ASSESSMENT OF SQUIRREL RIVER OIL AND GAS RESOURCE POTENTIAL

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EXECUTIVE SUMMARY

The Branch of Mineral Assessment, Division of Mineral Resources, Bureau of Land Management-Alaska, classifies the area in the vicinity of Squirrel River as having LOW potential for the geologic occurrence of oil and gas resources. We classify the area as having NO potential for economically recoverable reserves, based on the currently available information.

INTRODUCTION

The U.S. Bureau of Land Management (BLM) has management responsibilities for public lands in the vicinity of the Squirrel River, northwestern Alaska (Figure 1). The federally administered portion of the Squirrel River, in the southwestern Brooks Range, has been authorized for study as a possible addition to the Wild and Scenic River system by the Alaska National Interest Lands Conservation Act of December 2, 1980. Prior to inclusion in the Wild and Scenic River System, the area must be studied for possible impacts of future land use decisions by the BLM. This oil and gas assessment represents one aspect of these studies.

LANDS INVOLVED

The lands involved in this assessment of oil and gas resource potential include the public lands around the Squirrel River, in northwestern Alaska. The Squirrel River flows through the valley south of the Baird Mountains, west of the Kallarichuk Hills, and north of the Kiana Hills. The valley is northwest of Kotzebue Sound. Several major streams flow southward from the Baird Mountains into the Squirrel River. Numerous smaller streams flow northward from the Kiana Hills into the river. The Squirrel River flows southeastward into the Kobuk River. Most of the lands drained by the Squirrel River system appear to be public lands managed by the BLM. The NANA Regional Corporation has selected lands along the lower 35 miles of the Squirrel River from just below the junction of the Omar River to the Kobuk River and along a section of the Kobuk. These selected lands are not assessed here for oil and gas potential.

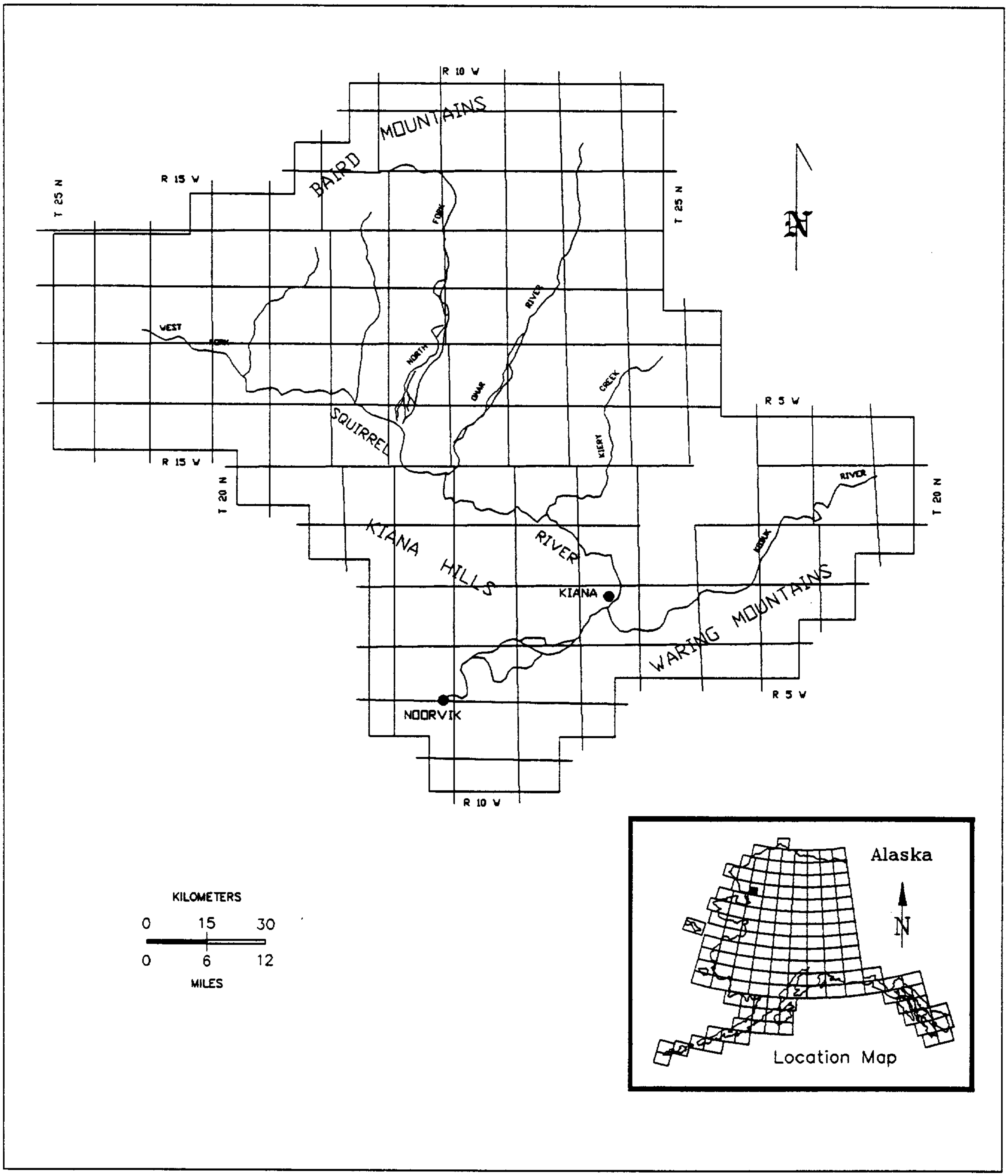


Figure 1. Location Map for the Squirrel River Study Area

ALASKAN OILFIELDS

The only operating oil or gas fields for onshore Alaska are on the North Slope and in the Cook Inlet-Kenai Peninsula area. Historically, the Katalla Field, near the mouth of the Copper River was the first producing oil field in Alaska. It has long since ceased production.

