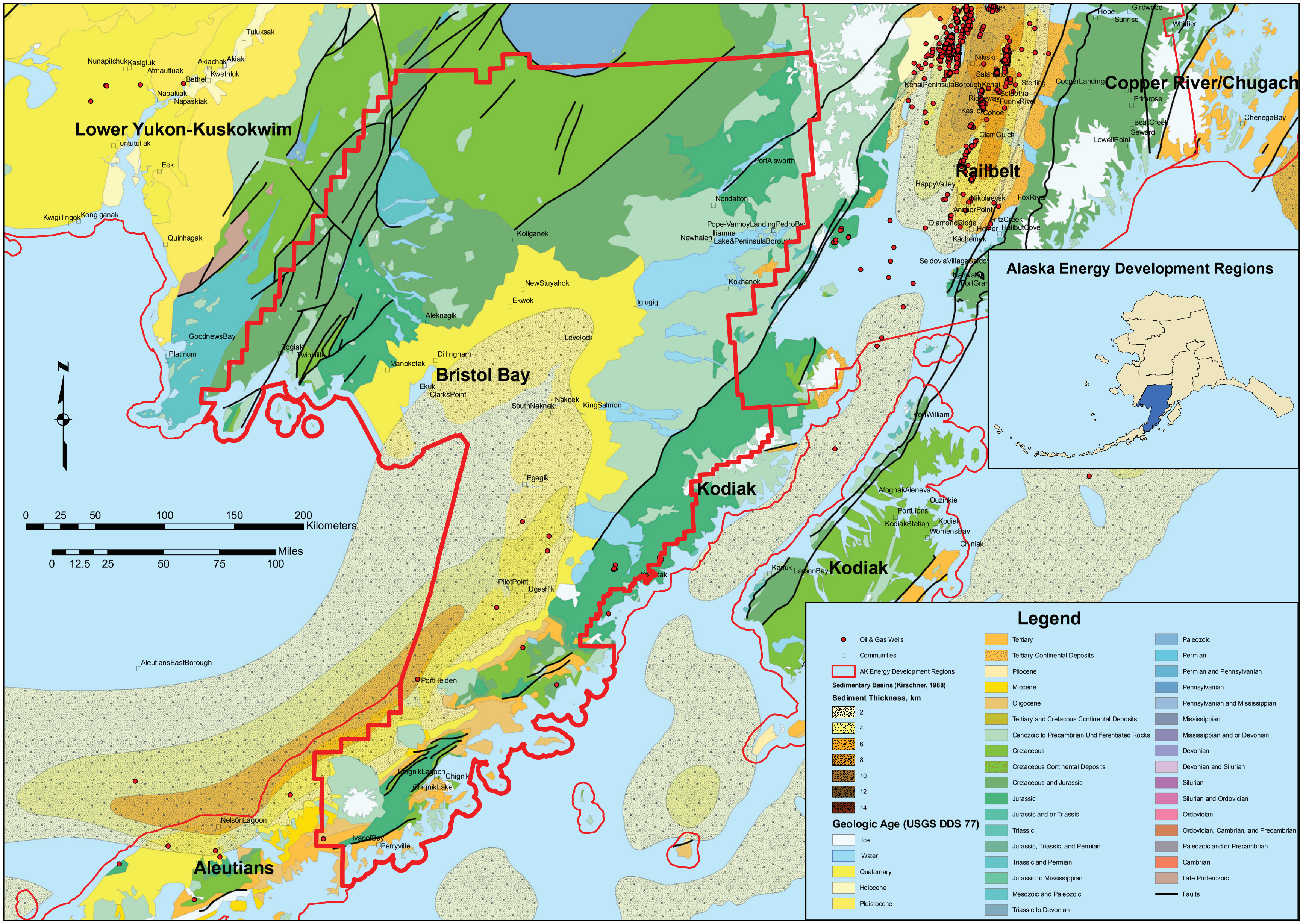
Geology of the Bristol Bay Energy Region, Alaska



SUMMARY OF FOSSIL FUEL AND GEOTHERMAL RESOURCE POTENTIAL IN THE BRISTOL BAY ENERGY REGION

by Paul L. Decker, Robert J. Gillis, Ken Helmold, and Shaun Peterson

INTRODUCTION

Purpose of this report

Economic growth and stability in Alaska's rural and urban areas hinges partially, if not primarily on the availability of affordable and sustainable energy supplies. Recent price increases in oil and gas commodities have created severe economic hardship in many areas of the state that are dependent on diesel and heating oil as their primary source of energy. All sectors of Alaska's economy rely on affordable energy sources with limited price volatility, highlighting the need to diversify the energy portfolio by developing locally available and sustainable resources that are not tied to the global market. Unfortunately, all areas are not created equal in energy accessibility; the resources available for local exploitation vary widely across the state. It is critical that funding decisions for expensive programs to reduce the dependence on diesel for heat and electricity take into account information concerning the entire suite of natural resources that exist in a given area.

This report draws from existing information to provide community and state leaders an objective summary of our current knowledge concerning the potential of locally exploitable fossil fuel and geothermal energy resources in the Bristol Bay energy region (fig. D1), one of 11 regions recognized by the Alaska Energy Authority in their Energy Plan (AEA, 2009). The potential geologically hosted energy resources considered here include exploitable coal, conventional and unconventional oil and gas, and geothermal resources. This report concludes with recommendations as to what additional data or strategies, if any, would provide the most leveraging in helping to develop new energy resources in the region.

