ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY2015 Project Description

COOK INLET BASIN ANALYSIS PROGRAM

The Alaska Division of Geological & Geophysical Surveys (DGGS) has led a multi-agency program of applied geologic research in Cook Inlet basin since 2006 to promote new hydrocarbon exploration investment to help meet the growing energy needs of south-central Alaska. This collaborative effort involving DGGS, the Alaska Division of Oil & Gas (DOG), the University of Alaska Fairbanks (UAF), and the U.S. Geological Survey (USGS) relies heavily on performing detailed field and subsurface studies and geologic mapping to develop a better understanding of the basin's hydrocarbon system.

Historically, Cook Inlet exploration has focused on locating conventional plays in structural traps in younger, shallower Cenozoic rocks. However, most of these structures were found and tested early in the exploration history of the basin. Since 2006, DGGS has been investigating the potential for stratigraphic traps in Cenozoic strata and, more recently, has focused on investigating the potential for conventional and unconventional reservoirs capable of hosting oil and gas in the older, deeper Mesozoic strata in the basin. Developing a better understanding of the petroleum potential of the Mesozoic interval is important because it remains virtually unexplored yet contains the oil source rocks for fields in upper Cook Inlet.

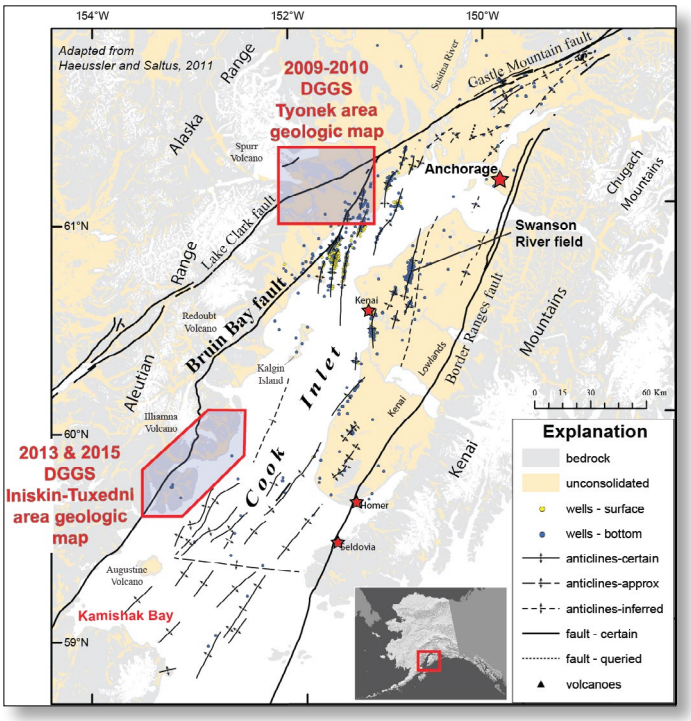

Figure 1. Generalized geologic map of Cook Inlet basin highlighting past and present hydrocarbon study areas and geologic mapping targets in the Cook Inlet basin. Modified from Haeussler and Saltus, 2011, U.S. Geological Survey Professional Paper 1776-D.

Field studies of Mesozoic strata in the Kamishak Bay and Iniskin Peninsula areas (figs. 1 and 2) focused on Jurassic- and Cretaceous-age rocks, both of which contain intervals that are oil saturated, indicating that they had sufficient conventional permeability and porosity to allow liquid hydrocarbons to flow through them in the past. Samples collected at both locations are helping to identify the hydrocarbon source rocks and determine whether sandstone composition or other factors were responsible for their enhanced reservoir quality. Continued stratigraphic and structural studies in the Iniskin Peninsula and Tuxedni Bay areas, including new geologic mapping of the Iniskin Peninsula in the summer of 2013 and proposed geologic mapping of the Red Glacier area in 2015, are focused on the depositional environment, organic geochemistry, and thermal maturity of oil source rocks, along with how major geologic structures, such as the Bruin Bay fault, influenced the basin's stratigraphic architecture. We are continuing fracture studies of Mesozoic rocks in the Iniskin Peninsula–Tuxedni Bay area to understand the stratigraphic and structural controls on their development and to gather baseline data on unconventional fracture porosity and hydrocarbon migration pathways.

This project is funded by the State of Alaska and the USGS, with contributions from industry. Results of this work have been documented in a series of publications available from the DGGS website (http://www.dggs.alaska.gov), including recently published edited volumes highlighting the significant findings from our 2012–2014 field seasons (http://dx.doi.org/10.14509/24824, http://dx.doi.org/10.14509/27303). Additional publications will be released as they become available.

