



U.S. GEOLOGICAL SURVEY ENERGY RESOURCES PROGRAM NEWSLETTER
SPRING 2008

Thank you for subscribing to the USGS Energy Resources Program (ERP) Newsletter. This quarterly newsletter provides the latest news, information, and products from the USGS ERP. In addition to recent publications, we are continuing to expand the content available through the ERP website. Previous newsletter issues have been archived (in PDF format) and may be downloaded at: <http://energy.usgs.gov/newsletter.html> .

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ENERGY SPOTLIGHT:

Alaska Geology and Energy Resource Studies

<http://energy.usgs.gov/alaska/>

Alaska’s scenic wilderness, its Arctic ecosystems with their unique flora and fauna, and its significant potential for energy and mineral resources are unmatched by any other onshore region of the United States. Thus, the accurate and unbiased scientific data provided by the USGS are

crucial to the Federal, State, and Native organizations that manage Alaska's resources and to meet the challenge of balancing America's needs for resources and a clean and healthy environment. The USGS ERP addresses this challenge by conducting scientific research to: (1) provide an understanding of the processes critical to the formation, accumulation, occurrence, and alteration of geologically based energy resources; (2) conduct scientifically robust assessments of those resources; and (3) study the impact of energy resource occurrence and (or) production and use on both environmental and human health. Highlighted below are recent publications and results from studies of Alaska's geologic framework. For more information on USGS research activities in Alaska, including biological and water resources and geologic hazards, please visit the USGS Alaska Science Center website: <http://alaska.usgs.gov/index.php>.

Sentinel Hill Core Test 1: Facies Descriptions and Stratigraphic Reinterpretations of the Prince Creek and Schrader Bluff Formations, North Slope, Alaska:

The Sentinel Hill Core Test 1 well is one of many holes drilled by the U.S. Navy between 1944 and 1953 to study petroleum potential in the Naval Petroleum Reserve No. 4 (now the National Petroleum Reserve in Alaska [NPRA]) on the Alaskan North Slope. To improve the knowledge of Alaska's geology and petroleum systems, the Alaska Division of Oil and Gas and USGS have re-examined this vintage core and conducted recent outcrop studies along the lower Colville River. The use of modern sequence stratigraphy principles has enabled new interpretations of the shallow subsurface stratigraphic relationships and subsequently refined understanding of the age and distribution of petroleum accumulations within the regional geologic framework.

The Sentinel Hill Core Test 1 well penetrates the nonmarine Prince Creek Formation and the marine Schrader Bluff Formation. Stratigraphic correlations of a potentially regionally significant sequence boundary between these two formations indicate that Schrader Bluff strata at this site and in nearby Colville River outcrops are probably at least as old as the isolated Tabasco sandstone near the bottom of the formation in the Kuparuk River Unit. If the Schrader Bluff Formation strata at the Sentinel Hill Core Test 1 well are as old as indicated, then the producing Schrader Bluff, West Zak, Aurora, and Borealis oil pools in the Milne Point, Kuparuk River, and Prudhoe Bay Units of the central North Slope are in younger reservoirs than the Schrader Bluff and Prince Creek Formations at and near the Sentinel Hill Core Test 1 well. The USGS Professional Paper documenting this collaborative study is available from: <http://pubs.usgs.gov/pp/1747/>.

Stratigraphy and Facies of Cretaceous Schrader Bluff and Prince Creek Formations in Colville River Bluffs, North Slope, Alaska:

The Upper Cretaceous Schrader Bluff and Prince Creek Formations are well exposed in the bluffs along the west side of the Colville River between Umiat and Ocean Point, Alaska. Previous studies describing these formations used composite-measured sections and limited subsurface core and log data. The Alaska Division of Oil and Gas and the USGS recently

completed a study to refine the understanding of these rock units and their relationship to nearby oil and gas reservoirs. The study increases the understanding of hydrocarbon resources in the region including (1) viscous oil from the Upper Cretaceous to Paleocene West Sak, Schrader Bluff, Orion, Polaris, and Ugnu fields; (2) light oil from the Upper Cretaceous Tabasco field; and (3) the potential development of free gas and gas hydrate occurrences in the main producing area of the central North Slope.