Readers without geological training are encouraged to peruse the geologic summaries of fossil fuel resources and geothermal energy in Chapter A. They provide an overview of the geologic elements that must be present in an area to economically develop coal, conventional oil and gas, unconventional oil and gas, and geothermal resources. These summaries will provide the necessary background to more fully understand the information presented in this chapter.

Geographic and geologic setting

The Bristol Bay Energy Region of southwestern Alaska encompasses an irregular area measuring approximately 365 miles from north to south and up to nearly 250 miles from east to west that rims the northeast end of Bristol Bay and reaches south to include much of the Alaska Peninsula (sheet 1). Physiographic provinces represented include the Nushagak–Bristol Bay Lowlands, the Nushagak–Big River Hills, and parts of the Aleutian Range, southern Alaska Range, and Ahklun Mountains (Wahrhaftig, 1960). The region's largest community is Dillingham, with a current population of approximately 2,400 residents. Other sizable communities

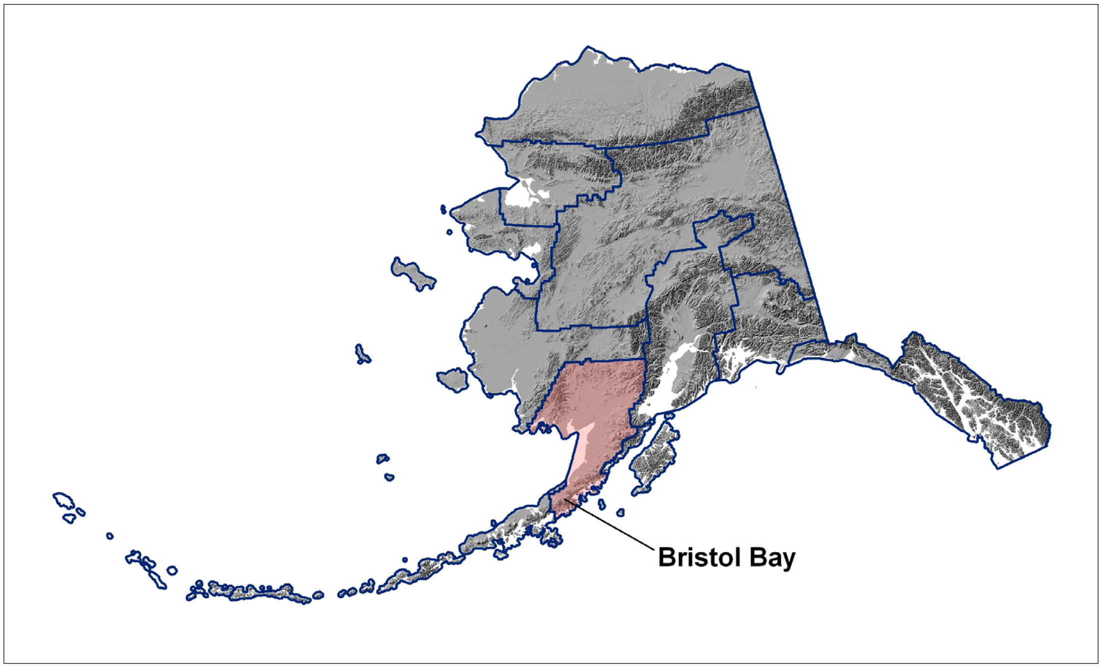


Figure D1. Location map of Bristol Bay Energy Region.

Bristol Bay

include Togiak, Naknek, New Stuyahok, Manokotak, and King Salmon, with populations ranging from nearly 800 to approximately 400 residents. Smaller populations occupy 24 smaller permanent villages. All of these communities are isolated from the major population centers along the Railbelt, and are only accessible by air, boat, or snowmachine.

Topography in the Bristol Bay region varies widely from high, rugged mountains of the southern Alaska Range, to the low-relief Nushagak hills, isolated volcanic peaks on the eastern Alaska Peninsula, and lowlands of the Nushagak and Mulchatna river basins and the western Alaska Peninsula. Geologically, southern Alaska is composed of a series of far-traveled crustal fragments that have been accreting to continental North America since early Cretaceous time (over the last 240 million years). Most bedrock within the Bristol Bay Energy Region represents a complex geologic history of mountain building and sedimentary basin development since early to middle Jurassic time (Detterman and others, 1996). The rock comprising the mountainous regions on the eastern Alaska Peninsula and in the Chigmit Mountains (Peninsular Terrane) are primarily the product of Jurassic-age subduction processes such as arc volcanism and intrusion of igneous rocks into the overriding continental crust, and their subsequent erosion and deposition into neighboring basins. These erosional products and underlying basement rocks are the hydrocarbon sources for the Bristol Bay and Cook Inlet basins (Decker and others, 2008; Detterman and Hartsock, 1966). This area has undergone subsequent episodic uplift and basin development since late Cretaceous time (Detterman and Hartsock, 1966) that has resulted in deposition of some of the coal-bearing rocks on the Alaska Peninsula and the principal hydrocarbon reservoir rocks in the Bristol Bay and Cook Inlet basins (Calderwood and Fackler, 1972; Helmold and others, 2008). These plate boundary processes, including arc volcanism and locally elevated geothermal gradients, were similar to what is presently occurring along the southcentral coast of Alaska.

