Cook Inlet
Activities & Natural Gas Update

AIDEA Board of Directors
December 18, 2013
Anchorage, AK

Bob Swenson, Deputy Commissioner
Alaska Department of Natural Resources
www.dnr.alaska.gov
• Petroleum Systems – necessary components
  – High organic source rock & maturity
  – Migration pathway
  – Reservoir quality rock – sandstones, porosity, permeability
  – Sealing Rock (or ‘cap rock’)
  – Trap

• Conventional vs. Unconventional Accumulations
• Reserves vs. Resources
Cook Inlet - Petroleum Systems

**Oil & Gas Accumulations***

- **Sterling**: Beluga River, Pretty Creek, N Cook Inlet, Swanson River, Beaver Creek, W Fork, Sterling, Cannery Loop, Kenai River
- **Beluga**: Nicolai Creek, Kalos, Moquawkie, Lone Creek, Three Mile Creek, Beluga River, Pretty Creek, Lewis River, Ivan River, Stump Lake, N Cook Inlet, Swanson River, Wolf Lake, Beaver Creek, Sterling, Cannery Loop, Kenai River, Falls Creek, Deep Creek
- **Tyonek**: W Foreland, McArthur River, N MGS, Redoubt Shoal, N Trading Bay, Granite Point, Nicolai Creek, Moquawkie, Lone Creek, Lewis River, Ivan River, Birch Hill, Swanson River, Wolf Lake, Sterling, Cannery Loop, Kenai River, Kasilof, Ninilchik, Deep Creek, N Fork, Nicolai, McArthur River, MGS, N MGS, S MGS, N Trading Bay, Granite Point, N Cook Inlet, Swanson River, Beaver Creek, Cosmopolitan
- **Hemlock**: W McArthur River, McArthur River, MGS, N MGS, S MGS, Redoubt Shoal, N Trading Bay, Swanson River, Beaver Creek, Cosmopolitan
- **West Foreland**: McArthur River

***Oil accumulations (roman) Gas accumulations (italics)***

**Petroleum Systems** (source rocks)

- Mostly Stratigraphic
- Combined Strat./Struct.
- Mostly Structural

**Petroleum Plays**

- Mostly Stratigraphic
- Combined Strat./Struct.
- Mostly Structural

Sand Distribution in a Fluvial System

Beluga River Gas Field
Reservoir Correlation Along Structural Crest
Sterling and Upper Beluga Formation

From Swenson, 1997, courtesy of ConocoPhillips, Chevron, MLP
COOK INLET
- NEW GAS FROM NEW EXPLORATION TYPES: OIL & GAS TRAPPING MECHANISMS -

Anticline

Normal Fault

Stratigraphic

Thrust Fault
Biogenic Gas & Thermogenic Oil Systems

Middle Jurassic Tuxedni source rocks at oil window maturity

Bacterial gas from coals
85% of gas discovered early in exploration cycle while drilling for oil

Only structural traps had been explored for or developed – stratigraphic trap potential essentially untapped

Nearly one in ten fields >2 tcf

4 largest fields have 86% of reserves

Field-size distribution lacks discoveries in 300-1300 bcf range ➔ yet to be discovered?
Cook Inlet - Exploration Wells Per Year (Excluding OCS) -

* Through October 2013
Cook Inlet
- Development Wells Per Year (Excluding OCS) -

* Through October 2013
Cook Inlet Gas Estimates, DOG, December 2012

- ~ 1.1 TCF estimated remaining producible reserves in 28 fields
- ~ 355 BCF in undeveloped gas resources in 3 primary fields
  - Beluga River Unit (BRU) (233 BCF)
  - Trading Bay Unit (TBU) Grayling Gas Sands (72 BCF)
  - North Cook Inlet Unit (NCIU) (50 BCF)
- Recent drilling has proven new reserves in existing fields
- Current production from these wells: 1.0-7.0 MMCF/D
Cook Inlet - Petroleum Reserves & Resource Definitions