None of these fields occur near the Squirrel River area and have no bearing on the oil and gas potential of the area.

REGIONAL GEOLOGY

The Squirrel River valley is on the southwestern flank of the western Brooks Range. The Brooks Range is on the western end of the North American Cordilleran orogenic belt. It is in this region that the east-west structural trend of the Brooks Range intersects the northeast-southwest trend of the Baird Mountains (Karl and Long, 1987). Mayfield et al. (1983) divide the surrounding area into four geologic provinces. From north to south, these include 1) the Colville Basin, 2) the DeLong Mountains allochthon belt, 3) the Schwatka Mountains province, and 4) the Yukon-Koyukuk province.

The Colville Basin, north of the Brooks Range, contains a thick sequence of Lower and Upper Cretaceous to Tertiary clastic rocks. These rocks get progressively younger towards the northeast. South of the Colville Basin, a belt of thrust sheets forms the DeLong Mountains allochthon. Some, and maybe all, of these thrust sheets overlie the Schwatka Mountains province. A belt of metasedimentary, volcanic, and plutonic rocks, regionally metamorphosed to the greenschist facies, forms the Schwatka province and the southwestern flank of the Brooks Range (Mayfield, 1976, and Mayfield et al., 1983). The Yukon-Koyukuk province consists of two distinct sets of rocks. Clastic rocks of upper Cretaceous age fill the basins around the margin of the province, and a suite of andesitic volcanics forms an arc through the central part of the province (Mayfield et al., 1983).

Jones et al. (1987) identified several lithotectonic terranes in this area: 1) the Arctic Alaska terrane (subdivided into several subterranes), 2) the Angayucham terrane, 3) the Kagvik terrane, and 4) the Koyukuk terrane with its associated Cretaceous clastic sediments. The Arctic Alaska terrane consists of the North Slope subterrane -- roughly equivalent to the Colville Basin of Mayfield et al. (1983); and the DeLong Mountains, Endicott Mountains, and Hammond subterranes. The DeLong Mountains and Endicott Mountains subterranes, along with the Angayucham and Kagvik terranes, are roughly equivalent to the DeLong Mountains allochthon belt of Mayfield et al. (1983). The Hammond terrane is roughly equivalent to the Schwatka Mountains province of Mayfield et al. (1983). The Koyukuk terrane and its associated Cretaceous clastic sediments are roughly equivalent to the Yukon-Koyukuk province of Mayfield et al. (1983).

The terranes and subterranes in the immediate neighborhood of the Squirrel River area are the DeLong Mountains subterrane, the Endicott Mountains subterrane, the Hammond subterrane, and the Angayucham terrane. The DeLong Mountains subterrane consists of a "complex stratigraphic assemblage" of "thick Devonian and Mississippian carbonates and younger sequences of chert and argillite," (Jones et al., 1987). The Endicott Mountains subterrane consists of a "stratified sequence of Devonian clastic rocks . . ., Mississippian shale . . . and carbonate rocks . . ., and lower Mesozoic chert, argillite and calcareous rocks," (Jones et al., 1987). The Hammond subterrane is a "structurally complex and polymetamorphosed assemblage of middle Paleozoic and older carbonate rocks (. . .), calc-schist, quartz-mica schist, quartzite, and metarhyolite; intruded by Late Devonian gneissic granitic rocks. Sparse radiometric ages suggest local presence of Precambrian basement rocks," (Jones et al., 1987). The Angayucham terrane is a "structurally complex assemblage of oceanic rocks, including gabbro, diabase, pillow basalt, tuff, chert, graywacke, argillite, and minor limestone; sedimentary rocks range in age from Mississippian to Jurassic. Major periods of basaltic volcanism appear to be late Carboniferous and Late Triassic, although many volcanic sequences are not yet well-dated. Separate thrust sheets of plutonic ultramafic rocks are found throughout the terrane, but none of these can yet be genetically linked to the basaltic rocks," (Jones et al., 1987).

LOCAL GEOLOGY

The main part of the Squirrel River system mostly drains rocks of the DeLong Mountains subterrane (Figure 2). The lower part of the system and Klery Creek drain part of the Hammond subterrane. The headwaters of the Omar River and some of the other streams with headwaters in the Baird Mountains drain part of the Endicott Mountains subterrane. The West Fork of the Squirrel River may drain a small area of the Angayucham terrane. Carbonate rocks are the major bedrock constituent of the west-central part of the Baird Mountains quadrangle (Dumoulin and Harris, 1987). Paleozoic limestones and dolostones, often folded and faulted, underlie much of the Squirrel River valley (Folger et al., 1987, and Folger and Schmidt, 1986). These sedimentary rocks appear to have been deposited in a continental-shelf environment (Einaudi and Hitzman, 1987). Carbonate-hosted mineral deposits in the vicinity of the Omar River are found in rocks of Late Devonian to Late Mississippian age (Einaudi and Hitzman, 1987).