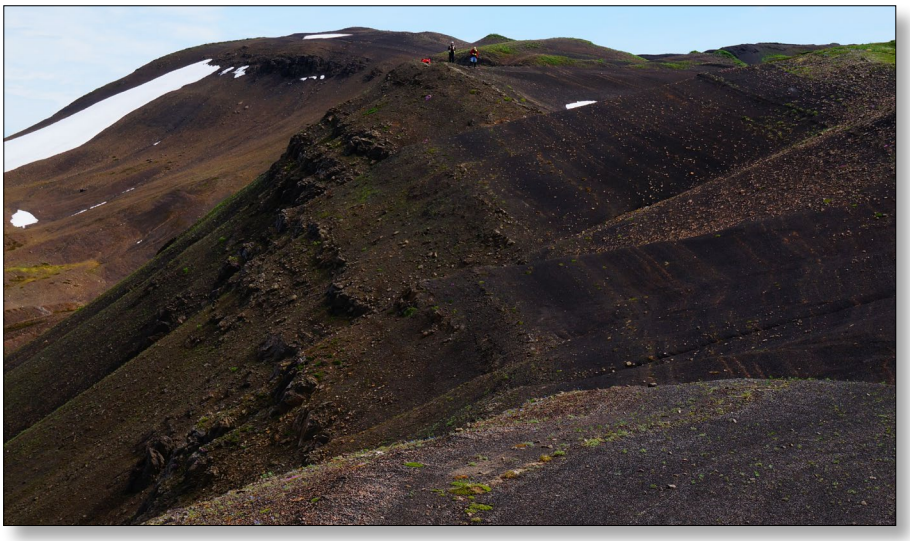

Figure 2. DGGS geologist David LePain and U.S. Geological Survey geologist Rick Stanley studying strata of the Red Glacier Formation; the organic-rich oil source rock in Cook Inlet basin.

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ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY2015 Project Description

GEOLOGIC MAPPING OF THE INISKIN–TUXEDNI REGION, LOWER COOK INLET

The Alaska Division of Geological & Geophysical Surveys (DGGS) is conducting a program in Cook Inlet basin focused on understanding how sediment composition, stratigraphic architecture, and geologic structure control potential conventional and unconventional (tight) hydrocarbon reservoir systems (see Cook Inlet Basin Analysis summary). This program includes detailed geologic mapping within younger, shallower Cenozoic and older, deeper Mesozoic stratigraphic intervals where outcrop relations are complex, poorly understood, and important for understanding the principal components of the petroleum system.

During summer 2013, DGGS, with assistance from the Division of Oil and Gas (DOG), completed 1:63,360-scale geologic mapping of approximately 240 square miles of Mesozoic stratigraphy on the Iniskin Peninsula, located west of Homer across Cook Inlet (figs. 1 and 2). Mapping of an additional ~270 square miles encompassing much of the adjacent region to the northeast between Chinitna and Tuxedni bays will be completed in 2015. This area was the location of some of the earliest oil exploration in Alaska, extending from the early 1900s to the 1950s, but it has remained idle since then. The Iniskin Peninsula–Tuxedni Bay region (fig. 1) is important to understanding Cook Inlet's Mesozoic petroleum system because it hosts numerous oil seeps and the only surface exposures of the primary oil source rock in the basin (the Red Glacier Formation) accessible for study. Despite this, the older stratigraphic intervals of the basin remain only lightly explored. Our new mapping is guided by nearly 25 new measured stratigraphic sections, new geochronology, and kinematic structural analysis, some of which is detailed in a series of short progress reports published in 2014 (http://dx.doi.org/10.14509/27303) and a forthcoming series of reports due to be published in early 2015. The final published products will be a new 1:63,360-scale geologic map encompassing approximately 500 square miles along the northwestern margin of Cook Inlet basin, and an accompanying report. Our mapping has unraveled important, previously unrecognized stratigraphic and structural relationships and represents a major step forward in understanding the geologic evolution of the northwestern margin of the basin.

Mapping in 2013 was completed with partial funding from the U.S. Geological Survey's STATEMAP program.

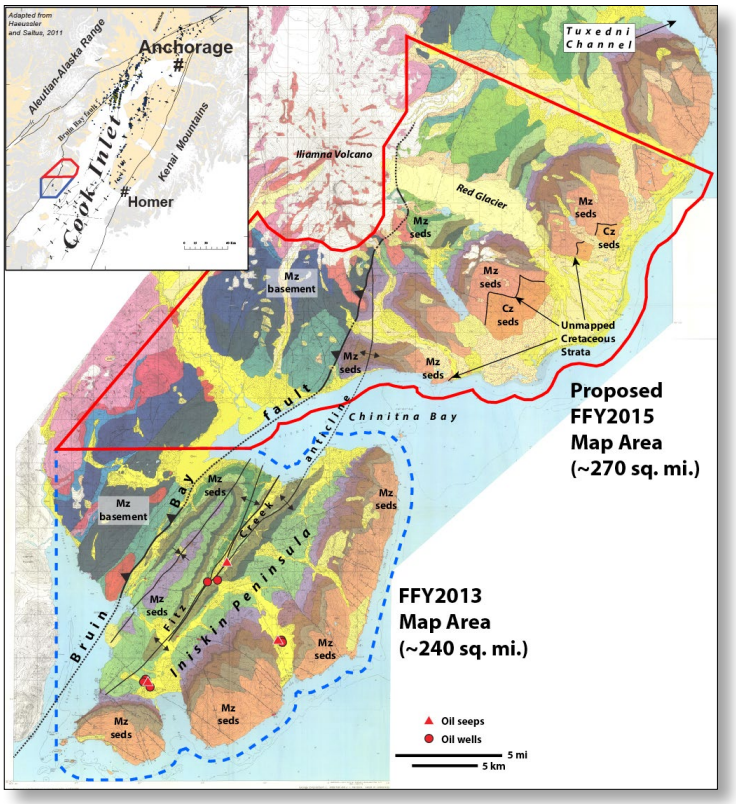

Figure 1. Locations of FY2013 (blue outline) and proposed FY2015 (red outline) geologic mapping of Mesozoic stratigraphy on the west side of Cook Inlet basin, with regional inset map of Cook Inlet.

