Abstract

The Priobskoye Field is one of the largest stratigraphic traps in the world, covering over 5400 km$^2$ and with a recoverable resource of 5.86 BBO and 1.17 TCF of gas. The trap is a complex series of fine-grained, highly heterogeneous reservoirs varying from basin-floor fans to slope channels and shallow-water deltas. The traps are within an overall progradational ‘clinoform’ complex, with regional seals created where shoreface ravinement of the delta top sets has removed the reservoir facies landward and placed marine shales over prodelta shales and siltstones. Additional pure stratigraphic traps occur within a multitude of turbidite fans and slope channels in the ‘Achimov’ Formation. Hydraulic fracturing is generally needed to obtain commercial flow rates. Most reservoirs are dominantly meso- and microporous, with the best reservoirs in hummocky cross-stratified deltaic shore face and delta-front sandstones. Locally, ‘massive’ deep-water sandstones and bioturbated shoreface sandstones form effective reservoirs. Most of the other facies are microporous and have a high content of bound-water and high water saturations. 3D seismic facies analysis clearly delineates many of these productive trends and can be used to high-grade ‘sweet’ spots of better reservoir-quality rock in the complex. Recognition of these better reservoir fairways can be used to enhance production with additional infill drilling and perhaps even horizontal well placement. The Priobskoye Field is a superb analog for similar combination and stratigraphically trapped reservoirs in deltaic successions.

References Cited


Seismic and Core Based Reservoir Characterization, the Giant Priobskoye Field, West Siberia, Russia

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Structural and field setting: Oil prone southern part of West Siberia

Shaded relief, Bazhenov Structure and oil, gas, condensate fields

Chronostratigraphy

Modified from work done by Stephen Lowe, BP
Flattened and unflattened regional seismic illustrating a Triassic Rift and then the main surfaces (A-basement—actually the rift to drift unconformity), T surface (top of Tyumen or top of J2 Glossifungites surface regionally. Sections flattened on Bazhenov. Onlap and deep paleostructures are obvious below the A surface; topography is on rift shoulders and also on highly folded Paleozoic strata which formed pre-rift during Uralian collision.

Location of Priobskoye field, key cores, and seismic profiles. Colors show structural shapes on the Aptian ‘M’ seismic horizon (roughly the top seal), with contours displayed in positive TVDSS, meters.

- Huge stratigraphic trap
  - 5.3 BBO + 1.17 TCF gas recoverable
  - Field outline over 5000 km² trap
- Very gentle ramp dip on Aptian surface (a top seal)
  - Subtle arch, but no closure
- Study area southern ½ of field
  - 4 key wells with core and 3D seismic
A near perfect petroleum plumbing system

Generalized stratigraphic trapping mechanism: Priobskoye Field

- Shale
- Achimov turbidites
- Slope channels
- Delta top sets
- Incised valley fills

- Hydrocarbons
- Clinoforms
- Migration pathways

Bazhenov or other major flooding shale source rocks
Depositional model (from Kendall, 2006)

## Major Priobskoye Facies

<table>
<thead>
<tr>
<th>Facies table</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Shale or mud rock</td>
<td></td>
</tr>
<tr>
<td>2 Interbedded turbidities</td>
<td></td>
</tr>
<tr>
<td>2a sandstone dominated</td>
<td></td>
</tr>
<tr>
<td>2b sandstone turbidite and mudstone</td>
<td></td>
</tr>
<tr>
<td>3 Sandstone</td>
<td></td>
</tr>
<tr>
<td>3a sandstone, cemented</td>
<td></td>
</tr>
<tr>
<td>3b sandstone, massive</td>
<td></td>
</tr>
<tr>
<td>3c sandstone, contorted</td>
<td></td>
</tr>
<tr>
<td>4 Debrite</td>
<td></td>
</tr>
<tr>
<td>5 Sandstone, vfg with mud rip ups</td>
<td></td>
</tr>
<tr>
<td>6 Siltstone</td>
<td></td>
</tr>
<tr>
<td>6a Siltstone, massive, contorted</td>
<td></td>
</tr>
<tr>
<td>6b Silstone, graded</td>
<td></td>
</tr>
<tr>
<td>7 Sandstone</td>
<td></td>
</tr>
<tr>
<td>7a sandstone, wavy bedded</td>
<td></td>
</tr>
<tr>
<td>7b sandstone, 50% mud, 50% sandstone</td>
<td></td>
</tr>
<tr>
<td>8 injectite</td>
<td></td>
</tr>
<tr>
<td>9 Sandstone, HCS bedding</td>
<td></td>
</tr>
<tr>
<td>9a Sandstone, HCS bedding, cemented</td>
<td></td>
</tr>
<tr>
<td>10 Sandstone, HCS with interbedded mudstone</td>
<td></td>
</tr>
<tr>
<td>11 Sandstone, bioturbated</td>
<td></td>
</tr>
</tbody>
</table>
Sequence boundaries: Glossifungites Assemblage
Characteristic Bedding Styles and Physical Sedimentary Structures: Priobskoye Cores