Like many parts of Alaska, the region spans several fault-bounded geologic blocks or terranes that were assembled by strike-slip and collisional tectonic processes during Mesozoic to early Tertiary time (Silberling and others, 1992). From southeast to northwest, the major faults in the region that mark the suturing of these provinces are the Bruin Bay, Castle Mountain, and Mulchatna faults and the Togiak–Tikchik strands of the larger Denali–Farewell fault system. Except where overlapped by younger Tertiary sedimentary strata on the edges of the North Aleutian (or Bristol Bay) basin (sheet 2), or by Tertiary and younger volcanic cover, bedrock in the Bristol Bay Energy Region consists of a wide variety of older, Mesozoic rock types. In the northern part of the region, outcrops include mostly metamorphic and igneous basement and complexly to pervasively deformed sedimentary to low-grade metamorphic rocks. Southeast of the Bruin Bay fault system, along the southeast side of the Alaska Peninsula, most bedrock comprises moderately folded and faulted Mesozoic sedimentary formations that were never buried to great depths and have maintained relatively lower thermal maturity. Two of the older formations in this succession include excellent oil and gas source rocks, and the youngest unit contains potential coal resources. The youngest bedrock units in the Bristol Bay region are the volcanic and associated sedimentary rocks formed by eruptions of the Aleutian arc volcanoes within the last 10 million years (summarized from Kirschner, 1988; Beikman, 1980).

GEOLOGIC ENERGY RESOURCE POTENTIAL IN THE BRISTOL BAY ENERGY REGION

Mineable coal resource potential

Significant coal resources occur only in the Alaska Peninsula region of the development area. The main coal-bearing area is the Chignik Field, near Chignik Bay (fig. D2). Nearby villages include Ivanof Bay, Chignik, Chignik Lake, Chignik Lagoon, Perryville, Port Heiden, Ugashik, Pilot Point, and Egegik.

Chignik Field. Coal in the Chignik Bay area occurs primarily in the Coal Valley Member of the Late Cretaceous-age Chignik Formation, with less abundant coal occurrences in the Paleocene–Early Eocene Tolstoi Formation. The Chignik Field extends for approximately 25 miles along the northwest shore of Chignik Bay, amounting to about 50 square miles of coal-bearing rocks (fig. D2; Merritt and McGee, 1986). Principal coal deposits in the Chignik Formation occur in a 1- to 3-mile-wide swath best exposed along the Chignik River, Whalers Creek, Thompson Valley, and Hook Bay, and in the areas of the Anchorage, Amber, and Nakalilok bays (Merritt and McGee, 1986; Detterman and others, 1984). The Alaska coal mined land inventory lists four mines in the Chignik area that were active to some degree in the late 1800s to early 1900s (Plangraphics, 1983). The Chignik River mine opened in 1893 and operated for at least 12 years to supply coal to a nearby cannery (Plangraphics, 1983). Activity on the Hook Bay mine was begun in 1908 (Plangraphics, 1983), however there is no data on actual coal production from these mines. Coals in these areas are ranked as high-volatile B bituminous with high ash content (~20 percent), low sulfur content, and raw heating values that range widely from approximately 5,500 to 12,500 Btu. After washing, this value may increase on average to more than 12,000 Btu with an ash content of less than 12 percent.

Peninsula-wide, it is estimated that there are 14 beds in the Chignik Formation that are greater than 14 inches thick. Individual coalbeds in the Chignik Field range in thickness from approximately six inches to 4.5 feet (Conwell and Triplehorn, 1978). Conwell and Triplehorn (1978) allude to possibly 8 square miles of recoverable coal from the Chignik Formation in the Chignik River area, amounting to about 60 million tons. Detterman and others (1984) conducted a