Ordovician-aged Carbonates

Ordovician-aged rocks crop out extensively throughout the Baird Mountains quadrangle. Dumoulin and Harris (1987) describe two lithofacies in the carbonate rocks of this area. Lithofacies I consists of dolostones with well-developed fenestral fabric, evaporite molds, and a conodont fauna which indicates deposition in warm, locally restricted, shallow to very shallow water. Finely-laminated mudstones and wackestones comprise the dominant rock type, with subordinate intervals of intraclasts and pelletal packstone. The conodont assemblages of this lithofacies indicate middle Early to earliest Middle Ordovician age. These rocks have been found along the Middle Fork of

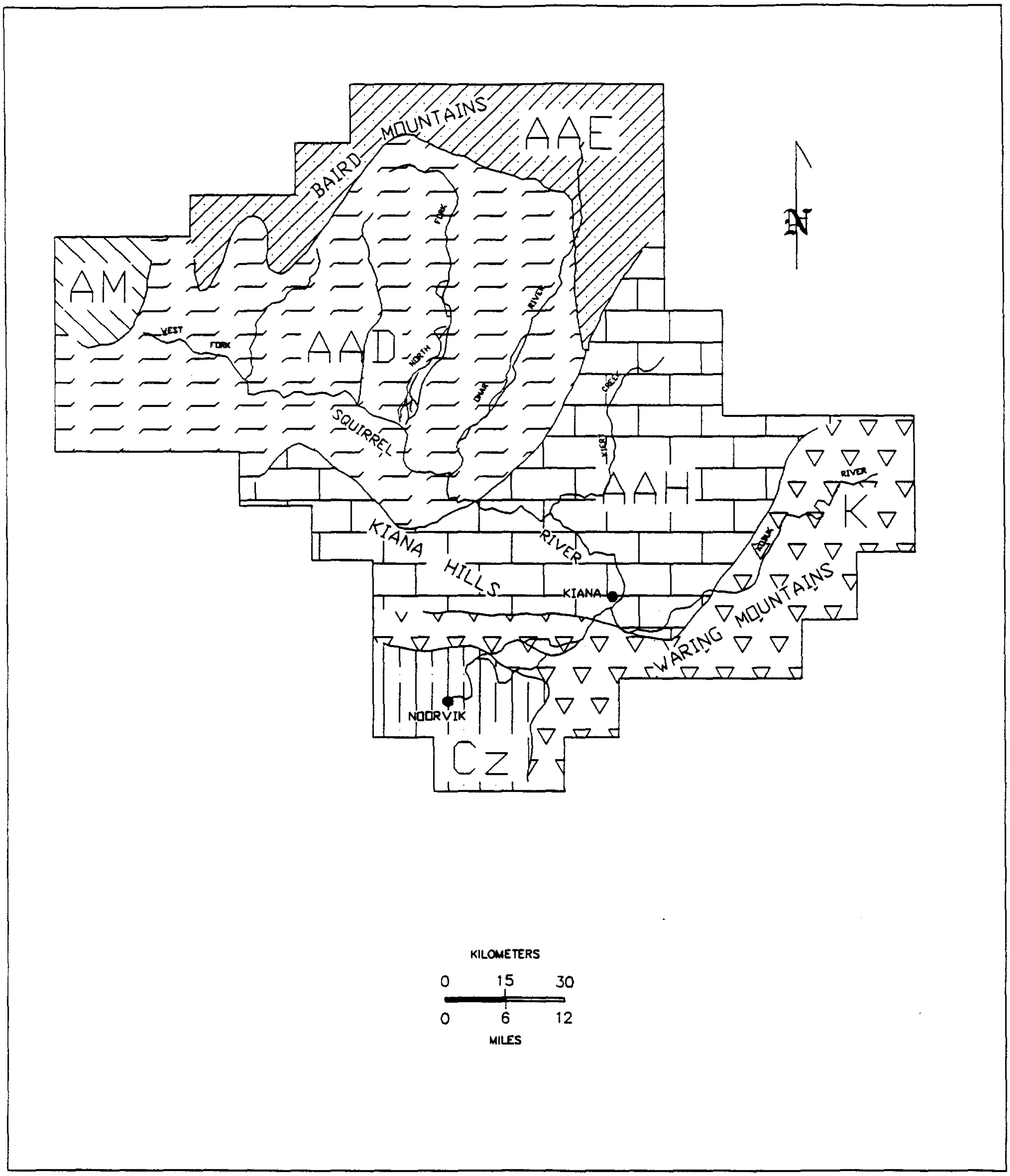
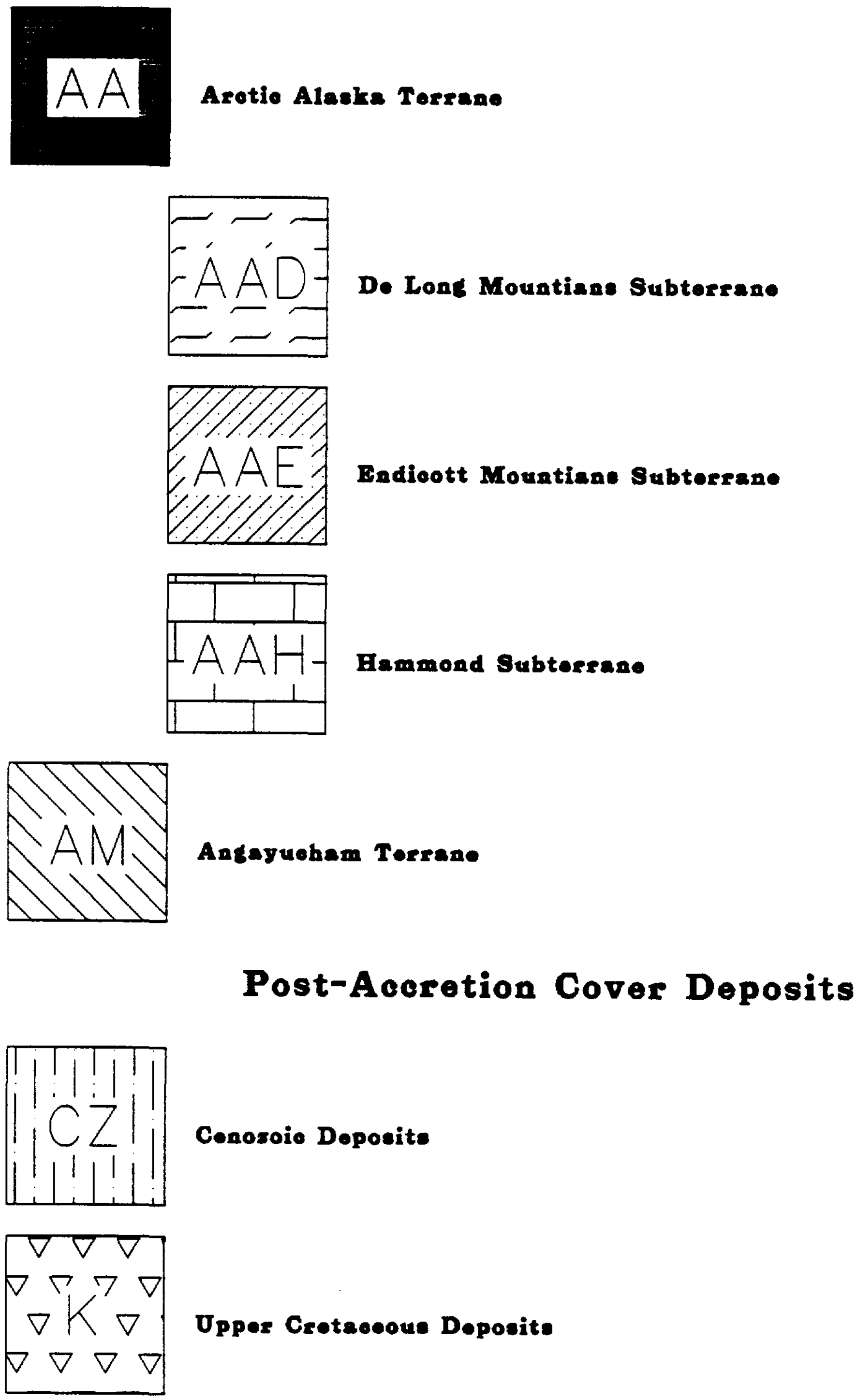