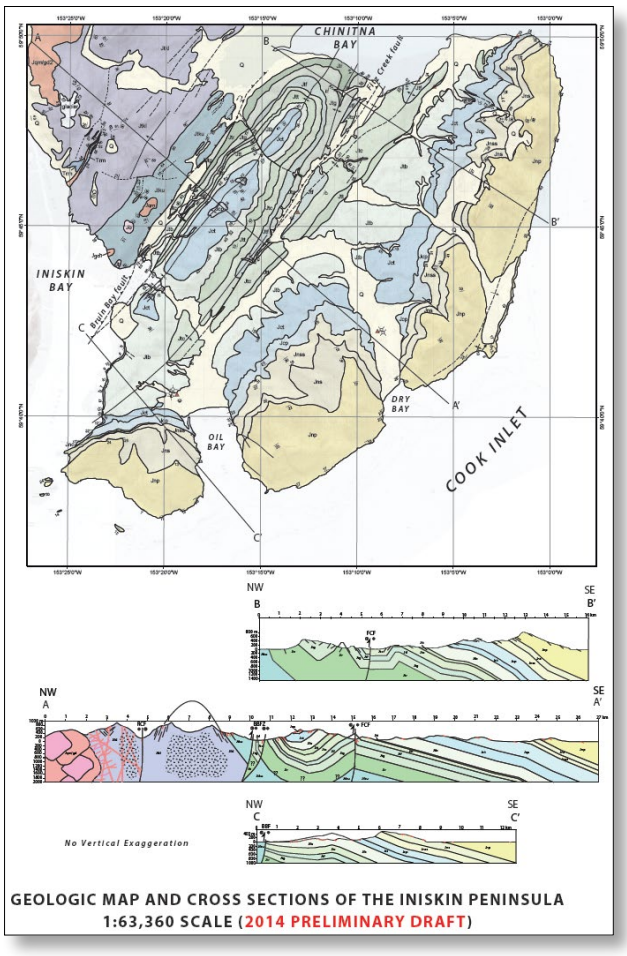

Figure 2. DGGS preliminary geologic map and structural cross sections of the Iniskin Peninsula.

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ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY2015 Project Description