Bristol Bay

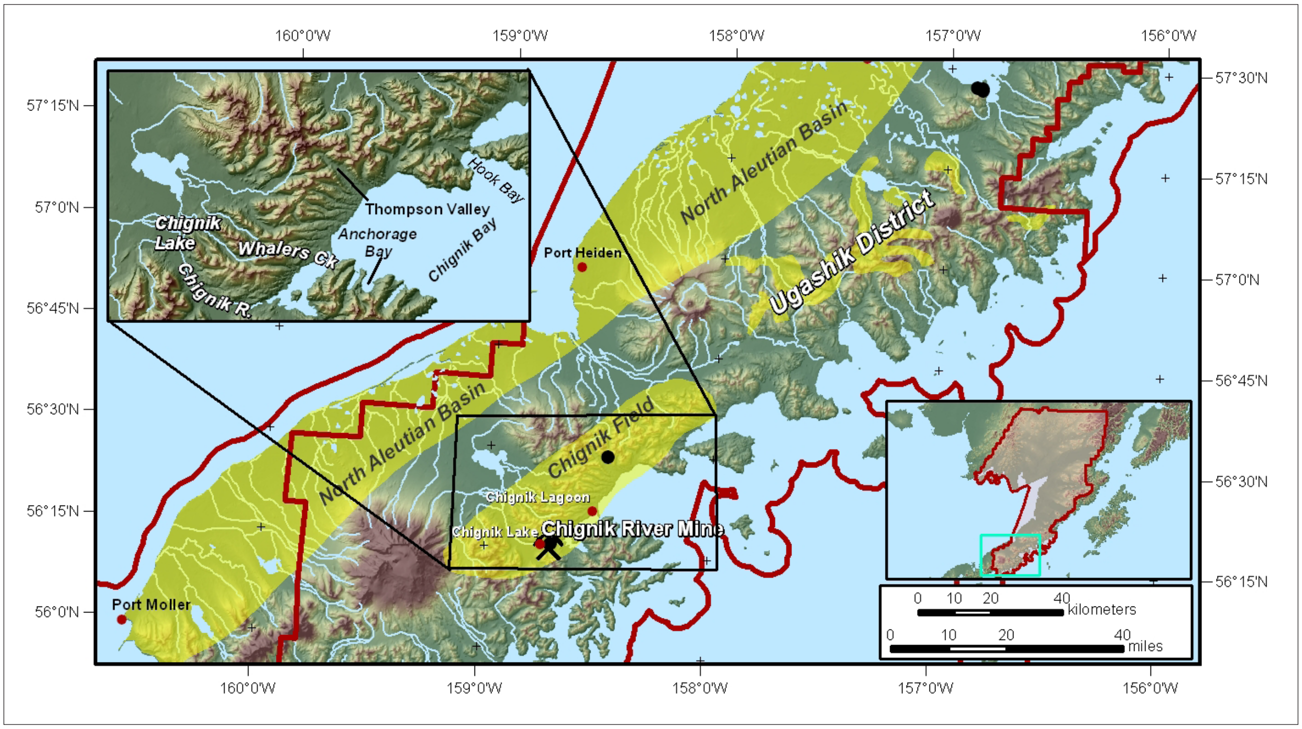


Figure D2. Location map of the southwestern Bristol Bay Energy Region, showing selected geographic references noted in the text (note inset detailed map of the Chignik Bay area). Black dots indicate reported coal occurrences; pick-axe symbol indicates location of a historic coal mine; yellow shaded areas are inferred to be underlain by coal-bearing rocks.

reconnaissance study in the Chignik area and estimated 242 million tons of inferred coal resources. Of the total resources, 56.4 million tons are estimated for the Chignik River area, 62.6 million for the Anchorage Bay area, 49.9 million for the Thompson Valley–Hook Bay areas, and 73.1 million for the Nakalilok Bay area (fig. D2). There are an estimated 430 million short tons of identified coal, and over 3 billion short tons of hypothetical coal Peninsula-wide, including the Herendeen Field in the Aleutian Energy Development Region to the south (Merritt and Hawley, 1986).

Coal quality and thickness vary greatly, both laterally and from bed to bed (Conwell and Triplehorn, 1978). Rocks of the Chignik Formation have also undergone multiple episodes of folding and faulting and, as a consequence, coalbeds along the Chignik River pinch and swell steeply-dipping faults (Merritt and McGee, 1986). Coalbeds in the Thompson Valley area have been alternately reported as mildly deformed (Merritt and McGee, 1986) to intensely deformed (Tyler and others, 2000). The lateral equivalent of coalbeds found along Chignik Bay also occur several miles inland, but are thinner and steeply dipping at the ground surface. These factors will complicate extraction of the coal, since single beds may not be traceable over long distances and may require underground mining in areas that may be prone to saltwater invasion. However, the field's close proximity to tidewater may also be an advantage for transportation of coal to market. Geologic field mapping of the Chignik Field with measurement of stratigraphic sections, and a well-conceived reconnaissance exploratory drilling program are required to better estimate the coal reserves in the area.

Other occurrences. Thin coalbeds have also been observed in the headwaters of the Kanektok River approximately 60 miles north of the village of Togiak on the north shore of Bristol Bay (fig. D3; Roehm, 1937), but they are low-grade lignite and not likely to be a significant source of energy. Isolated coal occurrences of unknown extent are reported near Puale Bay and Cape Douglas (lignite), and Amalik Bay (bituminous) by Merritt and Hawley (1986). Merritt and Hawley (1986) also depict a Ugashik coal district southeast of Ugashik Lakes (fig. D4) in what are Chignik and Tolstoi Formation strata, although mention of the district does not appear in prior or subsequent reports. Nonetheless, a local resident in the Ugashik Lakes area reported a 6- to 8-foot-thick coalbed near Old Creek (Roland Briggs, 2009, written commun.); although the rank and quality of this occurrence have not been evaluated, it may suggest a more significant coal resource in the region.

Conventional oil and gas resource potential

As explained in the discussion of requirements for exploitable oil and gas resources (Chapter A), functioning petroleum systems occur in thick sedimentary basins, and consist of three basic elements: Effective source rocks, reservoirs, and traps. Each of the elements must be in