Figure 2, Part 1. Tectonostratigraphic Terrane Map for the Squirrel River Study Area (After Jones et. al, 1987).

Figure 2, Part 2.

KEY



the Squirrel River and in the Omar River area about 12 miles to the east. Lithofacies II consists of bioturbated to laminated, orange- and gray-weathering, dolomitic marble and metalimestone. The conodont fauna indicates normal marine and slightly cooler water conditions than for Lithofacies I. Lithofacies II has a wide distribution in both the Squirrel River and Omar River drainages. Slightly dolomitic to argillaceous metalimestone and marble characterize this lithofacies. A conodont assemblage from near the Omar River indicates an Early Ordovician age for Lithofacies II. Conodont assemblages from elsewhere in the Squirrel River and Omar River drainages indicate Early Ordovician through earliest Middle Ordovician age. A section along the Omar River measures more than 2,600 feet thick but is cut by several brecciated zones which may be faults. They are associated with irregular areas of dolomitization and local repetition of lithologies; however, no definite repetitions were observed in the conodont collections. Conodont assemblages and sedimentary structures indicate deposition under normal marine-platform conditions. The environment during deposition was one less restricted, with slightly deeper and cooler water, than during deposition of the dolomite of Lithofacies I. Only a single locality of definitely Upper Ordovician rocks has been found in the western Baird Mountains quadrangle. This is a gray-brown, fine- to medium-crystalline marble in the Omar River area that contains Late Ordovician conodonts (Dumoulin and Harris, 1987).