In this new study, detailed measured sections were obtained from several outcrop locations and combined with an examination and interpretation of the cored sequence in the Sentinel Hill Core Test 1 well. The outcrops studied along the Colville River Bluffs were correlated to hydrocarbon reservoir rocks in the Prudhoe Bay area northeast of the NPRA. The reservoir rock characteristics were delineated, and provide a basis for volumetric estimates of hydrocarbon resources and for performance modeling critical to economic development and evaluation of oil and gas fields. The USGS Professional Paper documenting these findings is available from: <http://pubs.usgs.gov/pp/1748/>.

Regional Fluid Flow and Basin Modeling in Northern Alaska:

The foothills of the Brooks Range contain enormous accumulations of zinc and barium in Mississippian and Pennsylvanian shale, chert, and mudstone. Furthermore, associated prolific hydrocarbon source rocks of Mississippian to Pennsylvanian and Triassic to Early Jurassic age generated considerable amounts of petroleum that may have contributed to the world-class petroleum resources of the North Slope. To improve our geologic understanding of these factors and to contribute to more effective assessments of energy and mineral resources in sedimentary basins of northern Alaska and throughout the world, the USGS Mineral Resources Program and the Energy Resources Program initiated a study of the petroleum maturation and mineralization history of portions of the Brooks Range. The study was undertaken in collaboration with industry, academia, and other government agencies. Study results have improved the understandings of: (1) the architecture, kinematics, and timing of the complex thrust systems that disrupted and redistributed the Mississippian and younger rocks; and (2) the nature and extent of the petroleum system sourced from Mississippian rocks. A recently published USGS Circular, available from <http://pubs.usgs.gov/circ/1319/>, documents findings from the project.

Study indicates doubling of the coastal erosion rate in the past 50 years along a segment of the Arctic coast of Alaska:

USGS scientists published, in the July 2007 issue of *Geology*, a quantitative analysis documenting the effects of accelerated coastal land loss and thermokarst lake expansion and drainage along a section of the Alaska North Slope coastline. The data used in the analysis span the timeframe 1955-2005 and consist of 1955 USGS topographic maps, and 1985 and 2005 Landsat 5 Thematic Mapper images. From these data, it was observed that the rate of land loss attributed to coastal erosion more than doubled, from 0.48 km²/yr during 1955–1985 to 1.08

km²/yr during 1985–2005. This quantitative analysis contributes to an enhanced understanding of the dynamic and interactive processes shaping the landscape in this area, and provides information that is critically needed as a basis for sound land-management and policy-decision making with respect to sensitive Arctic areas. For more information on this study, including maps and images of the study area, please visit the following website:
http://energy.usgs.gov/alaska/ak_coastalerosion.html .

Color Shaded-Relief and Surface-Classification Maps of the Fish Creek Area, Harrison Bay Quadrangle, Northern Alaska:

The northeastern part of the NPRA has become an area of active petroleum exploration during the past five years. Recent leasing and exploration drilling in the NPRA requires the U.S. Bureau of Land Management (BLM) to manage and monitor a variety of surface activities. Timely and accurate completion of these land-management tasks requires topographic, hydrologic, geologic, petroleum-activity and cadastral data, all integrated in digital formats at a higher resolution than is currently available in non-digital (paper) formats. To support these land-management tasks, a series of maps, prepared by the USGS in cooperation with the BLM, was generated from remotely sensed data in an area of high petroleum-industry activity. The map series includes (1) a color shaded-relief map based on 5-m-resolution data (sheet 1); (2) a surface-classification map based on 30-m-resolution data (sheet 2); and (3) a 5-m-resolution shaded relief-surface classification map that combines the shaded-relief and surface-classification data (sheet 3). This map series and accompanying explanatory text may be accessed at the following website:
<http://pubs.usgs.gov/sim/2007/2948/> .

GAS HYDRATES:
<http://energy.usgs.gov/other/gashydrates/>

Results of the Indian National Gas Hydrate Program Expedition 01:

Gas hydrates are a naturally occurring, ice-like combination of natural gas and water underlying the world's oceans and polar regions. The natural gas endowment present within gas hydrate accumulations is estimated to greatly exceed the volume of all known conventional gas resources worldwide. Scientists are thus studying gas hydrates as a potential new source of energy and identifying the technical challenges that must be overcome to realize their potential.