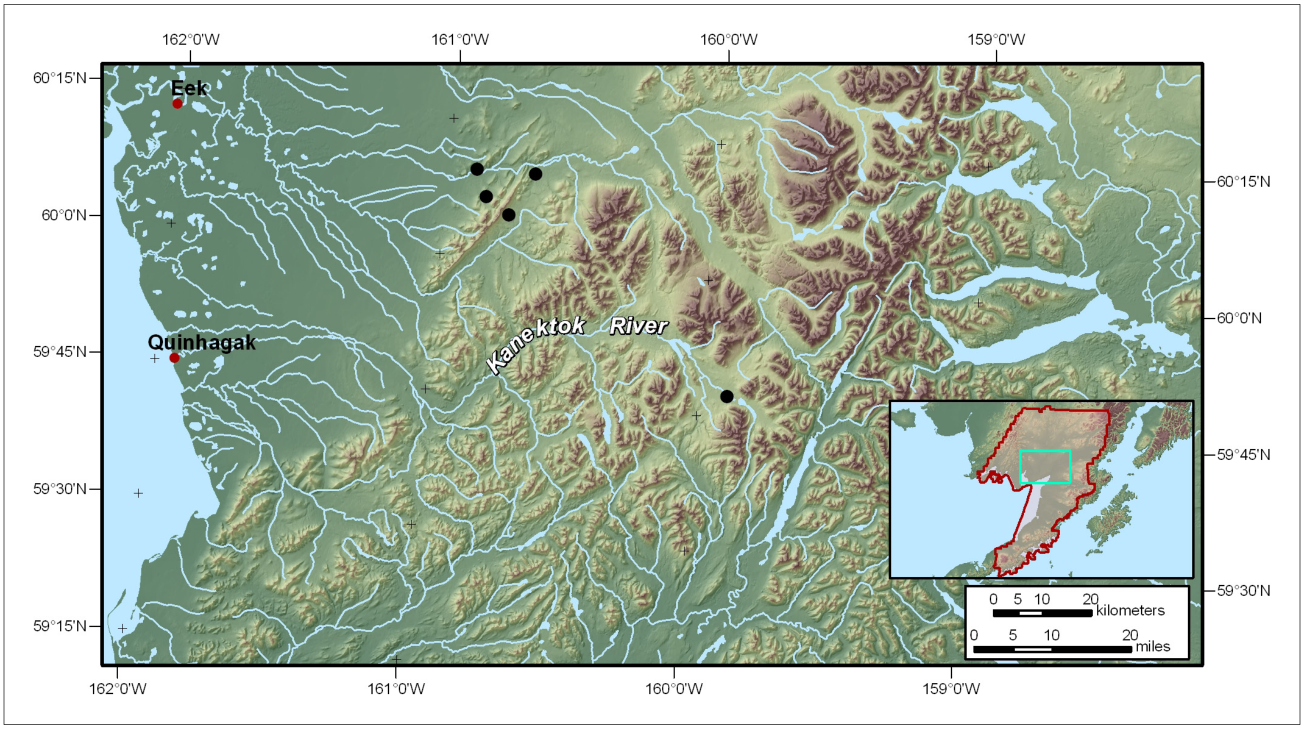


Figure D3. Location map of the central Bristol Bay Energy Region, showing reported coal occurrences (black dots) discussed in the text.

existence and connected by migration pathways at the time hydrocarbons are generated. This section considers each of these necessary elements of petroleum systems in turn to evaluate whether conventional oil and gas resources may play a role in supplying rural energy in the Bristol Bay Energy Region.

Distribution of sedimentary basins. Sheet 2 illustrates the distribution of Tertiary sedimentary basins (after Kirschner, 1988) that could potentially host petroleum systems in and near the Bristol Bay region. Other areas are underlain by igneous, metamorphic, or thermally overmature sedimentary rocks that are incapable of supporting a petroleum system. Geophysical data and limited exploration drilling demonstrate that the North Aleutian basin is the largest, thickest, and most likely to contain effective source rocks, reservoir rocks, and hydrocarbon traps, particularly along its southern margin near Nelson Lagoon and Port Moller. The northern part of the basin that extends into the Nushagak–Bristol Bay Lowlands near Naknek and Dillingham is much thinner and is unlikely to contain exploitable oil or gas accumulations because of low thermal maturity and limited source rock potential. Entirely offshore to the southeast of the Alaska Peninsula are the Shumagin, Tugidak, and Shelikof basins, all of which are smaller, relatively shallow, and have attracted limited exploration interest.

Source rocks. Outcrop studies have documented oil-prone source rocks in the Mesozoic Kamishak and Kialagvik Formations (Wang and others, 1988; Decker, 2008). These units are known to exist only in the belt of sedimentary rocks with low thermal maturity southeast of the Bruin Bay fault system near the southeast border of the Bristol Bay Energy Region. These source rocks are not known to be present beneath the main part of the North Aleutian basin, and available data indicate they are also absent from the remainder of the Bristol Bay energy region (Sherwood and others, 2006; McLean, 1977, 1979; Decker, 2008). Geochemical data indicate Mesozoic sources generated the oil and gas that occurs in a cluster of natural seeps near Puale Bay and Wide Bay on the southeast side of the Alaska Peninsula (Magoon and Anders, 1992; Blodgett and Clautice, 2005). Migrated oil or gas derived from these Mesozoic sources have not been documented in the younger Tertiary formations of the North Aleutian basin.

Farther northwest in the lower Nushagak River drainage, occurrences of iridescent sheen on standing water in boggy environments have been mistaken for oil seeps. Field studies and laboratory analyses have shown that the sheen observed in many of those locations is due to natural bacterial iron oxide films common in swampy settings and surficial peats, rather than oil seepage from the subsurface (Decker and others, 2005; Miller and others, 1959). In another case, a thin sheen of oil on the Nushagak River itself was attributed to human pollution (Miller and others, 1959). These findings are consistent with regional geologic information that suggests a lack of oil-prone source rocks in the northern and western parts of the Bristol Bay Energy Region.