Resources Classification Framework

Subclasses Based on Project Maturity

From: SPE, AAPG, SEG, SPEE, & WPC; Guidelines for Application of Petroleum Resources Management System, 2011
Undiscovered, Technically Recoverable Oil and Gas

- mean conventional oil 599 MMBO
  372 MMBO in Tertiary Ss play
  227 MMBO in Mesozoic Ss play

- mean conventional gas 13.7 TCF
  12.2 TCF in Tertiary Ss play
  1.5 TCF in Mesozoic Ss play

- mean unconventional gas 5.3 TCF
  0.6 TCF Mesozoic tight ss play
  4.7 TCF Tertiary Coalbed play
Cook Inlet assessment results.

[MMBO, million barrels of oil. BCFG, billion cubic feet of gas. MMBNGL, million barrels of natural gas liquids. Results shown are fully risked estimates. For gas accumulations, all liquids are included as NGL (natural gas liquids). Undiscovered gas resources are the sum of nonassociated and associated gas. F95 represents a 95 percent chance of at least the amount tabulated; other fractiles are defined similarly. Largest expected oil field in MMBO; largest expected gas field in BCFG. TPS, total petroleum system; AU, assessment unit. Gray shading indicates not applicable]

<table>
<thead>
<tr>
<th>Total Petroleum Systems (TPS) and Assessment Units (AU)</th>
<th>Field type</th>
<th>Largest expected mean field size</th>
<th>Oil (MMBO)</th>
<th>Total undiscovered resources</th>
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<td>Total Conventional Resources</td>
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<td>519</td>
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</table>

| Tuxedni-Naknek Continuous Gas Total Petroleum System    | Gas        |                                 | 257  | 568 | 1,254 | 637 | 3 | 8 | 19 | 9 |

| Cook Inlet Coalbed Gas Total Petroleum System           | Gas        |                                 | 1,581 | 3,989 | 10,069 | 4,677 | 0 | 0 | 0 | 0 |
|                                                        |            |                                 | 1,838 | 4,557 | 11,323 | 5,311 | 3 | 8 | 19 | 9 |

| Total Undiscovered Oil and Gas Resources                |            |                                 | 108  | 519 | 1,359 | 599 | 4,976 | 17,054 | 39,737 | 19,037 | 6 | 37 | 121 | 46 |
COOK INLET RESOURCE POTENTIAL
- LOG NORMAL DISTRIBUTION OF GAS ACCUMULATION SIZE -
COOK INLET RESOURCE POTENTIAL
- GAS FIELD SIZE DISTRIBUTION: EUR -

Gaps in lognormal distribution suggest undiscovered fields

EUR - Field Size Distribution

- Dashed curve is schematic, for illustrative purposes only

- TOTAL = 8576 Bcf
  Mean = 373 Bcf

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<th>Frequency</th>
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<td>Kenai</td>
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TOTAL = 8576 Bcf
Mean = 373 Bcf
In 2009, ENSTAR, Chugach Electric and ML&P commissioned PRA to study Cook Inlet supplies from existing fields; in 2012, PRA updated the study.

- Good solid product and analysis

- PRA report uses a decline curve analysis – a commonplace engineering technique that examines historical gas production rates and extrapolates forward, forecasting for how production rates will decline in years ahead.
  - However, this assumes no further drilling or other redevelopment work

- Based on the PRA report, predicted gas supply decline curve drops below the anticipated demand level in 2014-15, with the supply shortfall increasing year-on-year after that

- This is and should be a concern for all
Cook Inlet Geology
Discontinuous Sands

Source: Bob Swenson, DGGS

Source: Biddle and Wielchowsky, 1994, AAPG Memoir 60
Material Balance Analysis Explained:

- This approach uses the change in reservoir pressure over time to estimate how much gas is contained in the parts of the field that are in pressure communication with the wells.

- Basin wide, DNR’s material balance analysis identified 32% more gas reserves than the decline curve analysis in the existing developed field areas.

- Reserve estimates that were quoted by the utilities do not include material balance work.