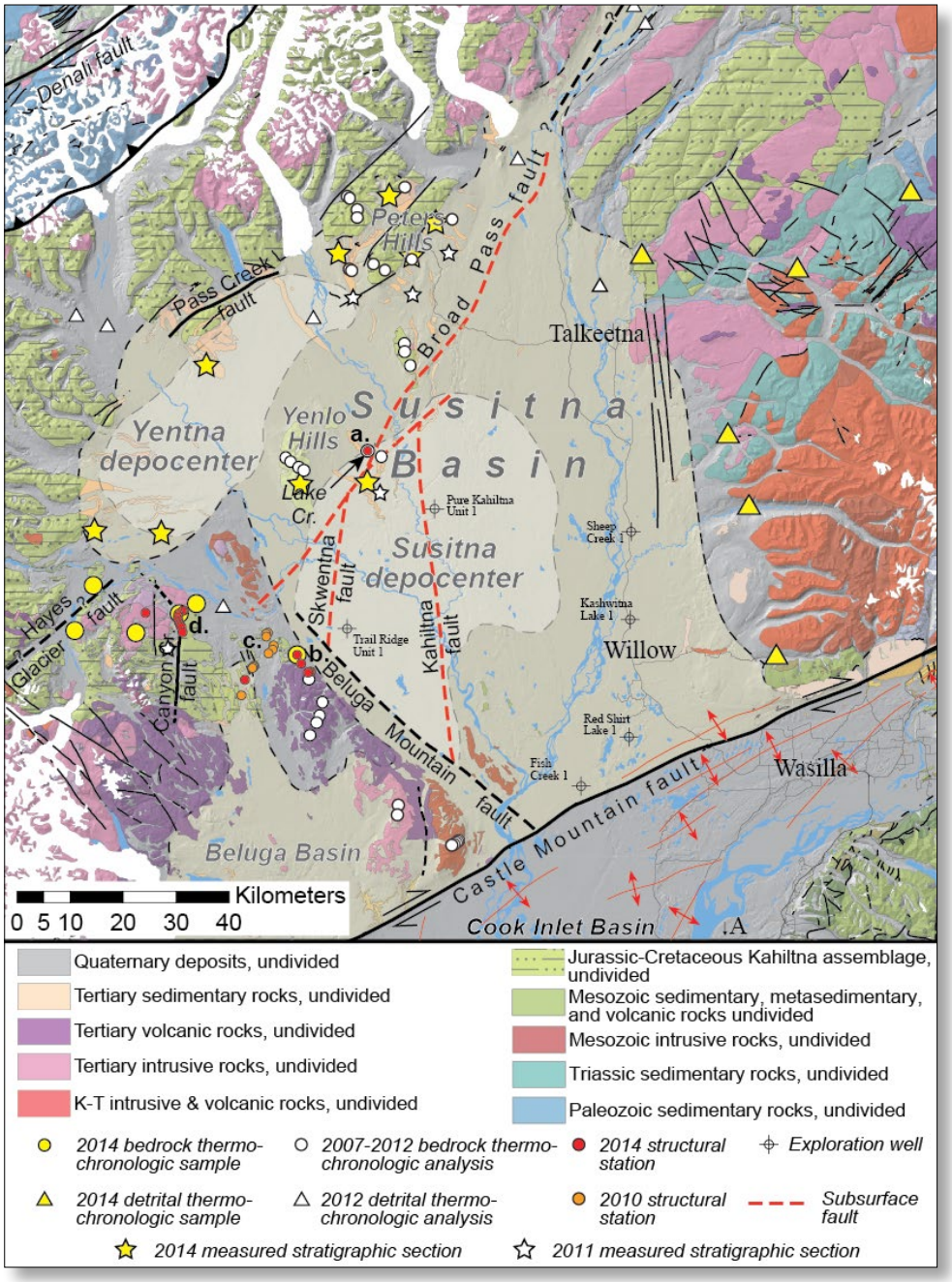
NATURAL GAS POTENTIAL OF THE SUSITNA BASIN

Alaska suffers from some of the highest domestic energy prices in the nation, particularly in rural areas and regions that are far removed from developed energy resources and lack sufficient infrastructure for low-cost delivery. These challenges could be mitigated by finding local sources of energy that have the potential to supply more affordable energy for local consumption.

The Alaska Division of Geological & Geophysical Surveys (DGGS), in collaboration with the Division of Oil & Gas (DOG), has responded to these challenges by reviewing publicly available data on sedimentary basins throughout Alaska to identify basins whose geology suggests significant natural gas potential (http://dx.doi.org/10.14509/24264).

We have identified the Susitna basin in south-central Alaska as having significant gas potential to help meet in-state needs based on its geology and relative proximity to infrastructure. However, this basin has not been adequately explored, and little geologic data exists to help attract exploration interest. The Susitna basin analysis project will help develop a better understanding of the possible presence of a functioning petroleum system. Preliminary fieldwork was completed in summer 2011, and a progress report was published in early 2013 (http://dx.doi.org/10.14509/25015). Additional fieldwork was completed in summer 2014, with a summary report expected to be published in 2014 or early 2015.

The Susitna basin (approximately 5,000 square miles) is thought to host some of the same coal-bearing, gas-prone rocks as neighboring Cook Inlet, which is a major gas-producing region. DGGS and DOG, in collaboration with the U.S. Geological Survey, have studied and described coal-bearing strata at several locations in the basin and collected more than 400 samples for various analyses related to evaluating reservoir quality, coal quality and its methane potential, and geologic development of the region. Structural studies and thermochronologic sampling along the basin margin will help to constrain how the basin evolved through time, which is important for understanding the timing of potential structural trap development and gas generation.



Geologic map of the Susitna basin region showing sample collection locations and proximity of the potential gas-prospective basin to major population centers.

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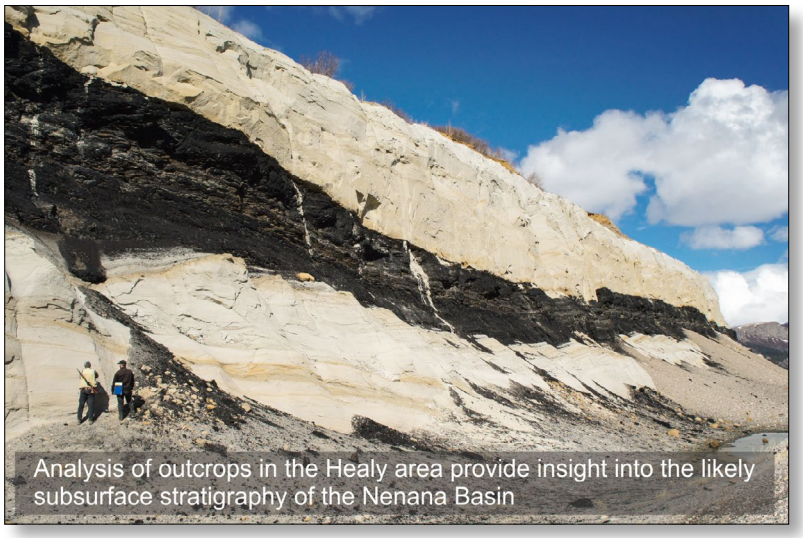
ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY2015 Project Description

HYDROCARBON POTENTIAL OF THE NENANA BASIN

Alaska faces significant challenges in supplying reliable, affordable energy to much of the state's population, particularly in rural areas and interior regions. This is because no adequate energy sources at reasonable cost have been identified to serve domestic needs over the next few decades. These challenges could be met by finding local resources with the potential to supply more affordable energy for nearby consumption.

