearly visualized. The new interpretation is focused on the offshore of the Republic of the Congo (Figure 1) and allows the visualization and interpretation of regional horizons in the Post-salt section Congo Basin. The regional Top Miocene horizon was interpreted on the full data set and provided the possibility of amplitude anomaly extraction within the Miocene sequences; allowing the identification of deep sea turbidite channels and providing details of both their topography and flow direction. Additional amplitude extracted time interval horizons were created to interpret detailed sedimentary features which are interpreted to represent multiple flow directions over time.



*Figure 1 Congo MegaSurvey area offshore Congo.*

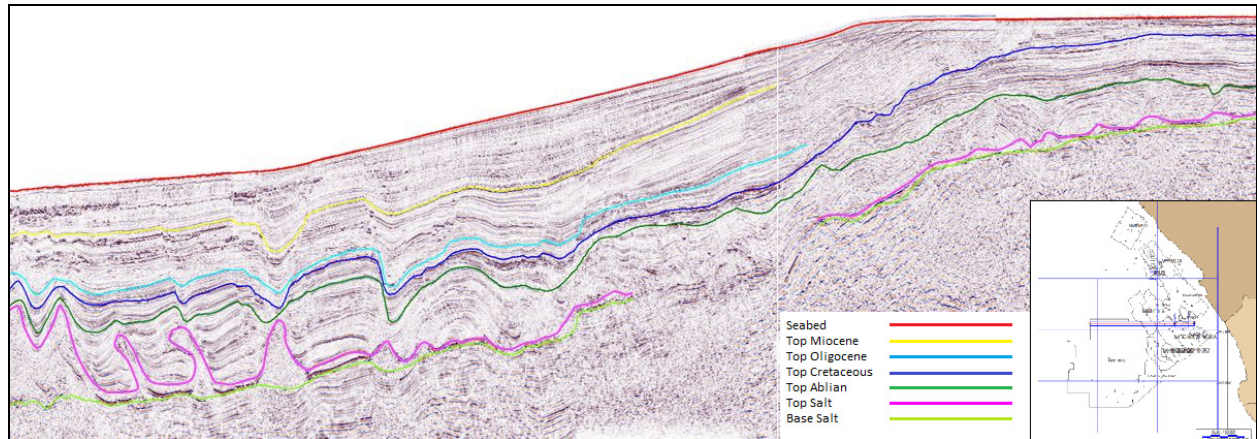
## Geologic Setting

The hydrocarbon bearing formations of the Congo Basin area of West Africa were formed, and influenced, by the rifting associated with the separation of the African and South American plates, initiated during the Late Jurassic. The West-Central Coastal Province of West Africa comprises a series of Atlantic type margin sag basins that extend from the southern edge of the Niger River Delta southwards to the Walvis Ridge and define the extent of the Aptian salt basin. Four distinct phases of deposition and deformation are recognized in the Congo Basin; Pre-Rift, Syn-Rift, Post-Rift deposition, and Salt Tectonic deformation. Petroleum systems are present in strata from all phases, but this paper focuses on the character of the Miocene sequence which comprises deeper marine turbidite systems with sediment sourced via the Congo River (Brownfield and Charpentier, 2006).

## Interpretation

The full interpretation of the Congo regional surveys includes seven key horizons (Seabed, Top Miocene, Top Oligocene, Top Cretaceous, Top Albian, Top Salt and Base Salt). Beneath the Salt, fluvial and lacustrine source rocks were deposited during the syn-rift phase. Above the salt, shelf carbonates are represented by the Albian Sendji Carbonate marked as “Top Albian” on the cross section below (Figure 2). The upper interval of Cenozoic sedimentation is dominated by progradational sandstone and siltstone (proximal to shore) and more distal turbidite and deep-marine

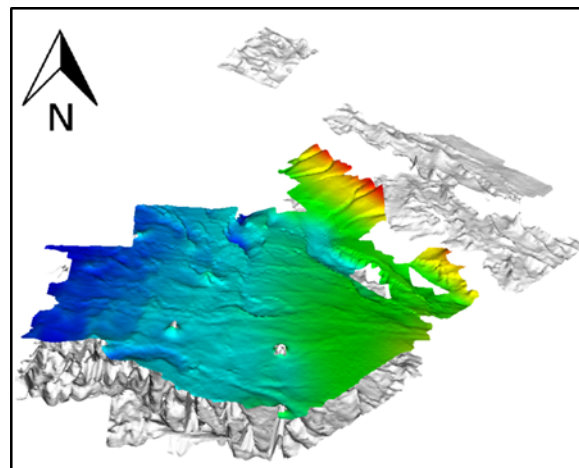
shale units that originated from the Congo River. Uplift and associated erosion and non-deposition occurred during both the Oligocene and Miocene forming regional unconformities. The Oligocene and Miocene are dominated by a series of fan, turbidite and stacked channel systems that provide numerous potential hydrocarbon reservoirs.