Silurian-aged Carbonates

Silurian carbonate rocks have been found on the Middle Fork of the Squirrel River. Where well-exposed, these rocks are all massive dolostone. They typically weather orange, and consist mainly of finely-laminated mudstone, with lesser, locally bioturbated, bioclastic to pelletal packstones. Halysitid corals and tubular and laminar stromatoporoids, as well as brachiopods, are locally abundant (Dumoulin and Harris, 1987). Biostratigraphically diagnostic conodonts indicate a Late Silurian age. Several assemblages indicate deposition in shallow, somewhat restricted platform conditions (Dumoulin and Harris, 1987).

Devonian-aged Rocks

Devonian rocks are widely distributed in the western Baird Mountains quadrangle. Lower and Middle Devonian dolostones, lesser metalimestones and marble, and rare metasandstones occur in the lower Omar River and Squirrel River drainages. Dumoulin and Harris (1987) describe two packages in this sequence of Devonian rocks. Package I, a mostly dolomitic bioclastic packstone, is locally cherty. Coral-stromatoporoid biostromes and bioherms up to tens of meters thick occur locally. Package I sequences contain few clastic rocks. Medium to coarse-grained sandstones, which contain a few percent of floating bioclasts (corals and megafossils), were found, however, in a measured section along a cut bank on the Middle Fork of the Squirrel River. The sandstone grains consist mostly of calcite with mica, chlorite, and notable amounts of accessory sphene. The abundance of chlorite and sphene suggests that the source for these sedimentary rocks included a volcanic or altered igneous-intrusive component. Conodonts, where biostratigraphically diagnostic, are of late Early and early Middle Devonian age. Fossils and sedimentary structures indicate a range of normal-marine-shelf depositional environments.

Intercalation of fossiliferous marbles and quartz-carbonate metasandstone, metasiltstone, and lesser phyllite characterizes Package II. Dumoulin and Harris (1987) did not report Package II rocks in the Squirrel River or Omar River drainages.

Devonian- and Mississippian-aged metasediments

Devonian and Mississippian age metasedimentary rocks, mainly quartzose metasandstone and phyllites assigned to the Endicott Group, are found in the northern part of the Baird Mountains quadrangle. Most workers consider the contact between the Baird Group and the Endicott Group to be a tectonic juxtaposition (Dumoulin and Harris, 1987).

STRUCTURE

There is little information available on the structure of the area. Mayfield et al. (1983) assign the rocks of the western Brooks Range to seven allochthons and the basement autochthon. These seven allochthons and the autochthon consist of hundreds of thrust sheets which "contain parts of structurally overlapping sequences that are composed of sedimentary, metasedimentary, and (or) igneous rocks." Each allochthon contains "multiple thrust sheets that contain similar" sedimentary "sequences and occur at approximately the same structural level . . . ." The rocks in the vicinity of the Squirrel River are assigned to the Schwatka Mountains province, the basement autochthon, and to the Brooks Range and Kelly River allochthons, the first and third allochthon, respectively, of Mayfield et al. (1983).

The Schwatka Mountains province, the least understood sequence of the western Brooks Range, forms the bedrock in the southern and southeastern part of the area and probably underlies the two allochthons. The province is an internally complex anticlinorium which may extend from the southern flanks of the Brooks Range to beneath the North Slope. The southern edge of the autochthon "dips south under thrust-faulted mafic igneous rocks that are partly covered by mid-Cretaceous clastic rocks." This province may contain thousands "of meters of lower Paleozoic and Precambrian metasedimentary rocks" that are intensely deformed (Mayfield et al., 1983).

The Brooks Range allochthon is, structurally, the lowest and most widely exposed of the seven allochthons. It may reach a thickness of five to ten kilometers measured approximately normal to the upper and lower bounding fault surfaces in certain areas. Mayfield et al. (1983) subdivide this allochthon into three sequences: 1) the Ivotuk sequence, 2) the Key Creek Sequence, and 3) the Lisburne Hills Sequence. Each sequence has certain characteristics which help to distinguish them from sequences of other allochthons. These are grouped together because of "important lithologic similarities" and they "occur at approximately the same structural level." The Kelly River allochthon is the third lowest of the seven identified by Mayfield et al. (1983). The greatest thickness reached by the thrust sheets of the Kelly River allochthon "is probably more than 2 km in the Wulik Peaks, and in the hills southeast of Cape Seppings." This allochthon thins and becomes more discontinuous east of Misheguk Mountain. Three sequences make up this allochthon: 1) the Amphitheater sequence, 2) the Kelly sequence, and 3) the Eli sequence.

On their cross-section "B" (the nearest one to the Squirrel River study area), Mayfield et al. (1983) show a section of the Brooks Range allochthon as a broad syncline thrust over the Schwatka Mountains province. Atop this, they show a thin layer of the Brooks Range and Kelly River allochthons, undifferentiated.

Folger and Schmidt (1986) identify some structural details near the Omar copper prospect in the Baird Mountains. Here, most units have a north-northeast to north-northwest strike; dips vary from about six degrees to vertical. The lower Ordovician platy-limestone unit commonly has tight to isoclinal folds which range from centimeter- to meter-scale. The axes of these folds commonly trend and plunge from four degrees to 20 degrees to the north. The more competent, massive limestone and dolostone commonly are brecciated and are rarely folded on a small scale.

