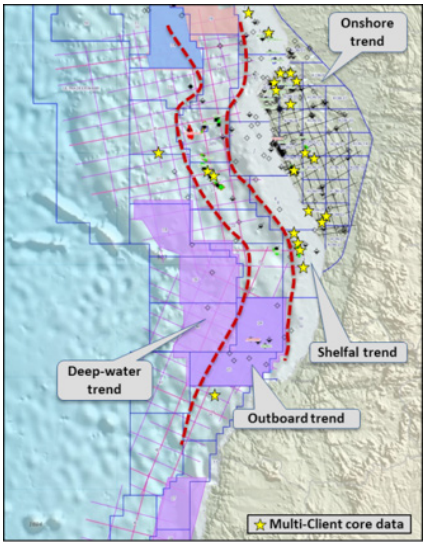
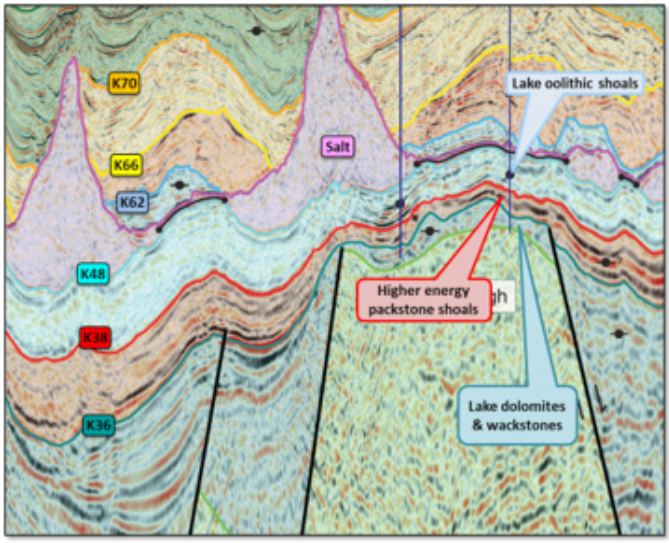
PESGB

LONDON EVENING LECTURE ABSTRACT
GEOLOGICAL SOCIETY OF LONDON, PICCADILLY
13 JUNE 2017 6.00PM

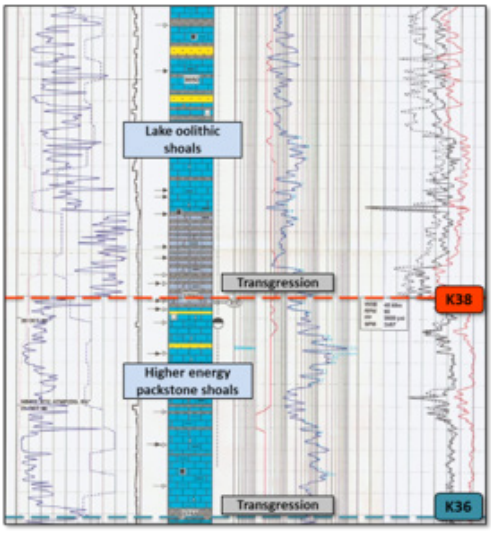


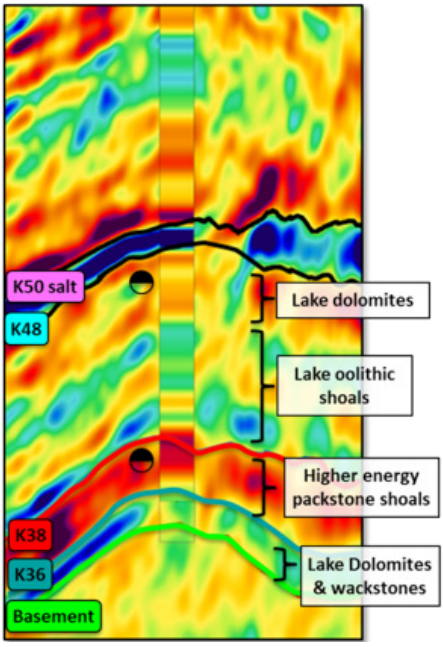


Exploration of the Kwanza Basin

Successes, challenges and what the future holds

With Matt Tyrrell, PGS





The Kwanza Basin, which lies in southern Angola along the West African rift margin, has witnessed 100 years of exploration drilling. Industry interest has followed four geographic trends, each of these influenced by a combination of socio-political events and increasing geological & technical understanding. The successes of these trends can now be analysed and the challenges mitigated through the increasing integration of exploration knowledge with multiclient seismic, well log, core & cuttings data.