**Figure 2** East - west seismic cross section with major interpretation horizons.

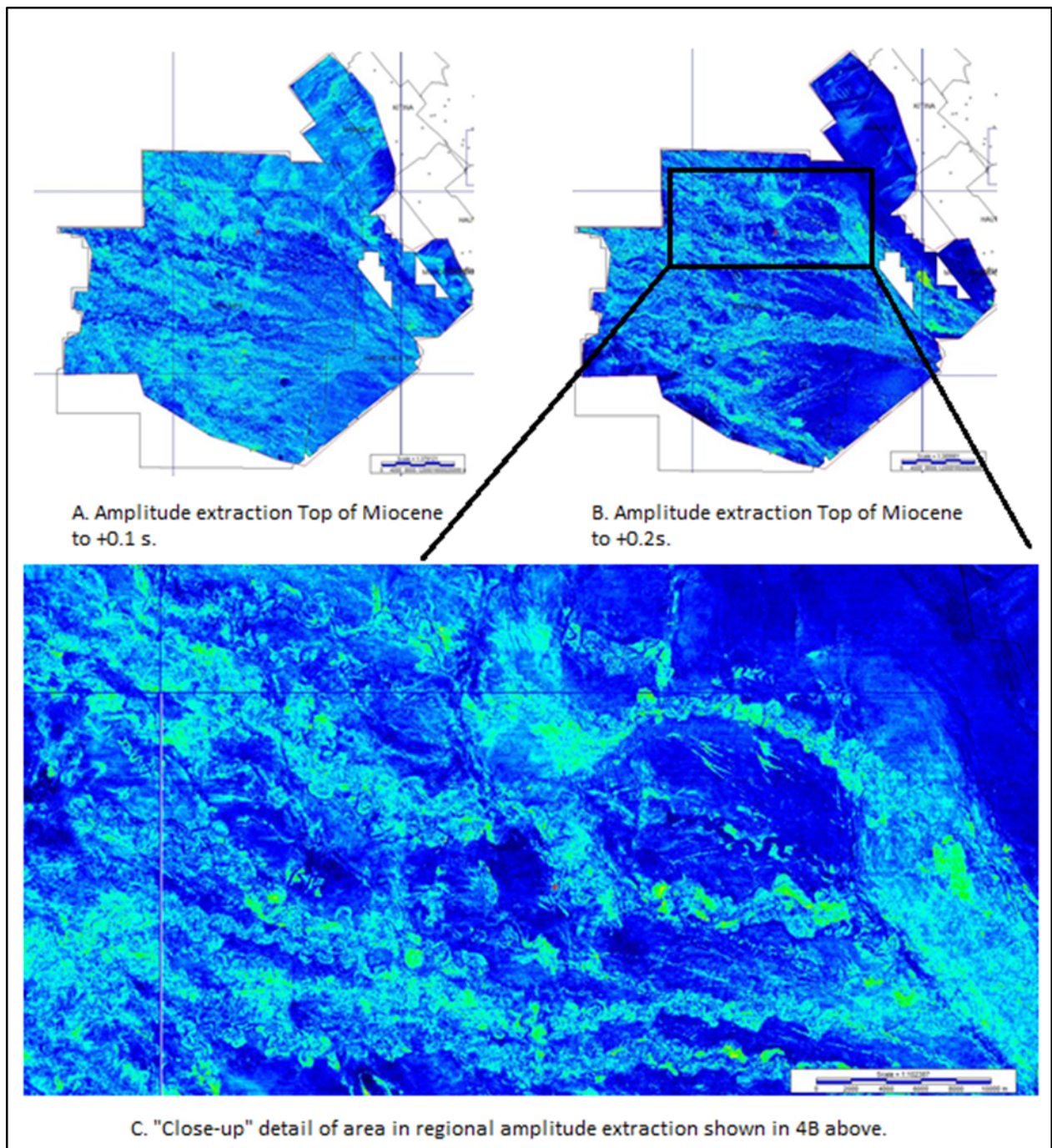
### Amplitude Extraction

The interpreted horizons for the Top Miocene and Top Salt are displayed on figure 3 which shows the basic Top Miocene surface topography and gives an indication of the interaction with the salt below. However the basic regional interpretation does not show the internal structure and detail that can be obtained by further analysis using amplitude extraction.



**Figure 3** Top Miocene (multicolor surface) with Top Salt below (white shaded surface) showing the basic topography of the regional surface.

