Drainage pierces ANWR in Alaska study scenario

A hypothetical scenario of petroleum industry activities adjacent to the 1002 Area of the Arctic National Wildlife Refuge (ANWR) suggests that development from leases under State of Alaska jurisdiction could drain reservoirs that extend under ANWR. Anticipation of such drainage might in turn trigger Congressional authorization for limited surface development of transboundary fields. This is the first in a series of five petroleum development scenarios culminating in industry activities throughout the 1002 Area. The scenarios were developed for an interdisciplinary study of community sustainability in the Arctic funded by the National Science Foundation. The full model—which includes climate change, vegetation, carbon, subsistence hunting, community labor markets...
and tourism development scenarios— is scheduled for release in September 1999. Details on the five scenarios are currently available at http://www.taiga.net/sustain.

The 40-year scenarios are not offered as predictions, but as "science fiction": stories combining the best available scientific information and a set of fictional but plausible assumptions to explore implications of a range of plausible outcomes. In each scenario, the locations and volumes of recoverable oil accumulations in and adjacent to ANWR, and the hypothetical sequence in which they would be discovered and produced, represent only a single run of a Monte Carlo simulation model. This model was based on probability distributions for the occurrence of recoverable hydrocarbons, estimated by the U.S. Geological Survey and published in 1998. The scenarios therefore do not purport to be "expected" values but only plausible in light of the USGS Assessment. The technical appendix to the USGS Assessment was released in April 1999 and was not available at the time the scenarios were developed.

Assumptions on field design and drilling and construction practices are based on the most recent Alaska North Slope operations: Arco’s most westerly Alpine development and BP Exploration’s (BPX) easternmost Badami development. The final scenario hinges on assumptions about continuing trends in technology that reduce future development costs and surface impacts.

**Land status, resource assessments**

The 1.57 million-acre 1002 Area of ANWR's coastal plain contains some of the most prospective remaining targets for petroleum development in Arctic Alaska. (The term 1002 refers to Sec. 1002 of the 1980 Alaska National Interest Lands Conservation Act.) However, federal law currently prohibits exploration, development, or production of hydrocarbons in the entire 1002 Area, including enclaves of private (Alaska Native) mineral rights, pending specific approval by Congress.

Geophysical surveys and test drilling have nevertheless taken place within and especially on the margins of ANWR in the past, and a number of exploration wells have been drilled on its perimeter. Data from such sources stand behind recent estimates of hydrocarbons resources published by the USGS. However, the information remains too meager within the 1002 Area itself to make confident location-specific forecasts of potential production or the in
vestment outlay and activity necessary to
develop such potentials.

The "1002 Area" includes about 97,000 acres in the vicinity of Kaktovik on
which the Arctic Slope Regional Corp. (ASRC) holds mineral title. ASRC is a
for-profit Alaska Native regional corporation established under the Alaska Native
Claims Settlement Act of 1981. The sur-
faced estate, owned by Kaktovik Inupiak
Corp. (an ANCSA village corporation), is
subject to the current Congressional pro-
hibition against commercial oil and gas
activity within the refuge. ASRC has
leased most of its subsurface estate to
BPX and Chevron, who drilled the
KIC test well east of Barter Island.

State offshore acreage adjacent to
ANWR—428,000 total acres—consists of
a strip extending three miles from the
shoreward boundary of the refuge into
the Arctic Ocean. On the western end of
this strip of submerged state acreage, two
wells have been drilled and plugged
without any announced commercial dis-
covery. Another well has been drilled,
plugged, and abandoned on the east end
of the study area, on a federal lease just
outside the outer jurisdictional boundary
and five miles northeast of the KIC well.
A few miles north of the outer boundary
between state and federal acreage, ten
wells have been drilled on federal off-
shore leases, with two discoveries of po-
litely commercial resources.

Survey and exploration activity on
state lands immediately to the west of
ANWR includes six wells within three
miles and 19 wells within about 30 miles
of the refuge boundary and at least two
announced discoveries of potentially
commercial hydrocarbons (Fig. 1).

USGS 1993 assessment
The USGS divided its assessment area
into four sectors.

Land status was classified as "federal"
(jurisdiction (the 1002 Area, less ASRC
lands) and "non-federal" (state offshore
lands, plus ASRC mineral inholdings
in the 1002 Area). A geological distinc-
tion was made along the Marsh Creek an-
ticline, separating "undeformed" (horiz-
onal) formations to the north and west,
and "deformed" (folded and fragment-
ed) formations to the south and east. The
anticline crosses the band of state off-
shore lands near the village of Kaktovik.

The USGS classification scheme allo-
cates about one-third of the total acreage
in the northwest corner of ANWR to the
undeformed sector and the remaining
two-thirds, including most of the ASRC
lands, to the deformed sector. Table 1
summarizes the USGS assessments of
total technically recoverable crude-oil
volumes, and volumes in accumulations
of 256 million bbl or more, in each of the
four sectors of the study area.

Relative attractiveness
The undeformed sector, which ac-
counts for only 33% of the study area
but 85.3% of the estimated recoverable
oil, contains the more attractive explo-
oration targets.