The first subsurface oil discovery in the basin was made in 1916 in the onshore trend, however it wasn't until 40 years later, after the acquisition of seismic in 1952, that the pre-salt Benfica oilfield was found. Early 1970s seismic acquisition preceded the discovery of eleven oil and gas fields and it is now anticipated that a recent multiclient 2D seismic shoot, together with the 2013 license round, will revive onshore exploration.

In the offshore shelf trend, the earliest wells were drilled in the early 1970s, initially targeting the post-salt before the first pre-salt penetrations in the early 1980s. The first significant discoveries came in 1983 at the pre-salt Denden Field and the Albian Cegonha Field; since the end of the 1990s however, the shelf trend has seen little exploration activity.

Exploration extended beyond the shelf to an outboard trend in the early 1990s resulting in the discovery of oil in the pre-salt Baleia and Delfim wells in 1996 and 1997. The acquisition of new multiclient 2D and 3D seismic data over these outboard blocks preceded the first commercial pre-salt discoveries in 2011 at the Azul field and in 2012 at the Cameia Field followed by the discovery of six further pre-salt fields nearby.

In the deep-water trend the timing of the 2011 deep-water license round coincided with the discovery of several large pre-salt oil fields offshore Brazil, as well as an era of higher oil prices and more adventurous exploration activities. Modern 3D seismic datasets were acquired over the trend in 2012 and 2013, however the results of frontier exploration wells in the area were somewhat disappointing with just one discovery at the Ombovo-1 well in Block 35.

SUCCESSES AND CHALLENGES

Analysis of the exploration results shows considerable technical success in each of the four trends. Discoveries have consistently been made in areas where new exploration data has been integrated with the knowledge of earlier drilling efforts; furthermore, they show that early exploration results are typically not necessarily indicative of future potential.

The challenges that are highlighted are both sub-surface and commercial. In the outboard and deep-water trends, frontier exploration wells predominantly targeted viable pre-salt structures; however with limited geological data available with which to model and predict the heterogeneous nature of pre-salt reservoir facies, play knowledge has often lagged behind the advances of the drill bit. The wells drilled encountered a variety of reservoir types and fluid fills; many were technical successes, encountering viable quantities of hydrocarbons but the commerciality was tempered by either a lack of infrastructure or unfavourable commercial terms for gas and condensate. The unexpected presence of CO2 in a number of wells also effected commerciality.

WHAT THE FUTURE HOLDS

In the offshore shelf trend, where there is considerable open acreage, the opportunity to acquire multiclient seismic data with which to integrate available well data, including pre-salt core and cuttings data, is apparent. In the outboard and deep-water trends, the pre-salt fields discovered contain a combination of oil, condensate and gas held within a complex range of clastic and carbonate lacustrine facies with variable lateral continuity and reservoir quality.

The opportunity to integrate exploration knowledge with modern multiclient seismic, well log, core & cuttings data enables many of the subsurface challenges to be overcome. Explorers are now developing valid structural and depositional sequence frameworks to compare play models, constrain depositional environments and reservoir facies characterisation and model, map and extrapolate these away from well control.

With a valid depositional framework and reservoir model in place, a more accurate calibration of known reservoir facies and fluids to elastic rock properties can be conducted using AVO analysis and quantitative interpretation techniques. The results of this work can permit reservoir qualities and potentially hydrocarbon charge to be predicted and identified throughout the basin. Where CO2 is encountered, the migration of 2D data to a depth of 15km has permitted interpretation of basin architecture, particularly deep-seated transform faults, and thus allows contamination trends to be understood and mitigated.

The future of exploration in all four of the trends identified looks promising. The availability and integration of data allows the value of past knowledge and exploration results to benefit future exploration efforts and significantly reduce technical and commercial risks. With the development of more robust models for predicting reservoir qualities and the distribution of hydrocarbon types, the opportunity presents itself to prepare for future success.

Matthew Tyrrell[1], Anne McAfee[2], Domingos Cunha[3],
[1]PGS, [2] Core Lab, [3]Sonangol