- Climbing Current Ripples
- Contorted Bedding
- Graded Rythmites
Indicators of Rapid Deposition: HCS, Current tipples

HCS

Massive Sandstone

Climbing Current Ripples

Climbing Ripples
Indicators of Rapid Deposition: Micro faults and Ramp Creep
Major trace fossils

Diplocriterion

Asterosoma

Rhizocorallium

Chondrites

Thallasonoides

Planolites

Schaubcylindrichnus

Glossifungites Assemblage

As

D

Rh

P

T

Ch

Sch

11221
2468.4

11221
2468.55

13055
2584.14

As

D

Rh

T

P

Sch

Diplcriterion

Thalassinoides

Planolites
Seismic wavelet classification (Stratimagic)

Seismic facies classification: Achimov AS12.1 to AS12.35 surfaces

Ravinement surface (TSE)

Frontal Splay

Well log and facies

8 KM
Seismic facies through cored well 19460

- Classic ‘Achimov’ turbidites
- Thick, widespread fans and sheet deposits
Deep Marine Facies: Well 19460

Facies:
- Mud dominated (1, 2, 7b)
- Silt dominated (6, 4)
- Sand dominated (3, 5, 7a)

Erosion surface

- Facies F1
- Facies F7b
- Facies F7a
- Facies F5
- Facies F3b
- Facies F2
- Facies F4

Massive Sandstone

Climbing Current Ripples

Microfaults

By-Up Cherts
Seismic amplitude extraction at well 19460, with log and core facies. Shown in the bottom right of the seismic panel is an enlarged view of the debrite and slump block, using seismic wavelet classification. Slump-scars like this are probably prevalent through the Priobskoye complex.
Facies breakout by K/PHI plots

Priobskoye Field: Major Facies by K/PHI ratio

- Cumulative K/PHI plots
- SEALS:
  - Contorted silts, laminated muds/sands 50%
- RESERVOIRS:
  - HCS-bedded sandstones
  - Low-calcite cement facies

‘Transition zone high water cut saturations’

• Representative pseudo-capillary curves—mimic actual cap pressure in study
• HCS- and massive-bedded reservoirs
  – Low water-cut low on traps
• Cemented and other facies
  – High water-cut low on the traps

Equations for pseudo-capillary pressure analysis from:
Conclusions

- Ideal stratigraphic trapping geometries
  - Turbidites and top-set deltaic sands plumbed directly onto underlying LK and JRSC source rocks
  - Primary shallow facies trapping is top-set truncation by marine ravinement
  - Primary deep-water (Achimov) facies is largely purely stratigraphic
  - Pervasively saturated with probably multiple free-water levels and trapping geometries
- A global model for similar traps in ‘clinoform’ packages (including carbonates)
- Slope turbidite deposition
  - Weakly developed slope channels and some slump-scarp development
- Proper log correlation requires higher resolution 3D seismic with well ties
  - Many older interpretations correlate deltaic top sets and Achimov facies as ‘blanket’ sheets of sandstone
- Most reservoirs are micro- and mesoporous
  - Require significant columns to produce water-free
  - Best reservoirs are top-set deltas and cleaner Achimov turbidites (less calcite cement)
- Hydraulic fracturing
  - Necessary for many commercial rates
A bit of humor--American Revenge on the Russian Language

• J. Dolson took weeks to learn the Russian word for ‘oil field’—
  —месторождение нефти
• He has enjoyed immensely forcing Russian colleagues to learn:
  —Glossifungites ichnofacies
Thank You!

Mid-Cretaceous

Paleo-geography