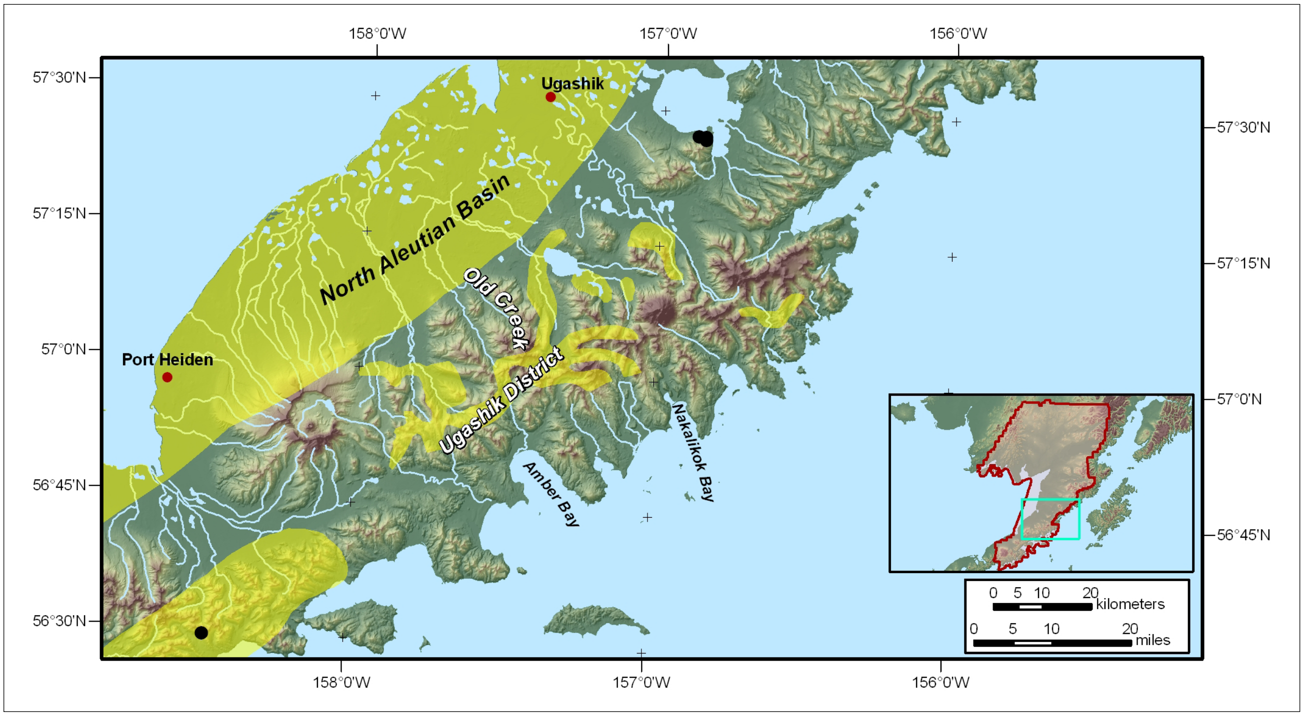


Figure D4. Location map of the south-central Bristol Bay Energy Region, showing selected geographic references noted in the text. Black dots indicate reported coal occurrences; yellow shaded areas are inferred to be underlain by coal-bearing rocks.

Outcrop and well control indicate that gas-prone source rocks are more widespread than oil-prone sources in the region, consisting of both shallow marine shales and nonmarine coaly strata of Tertiary age, notably in the Tolstoi, Stepovak, and Bear Lake Formations (McLean, 1987; Sherwood and others, 2006; Decker, 2008). Both biogenic and thermogenic gas may be present in some parts of the region's sedimentary basins. Exploitable accumulations of biogenic gas require recent uplift to migrate the gas into conventional reservoirs (Chapter A). This type of uplift may have occurred along the southern edge of the North Aleutian basin on the northwest side of the Alaska Peninsula but additional seismic and exploration drilling is required to substantiate..

The most promising area for thermogenic gas charge in the Bristol Bay Energy Region is beneath the Bristol Bay Lowlands near the southeastern margin of the North Aleutian basin (sheet 2). Between Egegik and Ugashik, as well as southwest of Port Heiden, much of the lower part of the Tertiary basin-fill succession appears to be mature for hydrocarbon generation (Sherwood and others, 2006). The area between Ugashik and Port Heiden was a massive volcanic complex during early to mid Tertiary time (Sherwood and others, 2006; Decker and others, 2008), and is likely devoid of coals or other strata with hydrocarbon source potential.

Reservoir rocks. Several Tertiary formations in the North Aleutian basin have adequate thickness of sandstone with sufficient porosity and permeability to serve as reservoirs for either oil or gas. In particular, the Bear Lake Formation and parts of the Stepovak Formation have been widely observed to have good reservoir quality in outcrop and in wells that encountered it at depth (McLean, 1987; Turner and others, 1988; Sherwood and others, 2006; Decker and others, 2005, 2006). The younger Milky River Formation also maintains high porosity and permeability, although this unit may be too shallow to host effective traps or maintain sufficient reservoir pressure. Available data indicate many formations are affected by alteration of the sandstone after burial, potentially creating a challenge to preserving reservoir quality (Lyle and others, 1979; Turner and others, 1988; Helmold and others, 2008). For example, well tests of gas-bearing sandstones in these units in the Becharof #1 well documented low flow rates and weak flowing pressures, consistent with compromised permeability.

Mesozoic formations of the Alaska Peninsula south and east of the Bruin Bay fault contain thick sandstones and some limestones that, where favorably altered, could serve as hydrocarbon reservoirs. Existing analyses of the porosity and permeability remaining in these units is typically below thresholds necessary for conventional oil and gas production. However, these data represent a relatively modest set of subsurface (well) and outcrop samples. In special cases, early entrapment of hydrocarbons can prevent porosity destruction in sandstone reservoirs, and hydrothermal alteration can create secondary porosity in limestone formations.

However, available data do not suggest that these processes have been effective over significant parts of the Alaska Peninsula, indicating that identifying adequate reservoir quality in Mesozoic units may be a challenge. Further, if hydrocarbons are sequestered in reservoirs with low porosity and permeability, then significant stimulation techniques may be required to induce production.