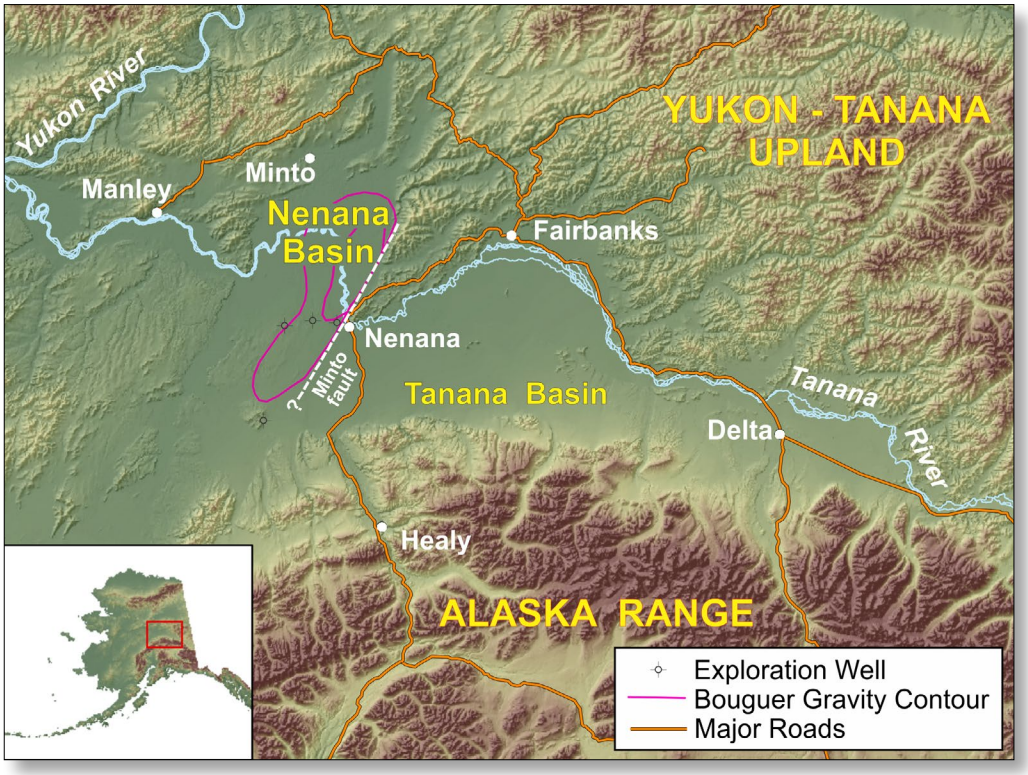


Analysis of outcrops in the Healy area provide insight into the likely subsurface stratigraphy of the Nenana Basin

The Alaska Division of Geological & Geophysical Surveys (DGGS), in collaboration with the Division of Oil & Gas (DOG), has responded to these challenges by reviewing publicly available data on sedimentary basins throughout Alaska to identify those with geology that suggests significant natural gas potential (http://dx.doi.org/10.14509/24264). The Nenana and Susitna basins (see Susitna project summary) were recognized as having potential to help meet in-state needs based on their geologic properties and proximity to infrastructure.

The Nenana basin in interior Alaska is largely defined based on geophysical data. Available information indicates the basin may be deep enough to host a viable petroleum system. Recent exploration activity led by Doyon Limited and their partners has included acquiring modern seismic data and drilling two new wells. Although no commercial discoveries were made, the efforts yielded improved, new information on the basin's subsurface, including geochemical data suggesting the presence of hydrocarbon source rocks.

No known Tertiary sediments (key to hydrocarbon potential in this basin) are exposed immediately around the Nenana basin; therefore, to improve our understanding of the subsurface stratigraphy, DGGS conducted reconnaissance fieldwork in the northern foothills of the Alaska Range, where the nearest correlative rocks can be examined in outcrop. This preliminary work was carried out in conjunction with DOG and the U.S. Geological Survey and summarized in a recent DGGS publication (http://dx.doi.org/10.14509/24880).



Samples collected during that campaign are undergoing additional analytical studies and results will be released in future reports. The final phase of this project will involve examining drill cuttings from the recent exploration wells, including supplementary analysis of source rock character, sandstone provenance, and biostratigraphy.

This project also involves collaboration with geophysicists at the University of Alaska Fairbanks who are utilizing seismology to investigate the crustal structure of the basin. This work will inform ongoing seismic hazard assessments by DGGS in support of potential pipeline corridors near the active Minto fault (see ASAP briefing sheet).

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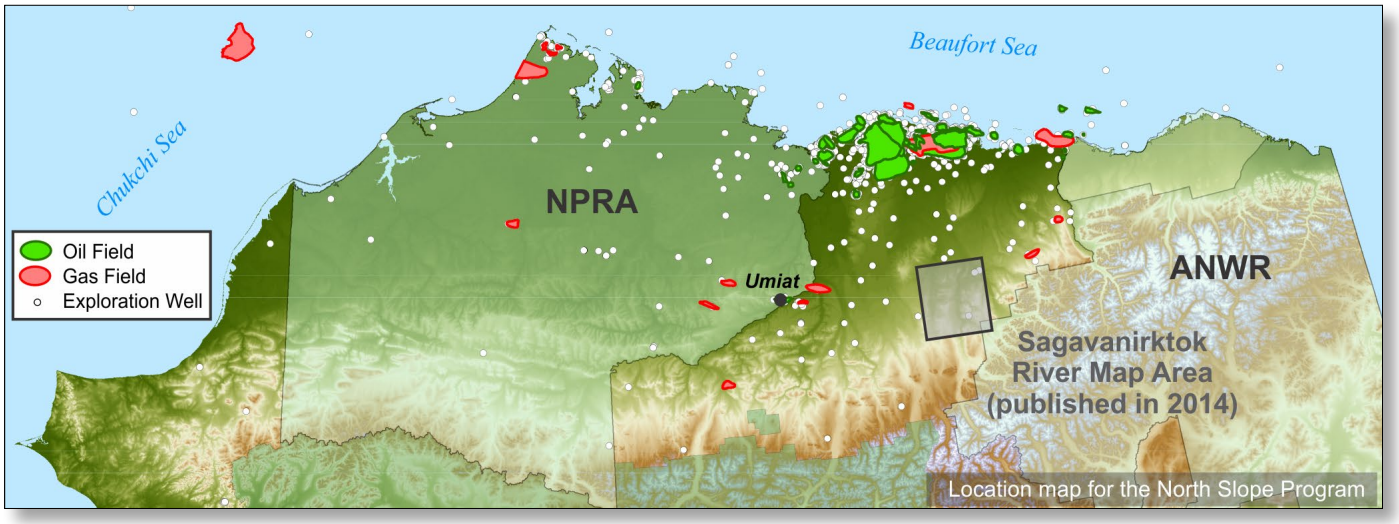
ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY2015 Project Description