“Behind Pipe” Volumes:

- PRA’s study only accounts for production from active completions.

- As discussed in DNR’s 2009, 2011 and 2012 studies, well logs indicate that existing Cook Inlet fields have nonproducing gas volumes behind pipe or in geologically isolated portions of the reservoir.

- These nonproducing volumes cannot be observed by either decline curve or material balance analysis because both approaches are based on production data.
Cook Inlet - Engineering Evaluation

Well log interpretation

Pay

Coal

Potential Pay

Volumetric mapping of reservoirs

Engineering evaluation of all 28 gas fields using Decline Curve Analysis and Material Balance Analysis augmented by in-depth geological estimates of gas reserves and resources for 4 of the 5 largest Cook Inlet gas fields.
Cook Inlet Natural Gas Reserves and Resources: Hypothetical Production Forecast
(Assumes substantial investment in redevelopment activity in existing fields + some exploration success but does not include wild-cat drilling that is going on today)
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Hilcorp
- Sharply increasing oil and gas production from legacy Marathon & Unocal fields
- Filling south-central utilities gas supply contracts through Q1 2018
- Dominant bidder in May 2013 areawide lease sale

Cook Inlet Energy
- Increased Osprey platform production at Redoubt Unit with RU-5B sidetrack, 250 bopd
- Drilled and completed Sword #1, flowed 833 boepd from Hemlock oil zone; planning tests of Tyonek G oil sands and Tyonek gas sands
- Acquiring North Fork Unit from Armstrong; expect closing Q1 2014

Buccaneer
- Used Endeavor jack-up to drill Cosmopolitan State #1; encountered & flow tested two Tyonek gas sands that may warrant development; Lower Tyonek oil zone not penetrated in previous wells
- Farmed-in for deep oil rights at North Cook Inlet
- Completed two more Kenai Loop wells in 2013; in dispute with CIRI

Furie
- Used Spartan 151 jack-up to drill and test Kitchen Lights #3, delineating gas encountered in KLU #1 & #2 with successful tests
- Planning offshore monopod development, two 10” pipelines to Nikiski

ConocoPhillips
- Applied to DOE for new Nikiski LNG export license

Agrium
- Evaluating restarting Nikiski fertilizer plant; applied for air quality permit

Nordaq
- 2013 Record of Decision allows access to develop Shadhura gas resources on CIRI land

Apache
- Regional cable-free 3-D seismic acquisition; drilled Kaldachabuna #2 well on CIRI land
- Consistent areawide lease offerings every year
- 3 in Northern Alaska, 2 in Southern Alaska
**Cook Inlet - 2013 Lease Sale -**

- Total tracts sold: 28
- Total acres sold: 100,322
- Total number of valid bids: 33
- Total high bonus bids: $3.08 MM
- Sale dominated by Hilcorp
  - > 60,000 acres on Kenai Peninsula
  - Bid on 22 tracts, won 16
  - Total high bids of $1.57 MM
- Historic Sales
  - 2012- $4.6 MM; 2011- $ 8.2 MM
  - 2010- $1.7 MM; 2009- $ 0.08 MM
  - 2008- $ 0.17 MM; 2007-$ 1.8 MM

**Map Notes:**
- Purple = available tracts receiving no bids
- Yellow = previously leased

**Historic Sales:**
- 2012 - $4.6 MM; 2011 - $8.2 MM
- 2010 - $1.7 MM; 2009 - $0.08 MM
- 2008 - $0.17 MM; 2007 - $1.8 MM
The keys to proved developed resources are:
exploration success and commercial validation

1. Find and Map Prospects with Seismic Data
   • Recon seismic acquisition and G&G interpretation (coarse 2-D grid)
   • Prospect-scale seismic acquisition and GG&E interpretation (tight 2-D grid or 3-D)

2. Land/Lease Access to Prospect
   • Competitive lease sale (e.g., DNR, BOEM, BLM)
   • Private lease (e.g., Native corporations)
   • Exploration license (DNR)