GEOLOGIC HISTORY

Conflicts reign about the geologic history of the Brooks Range. Several researchers have offered interpretations, but no interpretation seems to satisfy a majority of the geologists who have studied northern Alaska. I'm sure the interpretation offered here would satisfy few, if any, and it certainly does not satisfy the author.

The Precambrian history for the area is rarely discussed in detail in the literature. What little I have found refers to the Precambrian protoliths (pre-metamorphic rock varieties) of some metamorphic rocks and to the possibly Precambrian granitic intrusive of the Brooks Range. In short summary, some of the metamorphic rocks in the western Brooks Range were probably Precambrian sedimentary, volcanic, volcaniclastic, plutonic, and metamorphic rocks. Little elaboration is available, and none is offered here.

The Lower Paleozoic carbonate and associated rocks identified by Dumoulin and Harris (1987) indicate deposition in a range of shallow, continental-shelf and near-continental-shelf environments. The Middle to Upper Cambrian carbonates identified near Mt. Angayukaqsraq (also called Hub Mountain), to the northeast of the area covered in this report, indicates deposition in shallow-water environments. The Lower and Middle Ordovician carbonates near Mt. Angayukaqsraq indicate deposition in cool-water, mid-shelf to basinal environments. The Lower Ordovician carbonates in the Omar and Squirrel Rivers area, however, indicates deposition in restricted- to normal-marine, shallow- to very-shallow-water platform environments. The Upper Devonian near Mt. Angayukaqsraq indicates deposition in warm, shallow water.

The Upper Silurian, in both the Mt. Angayukaqsraq and Squirrel River areas, was deposited in somewhat restricted, shallow-water environments. The carbonates of the Lower and Middle Devonian, in the Omar and Squirrel Rivers area, indicate a range of normal-marine-shelfal environments. The Middle and Upper Ordovician carbonates in the Nakolik River area indicate deposition in a tectonically active environment transitional between the Lower and Middle Ordovician shelf environment and the Upper Devonian clastics-dominated environments (Dumoulin and Harris, 1987).

The Upper Devonian Hunt Fork Shale and Kanayut Conglomerate indicate a major change in the depositional environment from shelfal-platform carbonates to clastic sedimentation in a shallow sea. These sediments were derived from an uplifted source terrain to the east and northeast (Nilsen et al., 1981). The Kayak Shale which indicates a decrease in clastic input from the source terrain and a deepening of waters in the western Brooks Range overlies these formations. Mayfield et al. (1983) inferred that the Devonian and Mississippian sedimentary sequences of the Brooks Range allochthons were deposited in an ensialic basin (a basin on continental crust) that had both northern and southern margins. During Pennsylvanian time, they call for the area to have formed part of a south-dipping continental shelf. This, they inferred, formed when a rifting or strike-slip tectonic process removed a land area that lay to the south.

In the early Jurassic, prior to the Brooks Range orogeny, this portion of northern Alaska probably formed an extensive continental shelf with oceanic conditions to the south (Mayfield et al., 1983). The Brooks Range orogeny began in the Middle Jurassic with the Arctic Alaska plate subducted beneath the oceanic crust to the south. Major thrusting ceased by Albian time. Great quantities of clastic detritus shed northward into the Colville trough and southward into the Koyukuk-Kobuk basin with epeirogenic uplift in the Brooks Range during the Middle and Late Cretaceous. Broad folds and reverse faults in Upper Cretaceous sediments north of the Brooks Range record a later period of less intense deformation during Late Cretaceous or Tertiary time. Since that time, the area has experienced mainly erosion with some sedimentation along steams and rivers and in some intermontane basins. The glacial and Quaternary history has little, if any, bearing on the potential for oil and gas and will not be discussed here.

OIL GEOLOGY

Reservoir Rocks

To serve as a reservoir, rock needs to have interconnected void space either in the form of porosity or fractures. Porosity can occur either as a primary feature of the rock or as a secondary feature created through weathering or diagenesis. Fractures occur as the rock undergoes brittle failure because of applied stresses. The metamorphic rocks of the Schwatka Mountains province could, if fractured, act as reservoir rocks for oil and/or gas. It is more likely, however, that the carbonate rocks would act as reservoirs for any oil and/or gas that may exist in the area. Carbonate rocks commonly serve as reservoirs in many areas of the world. The carbonates in the Squirrel River area are limestone and dolostone, both of which can form excellent petroleum reservoirs. Folger and Schmidt (1986) point out that the massive, competent carbonate beds tend to be brecciated; this would enhance the porosity and permeability of the carbonates if the brecciated zone does not have an infilling cement.

Source Rocks

Dumoulin and Harris (1987) examined conodonts of the carbonate rocks in the vicinity of the Squirrel River. They report that the rocks contain conodonts which have color alteration indices of 5 or greater. This indicates that these rocks have reached at least 300 deg C. Color alteration indices for conodont fossils, according to Schmidt and Folger (1987), indicate a temperature range of 300 to 450 deg C. According to Harris et al. (1987), the only areas in the Brooks Range that have thermal potential for hydrocarbons occur outside the Squirrel River area.

