Dolomitization

Middle Eastern Diagenesis

• Arab
• Khuff
• Shayba

http://www.saudi-us-relations.org/energy/saudi-energy-abdul-baqi.html
Max Steineke - CASOC's Chief Geologist

http://www.saudi-us-relations.org/energy/saudi-energy-abdul-baqi.html

Ghawar Field
Ghawar: World’s Largest Oil Field

- 5 million barrels a day
- Mahmoud Abdul Baki (2004 in presentation to Center for Strategic and International Studies)
- 6.25% of world’s oil in 2003
- Matthew Simmons
- Most of the production comes from grain-dominated limestones
- Dolomites have rather poor reservoir quality
- Locally dolomites have great reservoir properties and can account for super-K behavior
- Initial super-K produced very high recovery of dry oil and hence was considered good but recently the contribution to early water encroachment and uneven flood advance

Saudi Oil Fields Production in 2005

- Has 80 fields & 1,000 wells
- More than 50% of reserves are contained in eight fields
- Ghawar and Safaniyah produce almost 65% of the Kingdom’s oil
- Manifa is offline

Oil Field Depletion Rates & Capacity

- Total depletion rate: % of the estimate oil resources has been pumped
- Saudi oil fields total depletion rate estimated to be 28%-30%
- To keep the same capacity, need more discoveries
- Total producible oil at given cost very difficult to estimate, as it gains from secondary and tertiary recovery
Publications


Other Relevant


Overall, this interval represents a series of shoaling upward packages that ultimately climax with the deposition of the overlying anhydrite.

• Internally within the reservoir, deposition of cyclic shoaling upward packages are identified using a succession of porosity breaks in porosity well-log patterns.

• Operationally, these porosity breaks are used to differentiate the five major reservoir zones depicted; these zones, from the top of the reservoir down, are Zones 1, 2A, 2B, 3A, 3B and 4.

• As noted in Mitchell et al., 1988 and Meyer et al., 2000, with the exception of the Zone 1 and 2A boundaries, these zone boundaries are tentatively identified as timelines.
The mineralogy is mainly a mixture of dolomite and calcite with the exception of Zone 1 where there are abundant evaporites. Most production comes from Zone 2b or rarely the top of Zone 3a.

In this particular well the zone of production occurs in Zone 2b where the permeability is fairly high and the porosity is between 10-20%.
Within this zone there are zones of 100% porosity marked by an anomalous caliper log and 0% core recovery. In many instances 90% of the oil production occurs in those intervals.

**Porosity %**

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<tr>
<th>Depth (ft)</th>
<th>Well B</th>
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<tbody>
<tr>
<td>6550</td>
<td>2a</td>
</tr>
<tr>
<td>6600</td>
<td>2b</td>
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<tr>
<td>6650</td>
<td>3a</td>
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<tr>
<td>6700</td>
<td>3b</td>
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**Permeability**

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**Mineralogy**

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These are defined as “super-K” zones and specifically are defined as intervals whose production or injection rates equal 500 barrels of fluid per day per foot.

• The dolomite within the “super-K” normally has fairly positive oxygen isotopic composition suggesting at least partial retention of an early emplaced O isotopic composition.

• These dolomites are similar to the Zone 1 dolomites which are intimately associated with evaporites perhaps suggesting a common origin.

• Dolomites in the remainder of the core can be as negative as -6 to -7 per mille, similar to other dolomites in the Arab-D which are probably higher temperature in origin.
Zone 3

- Partially dolomitized mudstone, showing sucrosic dolomite crystals. (Well C)
The dolomites in Zone 3 are associated with firmgrounds and hardgrounds. They are sucrosic, non-fabric preserving, and approximately 100 um in size. It is postulated that these dolomites formed in association with the non-depositional surfaces, first as small 10-50 um non-stoichiometric-dolomite rhombs that subsequently coarsened to their present size.
What about Super-K

What about Super-K

What about Super-K
The Future of Geochemical Indices

There are significant problems with all geochemical indices:
- 25 years since Land
  - No progress on the majority of the issues
• Non-conventional Geochemical Analyses
  - Chloride, Sulfate (isotopes), Sodium

Solution

Non-conventional geochemical Indicators
1. Well A
2. Well B
3. Sea level rise
4. Sea level increase