Stacked Deltas in the Great South Basin

Chris Uruski

OMV New Zealand Ltd

March, 2017
Southeast New Zealand

- Stewart Is.
- Auckland Is.
- Campbell Plateau
- Campbell Is.
- Dunedin
- Canterbury Basin
- Great South Basin
- Chatham Rise
- Bounty Trough
- Bounty Is.
The Great South Basin is a component of a basin system within the Campbell Plateau, a large shoal area to the southeast of South Island, New Zealand. The basin was formed by rifting leading up to separation of the New Zealand continental block from Antarctica and Australia. A Paleogene rifting episode is documented, particularly in the southwest around the Tara and Toroa wells. Neogene compression reversed some of the rift faults enough to create the large Toroa swell and some minor thrust faults close inshore. Fourteen wells have been drilled in this 250,000 km² region. Three sub-commercial discoveries of gas-condensate are recognised. Oil shows are present in several wells.
Area of interest

- Background map is basement
- Grey dashed polygon is the region underlain by Cretaceous and Paleogene delta lobes
- Overlies thickest section in the region
- Offshore from Foveaux Strait, mostly within PEP 55974 operated by Woodside
- Locations of wells and seismic section used for illustration are shown
Basement

- 1 – Western Province
- 2 – Median Batholith
- 3 – Brook Street
- 4 – Murihiku Basin
- 5 – Dun Mountain/Maitai
- 6 – Caples Terrane
- 7 – Otago Schist
- 8 – Rakaia Terrane
General stratigraphy of the GSB

- Development of modern plate boundary
- Long-lived episodic transgression
- Plate separation
- Pre-break-up rifting
- Subduction at Gondwana margin: Deposition in fore-arc (and back-arc?) environments
- Hikurangi Plateau impinges on margin - subduction stops

Panel from seismic line OMV10-045

Index map shows local onshore geology and bathymetry (100 m contours), wells and location of seismic panel
Regional Geoseismic section – DUN06-23
Well data – panels from GNS well sheets

Tara-1

Toroa-1
Tara-1 and Toroa-1 correlation

- Eocene
- Paleocene
- Haumurian (Maastrichtian & Campanian)
- Albian to Santonian

- Sand dominates
- Sand dominates, Coaly in Tara
- Very coaly in Tara, sand and Shale in Toroa
- Coal-bearing

Described as “fluvio-deltaic”
Panel from DUN06-23 flattened on Late Eocene reflector
Delta lobes

- 20 delta lobes mapped from seismic data
- Ages range from K20 (102 Ma) to T70 (40 Ma)
- All but three overlap southeast of Foveaux Strait
Stratigraphy of delta lobes

<table>
<thead>
<tr>
<th>Period</th>
<th>Epoch</th>
<th>NZ Series</th>
<th>Delta bodies</th>
<th>Sequence</th>
<th>NZ Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ma</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td>T70</td>
<td>Runangan (Ar)</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td>T70</td>
<td>Koatan (Ak)</td>
</tr>
<tr>
<td>45</td>
<td></td>
<td></td>
<td></td>
<td>T70</td>
<td>Bartonian (Ab)</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td>T70</td>
<td>Nebranui (Nh)</td>
</tr>
<tr>
<td>55</td>
<td></td>
<td></td>
<td></td>
<td>T70</td>
<td>Mangaroapan (Dm)</td>
</tr>
<tr>
<td>60</td>
<td></td>
<td></td>
<td></td>
<td>T70</td>
<td>Whakapan (Dw)</td>
</tr>
<tr>
<td>65</td>
<td></td>
<td></td>
<td></td>
<td>T10</td>
<td>Turian (Dm)</td>
</tr>
<tr>
<td>70</td>
<td></td>
<td></td>
<td></td>
<td>T00</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td></td>
<td></td>
<td></td>
<td>K100</td>
<td>Haumurian (Mh)</td>
</tr>
<tr>
<td>80</td>
<td></td>
<td></td>
<td></td>
<td>K90</td>
<td></td>
</tr>
<tr>
<td>85</td>
<td></td>
<td></td>
<td></td>
<td>K80</td>
<td>Piripalau (Mh)</td>
</tr>
<tr>
<td>90</td>
<td></td>
<td></td>
<td></td>
<td>K70</td>
<td>Teratan (Mt)</td>
</tr>
<tr>
<td>95</td>
<td></td>
<td></td>
<td></td>
<td>K60</td>
<td>Mangaroapan (Rm)</td>
</tr>
<tr>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td>K50</td>
<td>Awituan (Rit)</td>
</tr>
<tr>
<td>105</td>
<td></td>
<td></td>
<td></td>
<td>K40</td>
<td>Ngateraiti (Cn)</td>
</tr>
<tr>
<td>110</td>
<td></td>
<td></td>
<td></td>
<td>K30</td>
<td>Motuan (Cm)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Urutawan (Cu)</td>
</tr>
</tbody>
</table>

Panel from DUN07-023 ~ 70 km long
See slide 4 for location
Well and seismic data show gradually increasing water depths in GSB through Late Cretaceous and Paleogene time.

Global sea-level curves show an overall fall in sea-level through the same time period.

So what drove deposition in the GSB?
Lowstand wedges appear to onlap many prograding lobes.

Flooding is seen only after T00 and T20.

Lobes are stacked vertically and form the bulk of deposition in the region.

Minor rift faulting in the Paleogene.
Possible driving mechanisms

- Thermal contraction
  - Rifting prior to 85 Ma
  - Plate separation and drift phase

- Plate rotation
  - Compression in Reinga and New Caledonia Trough
  - Extension in Solander and nearshore GSB

- Sediment loading
  - Isostacy

- Global sea-level change
The Miocene Mataura River Delta
Potential source rocks encountered in wells
Source rock distribution

K20 distribution

K40 distribution
Distribution of reservoir facies – DUN07-023

- See slide 4 for location
- Sand-rich sediment supplied during lowstands deposited as pro-delta turbidites
- Much sand may also have been re-worked subsequently by bottom currents

~135 km

~2 s twt
Indicated by separation between topset and bottomset beds

Never more than 250 milliseconds and commonly less

The basin was shallow throughout its history with present-day bathymetry probably deepest

Panel from DUN07-023 ~ 100 km long

See slide 4 for location
Conclusions

- Foveaux Strait was a major source of clastic sediments to the GSB
- Stacked delta lobes define a distinct and long-lived basin margin
- Well and seismic data indicate that older lobes are richer in coaly source rocks while younger lobes are sandier
- Well data shows that large volumes of sand were transported into the basin from Clarence time (Late Albian) to at least mid-Eocene time
- Despite the distinct basin margin east of Foveaux Strait, accommodation space was limited and water depths were probably shallow until Neogene time