BROOKS RANGE FOOTHILLS & NORTH SLOPE PROGRAM

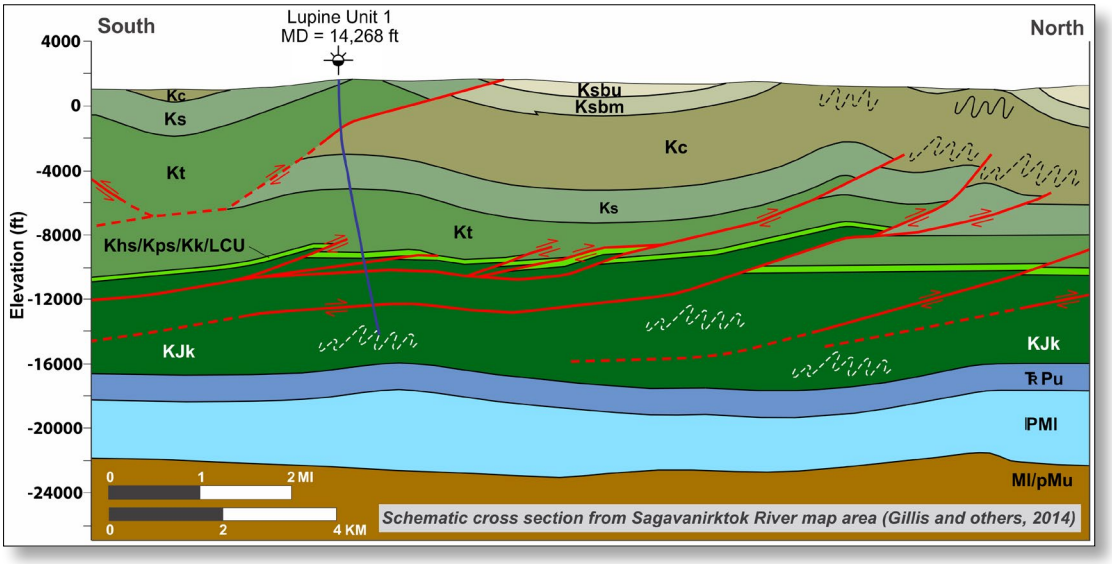
Northern Alaska is a world-class petroleum province that includes some of the most prospective onshore regions remaining in North America. Despite this potential, the North Slope remains underexplored relative to other sedimentary basins around the world. New exploration ventures are hampered by the limited amount of published geologic data, much of which is reconnaissance in nature. This problem is particularly acute for smaller companies with limited access to proprietary industry data. In an effort to stimulate hydrocarbon exploration in northern Alaska, the Alaska Division of Geological & Geophysical Surveys (DGGS) developed a program to acquire and publish high quality geologic data to improve our understanding of the regional petroleum system and entice new exploration investment.



Detailed analysis of outcrop geology leads to improved models for where hydrocarbons will most likely accumulate in the subsurface. Our fieldwork involves examination of the sedimentology and stratigraphy of key reservoir and source rock intervals, providing new constraints on the depositional history and correlation of units. Over the last several years we have also collaborated closely with Division of Oil and Gas to interpret available seismic and well data on the North Slope. The integration of our surface structural and stratigraphic observations with subsurface data has led to an improved understanding of basin evolution and regional exploration potential. DGGS also regularly conducts bedrock geologic mapping as an integral component of the Brooks Range Foothills and North Slope Program, and recently published an important new map of the Sagavanirktok River area.

Recent lease and exploration activity on the North Slope has drawn attention to the region's potential for unconventional shale oil targets. The key geologic characteristics of this type of accumulation are poorly understood in northern Alaska. To address this knowledge gap, we initiated a collaborative study between DGGS, the U.S. Geological Survey, and the University of Alaska Fairbanks. This ongoing project has acquired key surface and subsurface data that will improve our understanding of this prospective hydrocarbon play.

DGGS will publish two new 1:63,360-scale geologic maps in the upcoming year, including one encompassing the discovered oil and gas fields in the Umiat–Gubik area. In addition, a collection of topical structural and stratigraphic studies will be released, which will provide important new constraints on the regional petroleum system.



