Abstract

The F-O Field (Bredasdorp Basin) is a seismically defined, low-relief antiform. The last two of the four drilled wells found surprisingly poor porosity (<12%) in clean sands of the ‘Upper Shallow Marine’ (USM) reservoir, highlighting the need for a reliable predictive sedimentological model. Subsequent wireline correlations, core facies analysis and diagenetic studies have revealed or confirmed the following interpretations. (1) The depositional environment was a shallow marine tidal sand sheet (dunefield), for which suitable analogs are the modern North Sea and the Peninsula Formation of South Africa (Paleozoic, e.g. Table Mountain). Net-sand mapping for each of eight reservoir zones defined from log-shape correlations reveals lateral shifts in the sand-sheet axis. (2) The base of the USM is a sequence boundary, probably representing the 126 Ma eustatic superlow (Valanginian), consistent with imprecise USM microfossil dating. (3) The top of the USM is a diachronous flooding surface overlain by shales. (4) Not far (<100 m) above the USM is a low-relief angular unconformity (evident on dipmeter), formed during F-O antiform growth, reflecting Hauterivian early transpressive movement on the Agulhas-Falklands Fracture Zone, after USM “quiescent rift” deposition. The USM is partly to entirely eroded at the unconformity when traced laterally. (5) Porosity is secondary and generally poor due to deep burial (currently 3.5 km). Enhanced porosity (12-16%) can occur in the cleanest facies (central dunefield sand), but only near (<40 m below) the unconformity, indicating that it is telodiagenetically related. Overlaying of two isopach maps (net sand, and “sub-unconformity overburden”) will help to guide future well placement. Reservoir modeling and frac-suitability studies are underway.
Cretaceous ‘USM’ reservoir, F-O Gas Field, Bredasdorp Basin, offshore South Africa: sedimentological factors affecting economic viability

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on contract to

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ISSUE

-Deep (c. 3.5 km), undeveloped gas field, 4 wells

-First 2 wells yielded enhanced porosity (12-16%) near top of reservoir (DST 31.5 MMcf/d)

-Next 2 wells did not

-How to predict good porosity in future wells?
informal name of reservoir interval:

“Upper Shallow Marine Sandstone”
Tectonic setting: pre-oceanic transtensional rift basin
"submarine dune-field in a shallow, high-energy offshore shelf" (Jungslager, 1996, p. 29)
Best wells are 1 & 2, i.e. porosity not related to present structure.

Time-structure, top of USM reservoir ("1At1 unconformity"), F-O Gas Field.
Datum = base “Low-Velocity Shale”

Top of sand, seismic reflector, “1At1 unconformity”, interpretable instead as diachronous flooding surface

Note reservoir zonation, A-H
top USM diachronous
angular (erosional) unconformity, at base of low-velocity shale
USM FACIES ANALYSIS
cleanest sand (lowest GR) is Facies 5
Cross-stratified sandstone containing a cluster of foreset mud drapes (including couplets), indicating tidal slack-water episodes.
**USM FACIES ANALYSIS**

<table>
<thead>
<tr>
<th>OBSERVATION</th>
<th>INTERPRETATION</th>
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<tbody>
<tr>
<td>Cross strat with mud drapes</td>
<td>Tide dominated</td>
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<tr>
<td>Ammonites; no roots or paleosols</td>
<td>Marine; entirely subaquatic</td>
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<tr>
<td>Rare HCS &amp; sym ripples</td>
<td>Wave-influenced</td>
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**INTERPRETED ENVIRONMENT:** Shallow marine, storm-influenced tidal sand sheet

**MODERN ANALOG:** North Sea

**ANCIENT ANALOGUE:** Peninsula Fm, Paleozoic, South Africa

**PREDICTED SAND-BODY GEOMETRY:** Stacked sand sheets, area 100s km x 10s km
Depositional models for a tidal sand transport path in a shallow sea, based on NW European shelf.

MODERN ANALOG
ANCIENT ANALOG - Peninsula Fm (Lr Pzc)

Largely interpreted as tide-dominated shallow marine (Hobday & Tankard 1978).

Table Mountain more proximal in the sand sheet (pebbly sandstone common; mud drapes rare) than F-O? More analogous to F-A Field?
USM DIAGENESIS ANALYSIS
Enhanced porosity, F-O1, 3714.89 m, Facies 5

Diagnostic attributes of secondary porosity:
- oversize pores
- micro-pitted quartz borders
Enhanced porosity is (1) secondary, (2) in low-GR sand, (3) near BVLS unconformity, i.e. interpretable as telodiagenetically related.
F-O4, 3737.35 m, Facies 5. Advanced cementation by interlocking quartz crystals
Optimum future well locations found by overlaying two maps (per zone): (1) isopach of net clean sand; & (2) isopach to base LVS.
Figure 28. BLVS to top of Zone E (USM) isopach (m; brown contours), overlaid on Zone E net-sand isopach (m; black; 10% GR cutoff), F-O Field.

Gas-bearing enhanced porosity in Zone E (from cores/well logs; DST not achieved)

gas/water contact (PGS 2001a)
paleo-anticline axis
CONCLUSIONS

Two conditions required for “enhanced porosity”...
  - cleanest facies (central dune field sand)
  - less than 40 m below the BLVS unconformity
References


Thank you