Traps. The Alaska Peninsula and adjacent parts of the North Aleutian basin have undergone several episodes of deformation related largely to strike-slip processes during Tertiary time (Worrall, 1991; Detterman and others, 1996; Decker and others, 2005). Potential structural traps vary from simple anticlines to structurally complex folds and faults that may create traps for gas in the subsurface (Sherwood and others, 2006; Decker and others, 2008). These types of structures are best imaged in the offshore region, which has more dense seismic data coverage. The structural framework in onshore areas is generally insufficiently understood at present to define specific trapping geometries. Stratigraphic and unconformity trap configurations may exist along the southeast margin of the basin beneath the Bristol Bay Lowlands. Low-permeability silty mudstones capable of sealing hydrocarbons accumulated in traps have recently been documented in several formations on the Alaska Peninsula (Bolger and Reifenstuhl, 2008), although their lateral extent is not well constrained.

Summary of conventional oil and gas resource potential. The North Aleutian sedimentary basin has the highest potential to host exploitable conventional petroleum resources in the Bristol Bay energy region. Although limited exploration hasn't resulted in a discovery, the basin is known to contain effective source rocks, reservoir rocks, and untested traps, especially in the federally managed Outer Continental Shelf acreage beneath Bristol Bay. Based on existing information, the most likely conventional hydrocarbon resource for local energy use would be gas derived from coaly Tertiary source rocks. This gas may form exploitable accumulations in Tertiary sandstones in structural or stratigraphic traps in offshore or nearshore areas of the eastern North Aleutian basin, particularly along the northwest side of the Alaska Peninsula, southwest of Port Heiden or between Ugashik and Egegik. Other parts of the North Aleutian basin are probably too shallow or dominated by volcanic rocks.

Unconventional oil and gas resource potential

Coalbed methane. In the Bristol Bay region, coal primarily occurs in the Coal Valley Member of the Chignik Formation, with minor occurrences in the Tolstoi Formation. The Chignik field includes the most extensive coal-bearing exposures in the region, covering approximately 39 square miles (Merritt, 1986). Individual coalbeds in outcrop are relatively thin, ranging from 6 inches to 4.5 feet, and occasionally up to 8 feet thick (Merritt and McGee, 1986). Most analyses indicate a bituminous rank, except where altered by localized areas of high heat flow (Merritt and others, 1987). The Chignik area was evaluated for its coalbed methane potential by Smith (1995) and Tyler and others (2000). Both studies concluded the area was relatively unfavorable for exploration and development at the time, largely due to geologic complexity. Nevertheless, limited subsurface data from the area are promising, most notably significant gas shows in oil exploration wells where coal seams were encountered (Smith, 1995).

Scattered thin coals are also present in the Ugashik district although less is known about the thickness and aerial distribution of these occurrences. Based on available data these coals are probably insufficient in thickness and extent to support coalbed methane development.

Tight gas sands. A majority of Neogene sandstones in the North Aleutian basin have not been buried deep enough to reduce reservoir quality into the range considered typical for tight gas sands. Measured porosities are often in excess of 20 percent and permeabilities greater than 10 millidarcys (mD) have been measured in samples from both outcrop and subsurface core from the Milky River, Bear Lake, and Unga Formations (Helmold and others, 2008). Some of the Paleogene sands (Stepovak and Tolstoi Formations) have undergone sufficient compaction and cementation to significantly degrade reservoir quality. Porosities of 10 percent are common in these sandstones with permeabilities in the range of 0.1 to 10 mD. These rocks are more lithified than the Neogene sandstones and could represent tight reservoirs along the southern margin of the North Aleutian basin.

Many of the Mesozoic sandstones in the Bristol Bay region, in particular the Herendeen, Staniukovich, and Naknek Formations, have been relatively deeply buried and have undergone significant compaction and cementation. Porosities are typically less than 10 percent and permeabilities less than 0.1 mD are routinely recorded. These older, more lithified sandstones have potential as tight gas sands, particularly those that may have been naturally fractured and underwent burial diagenesis. Extensive regional fractures have been observed in outcrops of some of the Mesozoic sandstones, especially the Naknek Formation. These fractures are typical of tight gas sands and may well signal the presence of an unconventional, fractured reservoir. Furthermore, these Mesozoic sandstones overlie several candidate hydrocarbon source rocks that could provide the necessary charge to fill an adjacent tight reservoir.

Shale gas. One of the primary requirements for shale gas is an organic-rich source rock present in the thermogenic gas window that is brittle enough to host a natural fracture system. As noted above, the most promising area for thermogenic gas charge in the Bristol Bay energy region is beneath the Bristol Bay Lowlands. Burial depth estimates for the lower part of the Tertiary stratigraphy suggest it should be in the gas window, but insufficient data are available to assess the presence of a well-developed fracture system necessary for efficient shale gas production.

Mesozoic source rocks appear to be restricted to the southeastern coastal areas of the region and outcrop and well data indicate they are most likely oil prone (Decker, 2008). Although associated gas is possible, available information suggests shale gas potential is limited. However, recent advances in drilling technology have resulted in the production of oil directly from this type of oil-prone source rock (termed shale oil). Although this resource type has never been considered in this region, the high quality of the Triassic and Jurassic source rocks indicates that hydrocarbons may be reservoired directly in their source rock.

Gas hydrates. The main occurrences of gas hydrates in nature are in modern marine sediments and in arctic regions with a well-developed, continuous permafrost. Permafrost is not well developed in the Bristol Bay Energy Region and is discontinuous where locally present. Consequently the potential for economic concentrations of gas hydrates is low.

