

A Novel Oil Opens Up a New Play Beneath the Gadiaga Gas Field, Senegal

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ABSTRACT

The Gadiaga Gas Field is located onshore Senegal to the northeast of the capital, Dakar. This field, operated by Fortesa International-Senegal, supplies the only production in Senegal. All wells encountered gas and minor condensate with production from Campanian to Lower Santonian sandstones. Interbedded claystones provide seal. Production is slowly declining and the field is regarded as mature. However, oil has been unexpectedly encountered in tests at Gadiaga and it was commercially produced from the nearby Diam Niadio Field.

The sandstones were deposited in intra-slope channels fed from a delta. This associated succession overrode and buried a Lower Cretaceous to Middle Jurassic carbonate bank that had formed along almost the entire length of North West Africa following the onset of drift in the early Jurassic. By the time the bank ceased growth in the Albian, it separated shallow water settings to the east from increasingly deepwater environments to the west. Loading instability developed along the ocean-facing margin in the Cretaceous cover section with the development of multiple listric fault-growth anticline pairs. Both the Gadiaga and the Diam Niadio Fields lie within this trend.

In 2014 the Cairn Group discovered to the south of Dakar the giant SNE Oil Field which is positioned on the then shelf. To the west and in depositional settings analogous to Gadiaga, they had success with their FAN-1 oil and gas discovery. From 2015 onwards, Kosmos Energy have found in a trend broadly west of Gadiaga some 50 TCF of gas. The origin of all this offshore oil and gas is considered to be the Albian to Turonian sources intersected further west in DSDP coreholes 367 and 368.

Historically it was assumed that the Gadiaga and Diam Niadio hydrocarbons originated by updip migration from the same source beds. This possibility was discarded after two light oils recovered from unexpected finds in Coniacian sands were geochemically analysed. The biomarkers revealed that these oils originated from a littoral marine or lacustrine source, that is from an environment incompatible with mid-Cretaceous, deepwater settings of the DSDP sources. Subsequently it was found that the same biomarkers characterised all of Fortesa's oils and condensates, plus those from the Diam Niadio Field.

It had been previously suggested from seismic that a broad basin underlay the oldest Jurassic bank carbonates and it was speculated by others that this region might contain Lower Jurassic sources related to those known from Morocco and the American Atlantic coast. Mapping by FEC found that this basin runs the entire length of Senegal. Though it cannot be proved that this horizon is the source of the Gadiaga and Diam Niadio oils, this basin's rift-drift transition setting matches that indicated by these new biomarkers. The maturities obtained from the gas carbon isotopes appear consistent with the maturities obtained from the oils and condensates. The gasoline data for the oils and condensates

reveal a history of evaporitic fractionation. The geothermal gradient for the wells indicates that the gases are derived, assuming vertical migration, from the same depth as the seismically defined, Lower Jurassic section.

The lesson from Gadiaga is that it is never too late to cease being inquisitive about the workings of even mature fields. Pointers are readily overlooked if it assumed that nothing new remains to be found or learnt. The result in this case is a new deep source and multiple new play opportunities.