Schmidt and Folger (1987) report on the total organic carbon (TOC) and pyrolytic analysis of samples taken from all types of carbonate rocks within the area of the Omar copper prospect. These carbonate rocks include unmineralized Ordovician and Devonian dolostones, unmineralized Ordovician argillaceous limestone, and mineralized Devonian dolostone. They also analyzed two samples of organic blebs from within the mineralized zone. The carbonates have poor source rock potential as they have relatively low total organic carbon values. The unmineralized Ordovician dolostone and argillaceous limestone contain 0.07 to 0.15 weight percent carbon.

Unmineralized Devonian dolostone contain 0.19 to 0.22 weight percent carbon. Three samples from carbonates about eight kilometers from the Omar prospect had 0.06 to 0.14 weight percent carbon. The unmineralized Devonian dolostone have the lowest (0.05 weight percent) and the highest (0.73 weight percent) total organic carbon.

The S1 and S2 peak values obtained from pyrolysis measure the hydrocarbon yield of a rock. S1 measures free hydrocarbons distilled at temperatures of less than 300 deg C; S2 measures the additional hydrocarbons produced by further heating of the remaining kerogen in the rock. Productivity ratios (S1/S1+S2) for the Ordovician rocks (0.62-0.94, avg.=0.84) indicate that all rocks at the Omar prospect contain mainly free hydrocarbons. That is, they "have been heated beyond the thermal windows necessary for the production of oil (100-200 deg C) and gas (150-200 deg C)."

The organic blebs formed "late in the mineralization sequence and fill interstices within the dolostone breccia." They are found only within the mineralized zone at Omar and are always enclosed by vein-filling, hydrothermal dolomite or calcite. X-ray diffraction analysis of these blebs indicate that they have internal structure that nearly approaches crystalline graphite. Hydrothermal fluids associated with the mineralization carried the blebs, but later metamorphism transformed it into its near-graphite composition. Pyrolysis-derived Tmax values from seven samples range from 334 to 416 deg C. These values indicate a low greenschist metamorphic to glaucophane schist facies.

These measurements cited above indicate that all carbonate rocks within this area have been heated well beyond the temperatures necessary for the production of oil and gas. All hydrocarbons in the rocks are, in fact, overmature, and the area holds little potential for oil and gas.

GEOLOGIC POTENTIAL

We classify the Squirrel River area as having LOW (L) potential (Figure 3) for the existence of oil and gas resources at a certainity level of D (See appendix A). This classification is based on the metamorphic nature of the basement rock and the slight chance that it could serve as a potential reservoir. It also allows for the low probability that the carbonates in the area could serve as both reservoir and source rocks. Some portion of these carbonates could be rich in organic carbon and have a thermal maturity within the range which would have allowed the production and preservation of oil and gas.

ECONOMIC POTENTIAL

The geologic potential for oil and gas is so low in this area that we consider the area to have NO economic potential.

Additional information could possibly indicate an increase in both the geologic and economic potential. For instance, if unmetamorphosed sedimentary rocks underlie the metamorphic rocks, we would have to reconsider the geologic potential for the area. While this is possible, the currently available geologic information makes this prospect look highly doubtful.