Geothermal resource potential

Geothermal prospectivity in the Bristol Bay Energy Region is limited to the southern and eastern parts of the area, between Katmai National Park and Stepovak Bay. Two thermal springs with surface discharge temperatures of 73°F (23°C) and 151°F (66°C) are present in the region. The most promising geothermal feature in the region is the Mother Goose hot spring system, located at the northwest base of Mount Chiginagak. The largest Mother Goose spring discharges 151°F (66°C) water at a rate of >106 gallons per minute into a small stream that feeds into Volcano Creek (Motyka and others, 1994). Stream flow and temperature measurements indicate thermal water is discharged from the entire Mother Goose hot spring system at a rate of >1,321 gallons per minute (Motyka and others, 1994). The springs are near the contact of the Mount Chiginagak volcanic rocks and the underlying fossiliferous, feldspathic sandstone of the Cretaceous-age Staniukovich Formation (Motyka and others, 1994). The closest community is Ugashik, located 27 miles northwest of Mother Goose hot spring.

The Aniakchak thermal spring has a discharge temperature of 73°F (23°C) and emanates from near an old volcanic vent and flows into Surprise Lake, in the northeast part of Aniakchak caldera (Motyka and others, 1994).There are also numerous fumarole fields in Katmai National Park surrounding the site of the Valley of 10,000 Smokes, where Novarupta volcano deposited up to 700 feet of ash during a massive eruption in June 1912. Today there are at least seven fumarole fields actively steaming in the area, at temperatures of up to 212°F (100°C) (Motyka and others, 1983). Geothermal gradients established by temperatures taken in deep oil and gas exploratory wells show a normal heat flow in most of the region, except in local areas near volcanic centers.

RECOMMENDATIONS

Conventional oil and gas resource recommendations

Previous reconnaissance-scale geologic fieldwork has established the framework geology of the Alaska Peninsula (Detterman and others, 1996). However, significant improvements in our understanding of the region's petroleum potential could be achieved with additional detailed field mapping and stratigraphic studies. This type of work would build on the successful recent topical studies of the Alaska Peninsula by DNR geologists (Reifenstuhl and Decker, 2008).

The petroleum industry has expressed clear interest in exploring federal waters of the southern North Aleutian basin, which is considered prospective for commercial-scale natural gas accumulations (Anchorage Daily News, 2005; Shell Exploration and Production, 2008). A significant discovery could potentially make gas available to markets in the Bristol Bay energy region, although this cannot occur until offshore federal leasing is reinitiated. Industry has shown only moderate interest in exploring leasable state acreage onshore and beneath state waters. These lands have been available for leasing since 2005 through the Alaska Peninsula areawide lease sale. Acquisition of high-quality modern seismic data would be required to determine whether there are exploration prospects on currently accessible lands that would be worth evaluating by drilling. New industry-led exploration would improve knowledge of the prospectivity of state lands and any commercial discovery may have the potential to supply affordable energy resources to nearby communities.

Unconventional oil and gas resource recommendations

Coalbed methane. The Chignik area does possess coal of sufficient rank to host coalbed methane. The presence of gas in these coal seams was confirmed by significant mud log gas shows encountered during oil exploration drilling. However, compilations of available data conclude that stratigraphic and structural complexity poses a significant challenge to coalbed methane exploration or development (Smith, 1995; Tyler and others, 2000). Prior to any exploration drilling, it is recommended that substantial geologic fieldwork be conducted in the area, including detailed geologic mapping, structural studies, and analysis of lateral changes in sedimentary units.

Tight gas sands. The possibility exists for encountering fractured tight gas sands in portions of the Mesozoic section in the region, although available data suggest the probability of recovering commercial quantities of gas is low. In terms of unconventional resources, tight gas sands have the highest likelihood of providing producible quantities of hydrocarbons for local use. Nevertheless, this type of resource has not been extensively evaluated in the region and it would be difficult to entice commercial exploration for tight gas sands in this remote region. Although local exploration may succeed in identifying a resource, developing this type of unconventional play typically involves significant drilling and stimulation costs that could challenge its economic viability as a local source of energy.

Shale gas. Prior geologic investigations have not documented extensively fractured source rocks that are in the thermogenic gas window. The likelihood of finding commercial quantities of shale gas in the region is low and no further action is recommended at this time. However, unconventional shale oil has never been evaluated in the region and the high quality of oil-prone Mesozoic source rocks may warrant further geologic study to determine their potential.

Gas hydrates. Due to the lack of extensive, continuous permafrost in most of southern Alaska, the likelihood of finding gas hydrates in the region are very low, therefore no further action is recommended.

Coal resource recommendations

Coals from the Chignik Field offer the greatest potential to produce an economic resource. Prior work has established the presence of an extensive resource with appropriate coal quality. However, available information suggests the stratigraphic and structural complexity of the area would pose a challenge to any effort to exploit this resource for local energy use. A robust assessment of the coal potential of the Chignik region would require significant geologic mapping and topical stratigraphic studies of the coal-bearing section. Although these investigations should be a necessary precursor to any exploratory program, ultimately subsurface drilling data would likely be required to delineate the resource and accurately appraise the economic viability of potential resource development. Available information suggests coals from other areas in the region are unlikely to represent an exploitable resource. However, prior work has been largely reconnaissance in nature, and additional field studies of the local geology could improve our knowledge of the potential for mineable coal in regions like the Ugashik Lakes area.

Geothermal resource recommendations

Evidence for elevated subsurface heat flows in the Bristol Bay Region is closely associated with the Aleutian volcanic arc. Of the two thermal springs in the region, only Mother Goose has a discharge temperature >100°F (38°C). Steaming ground fumaroles and boiling-lake fumaroles are also abundant in the Mount Katmai region. However, these indications of active hydrothermal systems are currently located on protected federal lands and not available for development. In addition, the distance between population centers and known occurrences of elevated subsurface temperatures will be a limiting economic factor for geothermal exploration or development of any potential resource for local energy use.

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