Recently, an international partnership led by the Directorate General of Hydrocarbons (DGH) under the Ministry of Petroleum and Natural Gas (Government of India) and the USGS released the results of the Indian National Gas Hydrate Program (NGHP) Expedition 01, the most complex and comprehensive gas hydrate field venture yet conducted. Scientists conducted ocean drilling, coring, logging and analysis to study the geologic occurrence, regional context and

characteristics of gas hydrate deposits along the offshore of India. Results from the expedition include: (1) one of the richest marine gas hydrate accumulations yet discovered was delineated and sampled in the Krishna-Godavari Basin, and (2) for the first time, a fully developed gas hydrate system was established in the Mahanadi Basin of the Bay of Bengal. "NGHP Expedition 01 marks a monumental step forward in the realization of gas hydrates becoming a viable energy source," said USGS Director Mark Myers. "This partnership combines the expertise of two organizations dedicated to understanding gas hydrates, and research results provide new and exciting information about this important potential energy resource." To read the full conference press release and learn more about USGS research with India on gas hydrates, please visit the following website: <http://energy.usgs.gov/other/gashydrates/india.html> .

GEOLOGIC CO₂ SEQUESTRATION:
http://energy.er.usgs.gov/health_environment/co2_sequestration/

The recently enacted Energy Independence and Security Act of 2007 (H.R. 6; P.L. 110-140) contains new responsibilities for the USGS. Specifically, section 711 of H.R. 6 – Carbon Dioxide Sequestration Capacity Assessment – calls for the USGS to develop a methodology and conduct a national assessment of geologic carbon dioxide (CO₂) storage capacity. In response to H.R. 6, the USGS initiated a study to develop a geologic methodology that can be used to conduct a national assessment of CO₂ storage capacity in oil and gas reservoirs and saline formations. As with all USGS energy resource assessment methodologies, an independent non-USGS panel, consisting of individuals with relevant expertise and representing a variety of stakeholder organizations, will be convened to provide a technical review of the methodology. Upon completion of the review, the methodology will be published and available for public use. In support of this new effort, the USGS recently updated and expanded the content available through its geologic CO₂ sequestration website to promote the dissemination of information and research relevant to this new activity. For the latest information and results from this new effort, please visit http://energy.er.usgs.gov/health_environment/co2_sequestration/ .

HUMAN HEALTH AND ENVIRONMENT:
<http://energy.usgs.gov/healthenviron.html>

Mercury in the Environment – *Applied Geochemistry* Special Issue:

Mercury is an important trace element because (1) it can occur in organic forms that are highly toxic, such as methylmercury, and can be bioconcentrated, biomagnified, and bioaccumulated in the food web, and (2) it can be transported long distances, possibly hundreds or thousands of miles from its original source, via the atmosphere. Because of this behavior, mercury is

considered a global pollutant. Study of the fate and transport of mercury in the environment is challenging in that mercury has a complex biogeochemical cycle that facilitates its exchange among different ecosystem reservoirs, including multiple chemical transformations that affect its mobility and toxicity. The scientific journal, *Applied Geochemistry*, recently published (March 2008) a special issue entitled, “Transport and Fate of Mercury in the Environment.” The special issue was co-edited by the USGS, and contains several articles authored by USGS scientists. The articles in this special issue address the latest research findings pertaining to the transport, transformation and fate of mercury in the environment. For more information on ERP research on mercury in the environment and linkages with energy resource occurrence or use, please visit http://energy.er.usgs.gov/health_environment/mercury/ .