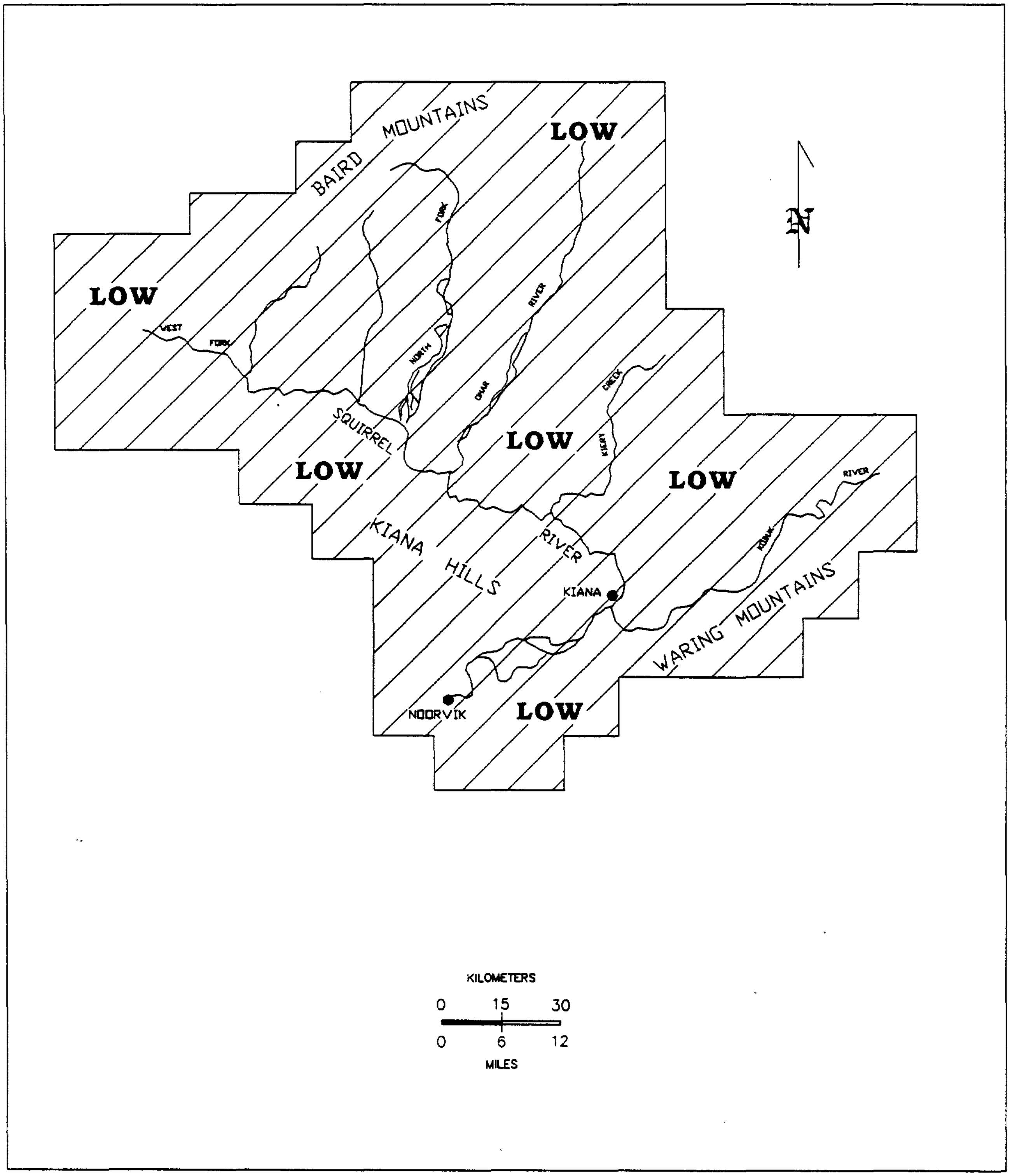


Figure 3. Geologic Potential for Oil and Gas in the Squirrel River Area

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APPENDIX A

3031 - Energy and Mineral Resource Assessment

Mineral Potential Classification System*

I. Level of Potential

- O. The geologic environment, the inferred geologic processes, and the lack of mineral occurrences do not indicate potential for accumulation of mineral resources.

- L. The geologic environment and the inferred geologic processes indicate low potential for accumulation of mineral resources.

- M. The geologic environment, the inferred geologic processes, and the reported mineral occurrences and/or valid geochemical/geophysical anomaly indicate moderate potential for accumulation of mineral resources.

- H. The geologic environment, the inferred geologic processes, the reported mineral occurrences and/or valid geochemical/geophysical anomaly, and the known mines or deposits indicate high potential for accumulation of mineral resources. The "known mines and deposits" do not have to be within the area that is being classified, but have to be within the same type of geologic environment.

- ND. Mineral(s) potential not determined due to lack of useful data. This notation does not require a level-of-certainty qualifier.

II. Level of Certainty

- A. The available data are insufficient and/or cannot be considered as direct or indirect evidence to support or refute the possible existence of mineral resources within the respective area.

- B. The available data provide indirect evidence to support or refute the possible existence of mineral resources.

- C. The available data provide direct evidence but are quantitatively minimal to support or refute the possible existence of mineral resources.

- D. The available data provide abundant direct and indirect evidence to support or refute the possible existence of mineral resources.

For the determination of No Potential, use O/D. This class shall be seldom used, and when used, it should be for a specific commodity only. For example, if the available data show that the surface and subsurface types of rock in the respective area is batholithic (igneous intrusive), one can conclude, with reasonable certainty, that the area does not have potential for coal.

* As used in this classification, potential refers to potential for the presence (occurrence) of a concentration of one or more energy and/or mineral resources. It does not refer to or imply potential for development and/or extraction of the mineral resource(s). It does not imply that the potential concentration is or may be economic, that is, could be extracted profitably.

Consideration of the Potential for Development and the Economic Potential

Whenever known, the quality, quantity, current, and projected development potential or economic potential should be part of the mineral resource assessment. Although this is not necessary or required for most BLM actions, it is often useful to the decision maker. Assessments of economic potential should not be attempted for actions requiring low levels of detail, or when data are scant.

Development potential means whether or not an occurrence or potential occurrence is likely to be explored or developed within a specified timespan under specified geologic and nongeologic assumptions and conditions. Economic potential means whether or not an occurrence or a potential occurrence is exploitable under current or foreseeable economic conditions. The time period applicable to the economic or development potential assessment should be specified in the assessment report (e.g., the occurrence is likely to be exploited within the next 25 years). Conditions that could change the economic potential, such as access, world energy prices, or changing technology, shall be an important part of every economic potential assessment. Determining the economic or development potential of either an actual or an undiscovered mineral occurrence is a matter of professional judgment based on an analysis of geologic and nongeologic factors. The rationale for that judgment shall be part of the Mineral Assessment Report, when the economic potential is assessed. The rationale may include data on the current marketing conditions for the mineral commodity, technological factors affecting exploitability, distance from roads, anticipated capital costs, etc. In other words, if the economic or development potential is assessed, the rationale for the conclusions regarding that potential must be thoroughly documented.

Calculating the quality of an occurrence, where the quality and quantity are not known from existing data, is only done for actions requiring a high level of detail. These calculations involve methods appropriate to the type of action and are described in the pertinent Bureau Manual (e.g., appraisal, validity, etc.).