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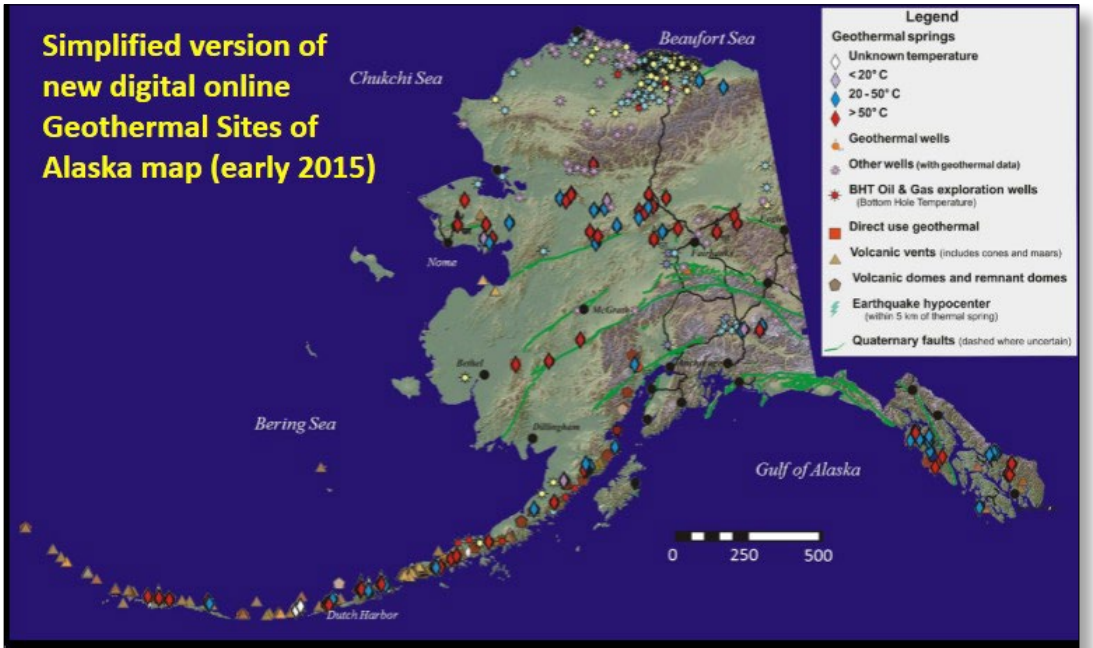
ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY2015 Project Description

STATE OF ALASKA CONTRIBUTIONS TO THE NATIONAL GEOTHERMAL DATA SYSTEM

The National Geothermal Data System (NGDS) is a U.S. Department of Energy-funded distributed national network of databases and data sites that collectively form a system for the acquisition, management, and maintenance of geothermal-based data. This national project, involving all 50 states, is organized by the Association of American State Geologists and administered by the Arizona Geological Survey. The NGDS is providing large amounts of geothermal-relevant geoscience data to the public and industry through a single website that was officially launched on April 30, 2014, http://www.geothermaldata.org/. The NGDS website serves unstructured data (such as PowerPoint, image, and pdf files), structured data (such as Excel, xml, and csv files), and interoperable standardized data. The NGDS is based upon well-documented interchange formats and standardized data exchange protocols, making it possible to view and analyze data using a variety of programs and to merge additional data sources into a content model. The state geological surveys develop, collect, serve, and maintain geothermal-relevant data as an integral component of NGDS. The project is digitizing at-risk, legacy geothermal-relevant data and publishing existing digital data by making state databases and directories available to the network.

The NGDS program allowed the Alaska Division of Geological & Geophysical Surveys (DGGS) to compile vast amounts of paper-only scientific data generated during earlier geothermal studies and exploration activities throughout Alaska and load this information into the online NGDS for easier access. A new cycle of geothermal exploration currently underway in Alaska is producing abundant new geothermal data that is being entered into the NGDS. Geothermal exploration at Pilgrim Hot Springs on the Seward Peninsula 60 mi north of the city of Nome is benefiting from integration of legacy and newly-acquired NGDS data (including aqueous chemistry, borehole, geoprobe, and ground-based geophysics such as magnetotellurics) with remote-sensing imagery and airborne geophysics to locate the hottest thermal upflow zone. Ongoing geothermal exploration at Akutan in the Aleutian Islands has contributed new geothermal data to the NGDS, and is anticipated to benefit from other data stored in the NGDS. Industry and academia are now able to readily access this data for use in collaborative efforts at both sites. Bottom-hole temperature observations from 567 oil and gas exploration drill holes now archived in the NGDS are currently being used to construct a new geothermal heat-flow map of Alaska.



New & Legacy Data Includes:	
Geothermal springs	97
Aqueous geochemistry	653
Geothermal wells data (from 9 wells)	121
BHT data from oil & gas wells (supplied by the petroleum industry)	409
Volcanic vents and fumarole records	395
Earthquake event data near hot springs within 5 km	1,974
Direct use geothermal sites	15

Preliminary version of the new Geothermal Sites of Alaska map, available online in digital format in early 2015. Table summarizes the data included in the NGDS and new online map.

DGGS is creating an online digital Geothermal Sites of Alaska map using the content model templates developed for and archived in the NGDS. This new ArcGIS-based map (preliminary simplified version of the map above) incorporates the related geothermal NGDS datasets into shapefiles. This map will be available online for the public by February 2015.

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ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY2015 Project Description

ALASKA COAL DATABASE—NATIONAL COAL RESOURCE DATABASE SYSTEM

The long-term goal of the Alaska Division of Geological & Geophysical Surveys' (DGGS) participation in the U.S. Geological Survey's (USGS) National Coal Resource Database System (NCRDS) cooperative program is to record all known coal occurrences in Alaska and archive the information in a single, readily accessible database available at the USGS website, http://energy.er.usgs.gov/products/databases/USCoal/. The NCRDS program is funded by USGS through a multi-year proposal process with final reporting at the end of each funding period.

Alaska's coal resources make up about half of the United States' coal-resource base and approximately one-sixth of the total world resource base. Alaska's identified coal resources (all ranks) total about 160 billion short tons, yet hypothetical and speculative resources are as high as 5.5 trillion short tons. While gathering information to expand the NCRDS database for Alaska, we recognized the need to collect new coal samples and stratigraphic field data for previously described occurrences. Sometimes a coal occurrence described in literature is poorly located and the description is either inaccurate or inadequate for a proper resource assessment. The most frequent problems we have encountered are unverified coal seams and coal sample locations, suspect coal quality analyses, and insufficient stratigraphic control.