NATIONAL OIL AND GAS ASSESSMENT:
<http://energy.cr.usgs.gov/oilgas/noga/>

Assessment of Undiscovered Oil Resources in the Devonian-Mississippian Bakken Formation, Williston Basin Province, Montana and North Dakota, 2008:

The USGS recently completed an assessment of the undiscovered, technically recoverable oil and associated gas resources of the Upper Devonian–Lower Mississippian Bakken Formation in the U.S. portion of the Williston Basin of Montana and North Dakota. The assessment is based on geologic elements of a total petroleum system that include (1) source-rock distribution, thickness, organic richness, maturation, petroleum generation, and migration; (2) reservoir-rock type (conventional or continuous), distribution, and quality; and (3) character of traps and time of formation with respect to petroleum generation and migration. Detailed framework studies in stratigraphy and structural geology and the modeling of petroleum geochemistry, combined with historical exploration and production analyses, were used to aid in the estimation of the undiscovered, technically recoverable oil and associated gas resources of the Bakken Formation in the United States. In developing the geological understanding of the Bakken Formation, the USGS worked with the North Dakota Geological Survey, a number of petroleum industry companies and independents, universities, and other experts working the Bakken Formation and Williston Basin. Using a geology-based assessment methodology, the USGS estimated mean undiscovered technically recoverable resource volumes of 3.65 billion barrels of oil (BBO) [F95 = 3.0 BBO; F5 = 4.3 BBO], 1.85 trillion cubic feet of associated/dissolved natural gas, and 148 million barrels of natural gas liquids in the Bakken Formation. The Bakken Formation estimate is larger than all other current USGS oil estimates of the lower 48 States and is the largest continuous oil accumulation ever assessed by the USGS. For comparison, the next largest continuous oil accumulation in the United States is in the Austin Chalk of the onshore Gulf Coast, with an undiscovered mean estimate of 1.0 BBO in the continuous chalk reservoir. The USGS Fact Sheet summarizing the results of this Bakken Formation resource assessment can be accessed from the following website: <http://pubs.usgs.gov/fs/2008/3021/> . For additional information, including links to GIS data, please visit: <http://energy.usgs.gov/> .

Assessment of Undiscovered Oil and Gas Resources of the Permian Basin Province of West Texas and Southeast New Mexico, 2007:

The USGS recently assessed the undiscovered, technically recoverable oil and gas resources of the Permian Basin Province of west Texas and southeast New Mexico. The assessment is geology based and uses the total petroleum system concept. The geologic elements of a total petroleum system are petroleum source rocks (quality, source rock maturation, generation, and migration), reservoir rocks (sequence stratigraphy, petrophysical properties), and traps (trap formation and timing). Only the potential for undiscovered, technically recoverable resources in new field discoveries was assessed; field growth (or reserve growth) of conventional oil and gas fields was not included. The USGS estimated mean undiscovered, technically recoverable resource volumes of approximately 41 trillion cubic feet of natural gas, 1.3 billion barrels oil and 1.0 billion barrels natural gas liquids in the Permian Basin Province. The USGS Fact Sheet summarizing the results of this resource assessment can be accessed from the following website: <http://pubs.usgs.gov/fs/2007/3115/> .

!!CD-ROM – Now available online at <http://pubs.usgs.gov/dds/dds-069/dds-069-p/>!!
Petroleum Systems and Assessment of Undiscovered Oil and Gas in the Denver Basin Province, Colorado, Kansas, Nebraska, South Dakota, and Wyoming– USGS Province 39, DDS-69-P:

The USGS, in 2002, conducted an assessment of the undiscovered, technically recoverable oil and gas resources of the Denver Basin Province. A USGS Fact Sheet summarizing the results of this assessment is available at: <http://pubs.usgs.gov/fs/fs-002-03/> . Recently, the USGS released a companion CD-ROM report, now available online at <http://pubs.usgs.gov/dds/dds-069/dds-069-p/> , providing additional supporting data for the total petroleum system framework underpinning this assessment, including core porosity and permeability and vitrinite reflectance data from 141 Denver Basin core holes. To request a CD-ROM copy of this report, please send an email to: eteamdsk@usgs.gov .