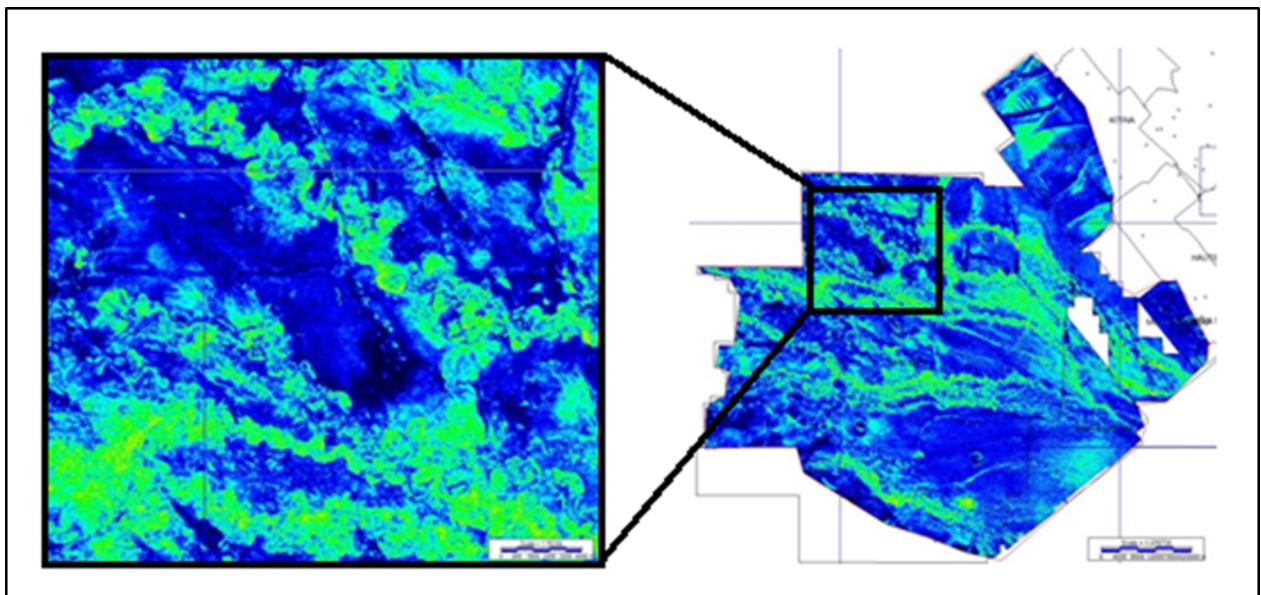
Extractions of amplitude anomalies were made within different time intervals in the Upper Miocene. Two amplitude anomaly extractions are highlighted in figure 4A and 4B (within the time interval Top Miocene to Top Miocene +0.1s and Top Miocene to Top Miocene +0.2s). Figure 4C shows the details of multiple “meander-form” channel systems traversing the lower slope and deep basin with several systems terminating in fan shaped topography. These channels systems are 1 to 2km wide and trend generally from SE to NW across the image. The source of the sediments carried in the channels is the Congo River Delta. Viewed regionally these features may be interpreted to provide information on paleocurrent direction, flow changes over time as well as displacement of channel systems due to offset by faulting and salt domes.



**Figure 4** Amplitude extraction surfaces from the regional Top of Miocene and detailed insert.

Additional features that can be seen in the amplitude extraction close up view include the NW – SE trending slope (right upper corner of the image) and the minor amount of sediment that is sourced directly from the east in Congo. The major channel systems highlighted on the image all originate with the Congo River as distributary channels migrate to form the delta cone and abut the slope.

The close up image in figure 5 highlights another “meander-form” channel system. The regional view in figure 5 shows the amplitude anomalies between Top Miocene +0.1s to Top Miocene +0.2s and shows fans and turbidite systems near the base of the slope to the east. This regional map shows paleocurrent data and can provide detailed data for an interpretation of the flow source and direction of these complex systems.



**Figure 5** Amplitude Extraction of Top Miocene + 0.1s to Top Miocene + 0.2s and “close-up” detail.

### **Conclusions**

The data seen in the regional Congo seismic surveys provide a regional view of complex features such as “meander-form” channels, reservoirs, depositional fans, salt diapirs and faults. The amplitude extraction maps represent a geologic time interval and hence these maps provide information regarding variation in channel flow direction relative to time and can thus give significant information about fault activity and salt movement.

### **Acknowledgements**

We thank PGS and Société Nationale des Pétroles du Congo (SNPC) for the authorization to present this work. We also want to thank Alain Richard Ngouala Nzoussi and Brice William Debi Obame who are both with SNPC and made significant contributions to the project.

### **References**

Brownfield, M.E. and Charpentier, R.R. [2006] Geology and total petroleum systems of the West-Central Coastal Province (7203), West Africa. *U.S. Geological Survey Bulletin*, **2207-B**, 52.