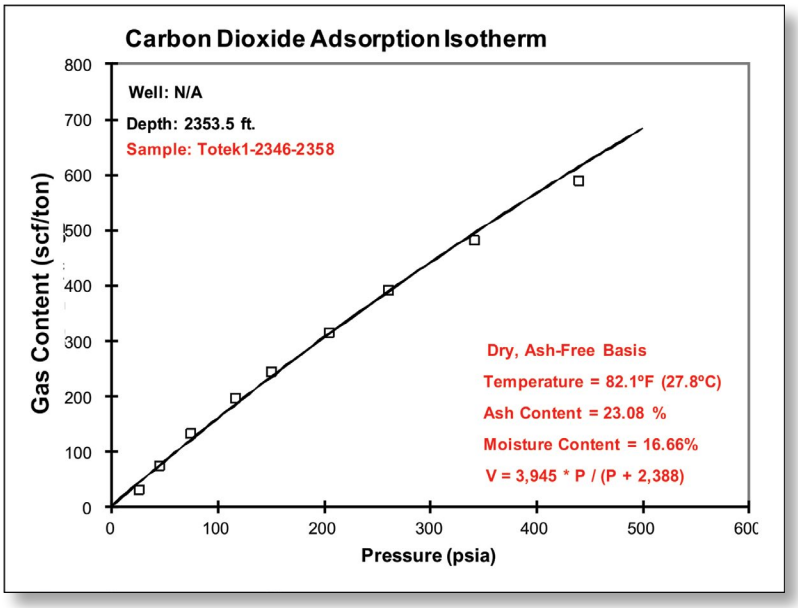

Figure 1. Example of carbon dioxide pressure isotherm from the Totek Hills well, Nenana basin, at a depth of 2,353 ft.

We continue to submit coal samples collected by field crews conducting studies in Alaska's coal provinces for proximate and ultimate analyses. We focus only on thicker, potentially mineable coal seams that have not been sampled previously. The project continues to make progress refining the legacy Alaska NCRDS data.

During 2014 we evaluated high-pressure gas adsorption analytical data for well and outcrop samples from the Cook Inlet, North Slope, and Nenana basins (fig. 1). We are finishing the final report describing the gas holding capacity of coal seams for both methane and carbon dioxide in these basins. This new report, to be released in 2015, highlights the economic and carbon-sink potential for coal deposits in these three basins and is the first actual CO_2 adsorption data for coal seams in Alaska (rather than hypothetical data based on estimated coal rank).

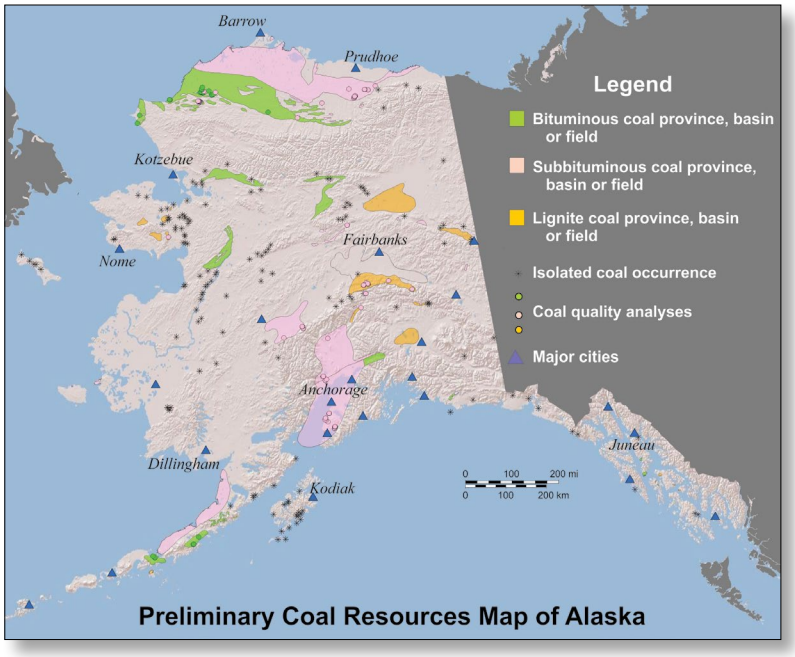

Figure 2. Preliminary draft version of GIS-based Coal Resources of Alaska map that displays coal provinces, basins, coal fields, and isolated coal occurrences and incorporates NCRDS coal quality point source data

The database for Alaska coal quality and stratigraphic information continues to grow and we are incorporating this data and the appropriate Geographic Information System (GIS) files into a new digital Alaska coal resources map. This new coal resources map (fig. 2) meshes well with the NCRDS work by incorporating the coal data into a meaningful and useful format. Where available, the map contains compiled geology layers and coal isopachs, where calculated. We are also incorporating the Alaska abandoned coal-mine inventory, which has never been accessible in a digital format. The complete coal dataset incorporated into this new GIS map will allow for calculations of coal resources in areas with sufficient coal-thickness point-source data. At completion of the current 5-year NCRDS program in September 2015 the entire Alaska NCRDS dataset will be incorporated into the GIS map, with the goal of creating an online, interactive Alaska coal resource map on the DGGS website.

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