Petroleum Systems and Geologic Assessment of Oil and Gas in the San Joaquin Basin Province, California:

In 2003, the USGS completed an assessment of the oil and gas resource potential of the San Joaquin Basin Province of California (USGS Fact Sheet available from <http://pubs.usgs.gov/fs/2004/3043/>). The assessment is based on the geologic elements of each total petroleum system defined in the province. Using a geology-based assessment methodology, the U.S. Geological Survey estimated a mean of 1.7 trillion cubic feet of undiscovered natural gas (TCFG) [F95 = 0.3 TCFG; F5 = 4.3 TCFG], a mean of 393 million barrels of undiscovered oil (MMBO) [F95 = 80 MMBO; F5 = 853 MMBO], and a mean of 86 million barrels of natural gas liquids (MMBNGL) [F95 = 14 MMBNGL; F5 = 223 MMBNGL] in the San Joaquin Basin

Province. In addition, the potential was estimated for further growth of reserves in existing oil fields. The USGS recently published several geologic reports documenting in greater detail the geologic framework studies and analyses supporting this assessment. These reports, available from <http://pubs.usgs.gov/pp/pp1713/>, are organized into five themes: (1) geologic framework and exploration history, (2) petroleum systems and modeling efforts, (3) geologic assessment of undiscovered oil and gas resources, (4) reserve growth, and (5) assessment methodology.

WORLD PETROLEUM:

<http://certmapper.cr.usgs.gov/rooms/we/index.jsp>

An Approach to the Classification of Potential Reserve Additions of Giant Oil Fields of the World:

Reserve growth, or field growth, is defined as the increase through time in successive estimates of recoverable petroleum quantities in discovered fields. This increase is based upon geological and engineering data in conjunction with a reasonable certainty that such volumes are recoverable with existing economic and operating conditions. Reserve growth occurs in almost all petroleum provinces in the world and is considered the most important source for additional reserves in the United States. Reserve growth can result from field extension, field revision, improved recovery efficiency, improved reservoir characterization, and the addition of new pools or reservoirs, as well as recalculation of viable reserves in changing economic, operating, and regulatory conditions.

The USGS recently published a set of annotated slides excerpted from a presentation on USGS reserve growth studies given on 17 October 2007 in Geneva, Switzerland, to the Committee on Sustainable Energy and the United Nations Ad Hoc Group of Experts on Harmonization of Fossil Energy and Mineral Resources Terminology. This slide set describes USGS research efforts to characterize and quantify petroleum-reserve additions and how the application of this research can help classify quantities. The USGS Open-File Report of this presentation may be accessed from the following website: <http://pubs.usgs.gov/of/2007/1438/>.

Database for Assessment Unit-Scale Analogs (Exclusive of the United States):

The comparison of a geologic area of interest with analogous geologic areas is typically one component of an assessment of undiscovered oil and gas resources. To facilitate such comparisons, the USGS recently published a database of geologic analogs that can be utilized during the assessment process. The database also includes information pertaining to numbers and sizes of oil and gas fields and the properties of their produced fluids. As one example of the utility of this database, users can compare an immaturely explored area with few or no discovered oil and gas fields to a geologically analogous area that has been more maturely

explored. The database also affords opportunities for the analysis of patterns of oil and gas occurrence.

Each of the 246 analogs in the database is at the assessment-unit scale and is based on the assessments of undiscovered conventional oil and gas resources in the USGS World Petroleum Assessment (WPA) 2000 (available from <http://pubs.usgs.gov/dds/dds-060/>). The USGS WPA 2000 defined an assessment unit as “a mappable volume of rock within the total petroleum system that encompasses fields (discovered and undiscovered) which share similar geologic traits and socio-economic factors.” Although based on the USGS methodology, this database can be used with other methodologies. Because the WPA 2000 provided conventional resource estimates only for selected geologic provinces outside the United States, the database does not include any U.S. analogs. The database download files and companion USGS Open-File Report may be accessed from the following website: <http://pubs.usgs.gov/of/2007/1404/>.

Statistics of Petroleum Exploration in the World Outside the United States and Canada through 2001:

Future oil and gas supplies depend, in part, on reserves expected to be added through exploration and new discoveries. However, considerable debates persist about the future supply of world oil, as various analysts have come to radically different conclusions based on different interpretations of the same data, depending on the variables analyzed. The statistics of exploration represent one set of indicators that can be used as a foundation for analyses of the long-term future oil and gas supply.