3. Exploration Drilling ➔ Reservoir Discovery
   • Wildcat exploration drilling, logging, testing (80-90% failure rate); refine prospect model
   • Appraisal and delineation drilling of discovery; extensive logging, testing; refine model

4. Project Sanction
   • Engineering analysis, design, costing
   • Environmental/Permitting feasibility
   • Commercial hurdles, board/investor approval

5. Development
   • Gravel construction
   • Facilities & pipeline construction and installation
   • Development drilling
Categorization of Cook Inlet gas volumes identified by DNR

**Reserves** = oil and gas volumes that have been confirmed by drilling and are known or expected to be economically producible

**Resources** = much broader term, and includes volumes that have not yet been proved by drilling, as well as volumes that have been discovered but whose commerciality is not yet established.
**Cook Inlet**

- Seasonal Swings in South-Central Daily Demand -

![Graph showing daily demand fluctuations with peak day rate and average demand levels marked.](image)

- Average Peak Day Rate = 410 MMcf/d
- Avg. = 224 MMcf/d
Union ➔ Hilcorp
Pretty Creek Field
7 MMCFD & 0.7 BCF

Union ➔ Hilcorp
Swanson River Field
20 MMCFD & 2 BCF

Aurora
Nicolai Creek Field
Rate TBD, 0.6-0.7 BCF (potential)

CINGSA/SEMCO
Cannery Loop Sterling C sands
150 MMCFD & 11 BCF
(under construction)

Marathon
Kenai Field Pool 6
60 MMCFD & 6 BCF
COOK INLET
- RECENT ACTIVITY -

- Legacy fields being reworked to increase deliverability
- Cook Inlet pipeline reconfigured for flow in either direction
- CINGSA gas storage reservoir in operation, major increase in deliverability, year-round gas market
  - Potential for further expansion of gas storage capacity
- New wells brought online in legacy and newly discovered fields
- Increased onshore and offshore exploration for both oil and gas, attributed to legislative incentives
  - Extensive 3-D seismic
  - Jack-up drilling offshore
  - Onshore drilling
- USGS 2011 resource assessment estimates up to 19 TCF undiscovered gas
• Hilcorp aggressive as single-operator of former Marathon and Unocal assets
  o New life to mature fields through workovers, new wells, recompletions
• Higher gas price contracts approved
• New players, new technologies
• Increased gas storage → year-round production
• Industrial users considering restarting facilities
  o ConocoPhillips LNG export facility
  o Agrium fertilizer plant

• Tax credits and related incentives customized to Cook Inlet
  o Jack-up credits (80-100% up to $20-25 MM; first 3 wells) AS 43.55.025(a)(5), (l)
  o Alternative tax credit for exploration (30-40% for wells and seismic) AS 43.55.025(a)(1-4)
  o Capital expenditure credit (40%) AS 43.55.023(a), (l)
  o Loss carry-forward (25%) AS 43.55.023(b)
  o Cook Inlet Tax ceiling (Zero for oil, 17.7 cents per MCF for gas) AS 43.55.011(j), (k), (o)
  o Gas storage incentives ($1.50/MCF up to $15 MM or 25% of facility cost) AS 43.20.046
Undiscovered, Technically Recoverable Resource:
• Oil and gas estimated to exist in accumulations that have not yet been found by drilling, but if found, could be potentially produced using current technology and industry practices.
• Only an unknown fraction of this category will be commercially viable to find, develop, and produce. Sometimes called Prospective Resources.

Proved Reserves:
• “oil and gas, which, by analysis of geoscience and engineering data, can be estimated with reasonable certainty to be economically producible—from a given date forward, from known reservoirs, and under existing economic conditions, operating methods, and government regulations…” (Securities Exchange Commission, 2008).
• Sometimes called 1P Reserves, with a 90% certainty of meeting or exceeding the quoted value (SPE, 2007).

Proved Developed Reserves:
“Proved reserves that… can be expected to be recovered through existing wells with existing equipment and operating methods…” (Securities Exchange Commission, 2008)
Questions