The USGS expected 9.6 large (256 mil-
lion bbl or more technically recoverable)
 crude-oil accumulations to exist in the
undeformed sector: about one for every 23,000 square miles. In contrast, USGS ex-
pected only 2.6 million bbl in the much larger
deformed sector: about one for every 395,000 square miles. Likewise, the mean ex-
pected volume of recoverable oil per unit

area in the undeformed sector is almost
nine times the volume of oil expected in
an equivalent area within the deformed
sector. The USGS did not report a signi-
ficant difference in mean size or distribu-
tion of sizes of oil accumulations.

The expected concentrations of oil do
not differ significantly between the fed-
eral and non-federal parts of the unde-
formed sector, as measured by either the
expected number of accumulations per
unit area or the volumes of recoverable
oil per unit area. Moreover, because the
existing stock of geophysical and geolog-
ic information is much richer on the
nonfederal than on the federal part of the
USGS study area, we infer that:

- Independently of their legal status, the
undeformed sectors contain the more
promising exploration targets for oil.

The April 1999 USGS Open File Report
discloses that the deformed area is sub-
stantially more prospective for gas than
for oil.

- This assessment is more reliable for
the nonfederal (i.e., state offshore) part
of the undeformed sector than for the fed-
eral, because of the richer geophysical
information base and because of the exis-
tence of two test wells on the unde-

\[\text{Table 1: Mean expectations of technically recoverable oil by land status and geological sector} \]

<table>
<thead>
<tr>
<th>Land category</th>
<th>Study area</th>
<th>Percentage of total area</th>
<th>Technically recoverable oil, million bbl</th>
<th>Percentage of total oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undeformed federal</td>
<td>431,360</td>
<td>24.1</td>
<td>6,420</td>
<td>52.8</td>
</tr>
<tr>
<td>Undeformed nonfederal</td>
<td>172,080</td>
<td>9.6</td>
<td>2,530</td>
<td>20.7</td>
</tr>
<tr>
<td>Deformed federal</td>
<td>1,026,640</td>
<td>57.3</td>
<td>1,250</td>
<td>10.2</td>
</tr>
<tr>
<td>Deformed nonfederal</td>
<td>142,323</td>
<td>8.0</td>
<td>270</td>
<td>2.2</td>
</tr>
<tr>
<td>Total</td>
<td>1,798,684</td>
<td>100.0</td>
<td>10,250</td>
<td>82.7</td>
</tr>
</tbody>
</table>

*Accumulations of 256 million bbl or more.

Source: USGS 1998 ANWR Assessment.

\[\text{The Authors} \]

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Anchorage.
**TECHNICAL SESSIONS**

**Break**

**TECHNICAL SESSIONS**

**Break**

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**Break**

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**TECHNICAL PROGRAM**

One hundred and eleven technical talks will be given by specialists from more than 18 countries.

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**POSTER SESSIONS**

Thirty technical papers will be presented by the respective authors concerning different aspects of the oil and gas industry.

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**TECHNOLOGICAL EXHIBITION**

Industrial services and supply companies may expand their markets by promoting and exhibiting novel products as well as advances in specialized technology. Stands reservations must be made before **August 30, 1999**. Basic stands area are 2 x 3 meters.

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**Closing Ceremony**

**Closing Dinner Show**

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**USGS assessment**

The USGS assessed the expected volume of "technically recoverable" resources in the total study area at 10.5 billion bbl, with a 95% probability that the actual value is at least 5.7 billion bbl and a 5% probability that it is 16.0 billion bbl or more. Of the expected 10.5 billion bbl, 6 billion bbl are technically recoverable, moreover, only 6.9 billion bbl are expected to be found in accumulations containing at least 522 million bbl, deemed the "minimum commercially recoverable field size." More notably, yet, the USGS estimates that no crude oil from the study area would be "technically recoverable" at a West Coast crude-oil market price of $45/ton or less (1996 dollars) and that only 3.3 billion of the 10.5 billion bbl technically recoverable would be economically recoverable at a price of $40.

After averaging about $11 in 1998, reported West Coast prices for Alaska North Slope (ANS) crude oil fell to $9.15 in early 1999, rebounding to about $16 in mid-May. Some analysts, including Philip Verhooge, expected even higher prices over the next year or so and there are also those who still anticipate the imminent onset of the steep price schedules which were widely predicted in the late 1970s and early 1980s. Nevertheless, we are not aware of any mainstream forecasting authorities that now anticipate short-term delivered prices for ANS crude oil greater than $15.

Taken at face value, the USGS assessment implies only a small probability that any crude oil resources at all will be developed, or produced from or immediately offshore of the ANWR 1002 Area. In particular, the study seems to rule out the discovery of "prudhoe-bay" accumulations of economically recoverable crude oil, i.e., ultimately recoverable reserves of crude oil at the end of the order of, say, 10 billion bbl. Combined with the probable geographic distribution of crude-oil accumulations within the study area, the USGS assessment implies that any or all of the economically recoverable crude oil will be found and developed on ASRC acreage or elsewhere in the deformed sector.