The USGS recently published a study, available from <http://pubs.usgs.gov/circ/1288/>, containing a summary of the statistics and an analysis of petroleum exploration in the world outside the United States and Canada through 2001. The study contributes to the analysis of the world oil supply by facilitating the access of exploration statistics to researchers and decision-makers alike. Data are presented by country and organized by petroleum provinces as delineated in the USGS WPA 2000. Information includes well location, depth, initial classification (such as wildcat, exploration, or development), final classification (dry hole or producer), spud date, and completion date. In particular, maps and companion graphs are presented to show the historical exploration areas and those parts of the exploration areas having a high drilling density. As shown by the drilling record and the locations of new drilling, the search for oil and gas has continued, but expansion has slowed considerably.

RECENT PUBLICATIONS:

Basic Statistical Concepts and Methods for Earth Scientists
U.S. Geological Survey Open-File Report 2008-1017

<http://pubs.usgs.gov/of/2008/1017/>

Chemical Results of Laboratory Dry/Rewet Experiments Conducted on Wetland Soils from Two Sites in the Everglades, Florida

U.S. Geological Survey Open-File Report 2008-1090

<http://pubs.usgs.gov/of/2008/1090/>

Earth Science and Public Health: Proceedings of the Second National Conference on USGS Health-Related Research

U.S. Geological Survey Scientific Investigations Report 2008-5022

<http://pubs.usgs.gov/sir/2008/5022/>

A Hammer-Impact, Aluminum, Shear-Wave Seismic Source

U.S. Geological Survey Open File Report 2007-1406

<http://pubs.usgs.gov/of/2007/1406/>

Petrographic Descriptions of Selected Rock Specimens From the Meade Peak Phosphatic Shale Member, Phosphoria Formation (Permian), Southeastern Idaho

U.S. Geological Survey Scientific Investigations Report 2007-5223

<http://pubs.usgs.gov/sir/2007/5223/>

USGS Science in the Decade 2007-2017: Facing Tomorrow's Challenges—An Overview

U.S. Geological Survey Fact Sheet 2008-3008

<http://pubs.usgs.gov/fs/2008/3008/>

UPCOMING EVENTS:

The 33rd International Technical Conference on Coal Utilization & Fuel Systems (June 1–5, 2008):

The 33rd International Technical Conference on Coal Utilization & Fuel Systems—Coal for the Future (known informally as the Clearwater Coal Conference) will be held June 1–5, 2008, at the Sheraton Sand Key in Clearwater, Florida, USA. This conference provides a forum for participants to learn about coal and coal utilization technologies. Coal is used as fuel to generate over half of the Nation's electric power, and increased coal demand combined with energy security issues, uncertainty in the oil sector, regulatory issues and environmental concerns underscore the growing need for information to address coal utilization issues. Information on coal resources and coal quality facilitates informed decisions regarding domestic coal resources, domestic and foreign policies, technology, environmental and human health studies, and coal byproduct use and disposal. The USGS ERP research efforts yield modern, digital assessments of the quantity, quality, location, and accessibility of the Nation's coal resources. The USGS also provides information on the environmental and human health impacts of coal extraction, coal

combustion, and coalbed methane production. To learn more about the latest USGS coal research and resource assessment activities, please stop by and visit the USGS exhibit booth at the conference. More information on this conference is available at <http://www.coaltechnologies.com/conferences.html> .

The Ninth Pan-American Current Research on Fluid Inclusions Conference (PACROFI IX), June 2-5, 2008:

The PACROFI-IX Conference will be held June 2-5, 2008, at the USGS National Center in Reston, Virginia. This conference will provide a forum for the exchange of ideas and presentations on cutting-edge fluid and melt inclusion research. Fluid inclusions are small volumes of fluid (such as water, carbon dioxide, methane or other hydrocarbons, or melt material) that are trapped within a crystal. Fluid inclusion analysis can be a powerful tool to understand geologic and potentially biologic processes. As one example, the study of fluid inclusions can provide information about the composition of the original fluids that were transported through geologic formations, and the pressure and temperature conditions associated with such transport. This information is critical to the understanding, for instance, of the processes affecting the generation and accumulation of mineral deposits and petroleum resources. For more information about the upcoming PACROFI-IX conference, please visit: http://www.minsocam.org/PACROFI/pacrofi_index.html .