UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Mineral Resource Potential of the Reservoir-North and the Deep Creek Roadless Areas, Teton County, Montana

By

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STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal lands to determine their mineral resource potential. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral and hydrocarbon resource potential survey of the Reservoir-North and Deep Creek Roadless Areas in the Lewis and Clark National Forest, Teton County, Montana. The Reservoir-North and Deep Creek Roadless Areas were classified as further planning areas during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

SUMMARY

The Deep Creek and Reservoir-North Roadless Areas in northwest Montana contain highly thrust faulted and folded sedimentary rocks that range from Cambrian to Early Cretaceous in age. The areas have a high potential for hydrocarbons and a low potential for metallic mineral resources. The areas contain high purity dolomite and high calcium limestone.

The roadless areas contain hydrocarbon source rocks, reservoir rocks, and structural traps. The thermal history of the area suggests that the potential for gas accumulation is greater than the potential for oil.

INTRODUCTION

The Deep Creek Roadless Area covers 43 mi^2 (111 km^2) and the Reservoir-North Roadless Area is 2.3 mi^2 (3.5 km^2). Both areas are in the Lewis and Clark National Forest, Teton County, Montana (fig. 1). The areas are north of Gibson Reservoir and are contiguous with the east boundary of the Bob Marshall Wilderness.

The study areas are in the central part of the rugged Sawtooth Range, the front range in northern Montana. Elevations range from about 5,100 ft (1,555 m) to about 7,800 ft (2,380 m).

PREVIOUS AND PRESENT INVESTIGATIONS

The geology of the Reservoir-North Roadless Area and most of the Deep Creek Roadless Area was mapped at a scale of 1:24,000 on the Arsenic Peak and Patricks Basin quadrangles (Mudge, 1966; 1967), and is discussed in detail by Mudge (1972a,b). The geology of adjoining areas to the west and north is discussed by Mudge and others (1978). The adjacent areas to the north and south of the study area were sampled and evaluated for their potential as hydrocarbon source rocks (Mudge and others, 1978).

This report consists of compilations from the Arsenic Peak and Patricks Basin quadrangles and of subsequent geological, geochemical, and geophysical studies of the mineral resources and hydrocarbon potential of the Bob Marshall Wilderness and proposed additions.

During the mineral survey of the Bob Marshall Wilderness and contiguous areas by the U.S. Bureau of Mines in 1971, 1973, 1974, and 1976 (Marks, 1978), the area designated Reservoir-North (RARE II No. HI-485) in January 1979 (U.S. Forest Service, 1979) was examined, along with other lands adjacent to the earlier study areas. However, the open-file report (U.S. Geological Survey and U.S. Bureau of Mines, 1978) covered only areas originally designated for study. The present report on Reservoir-North is based on earlier work. No work has been done in the area since 1976.

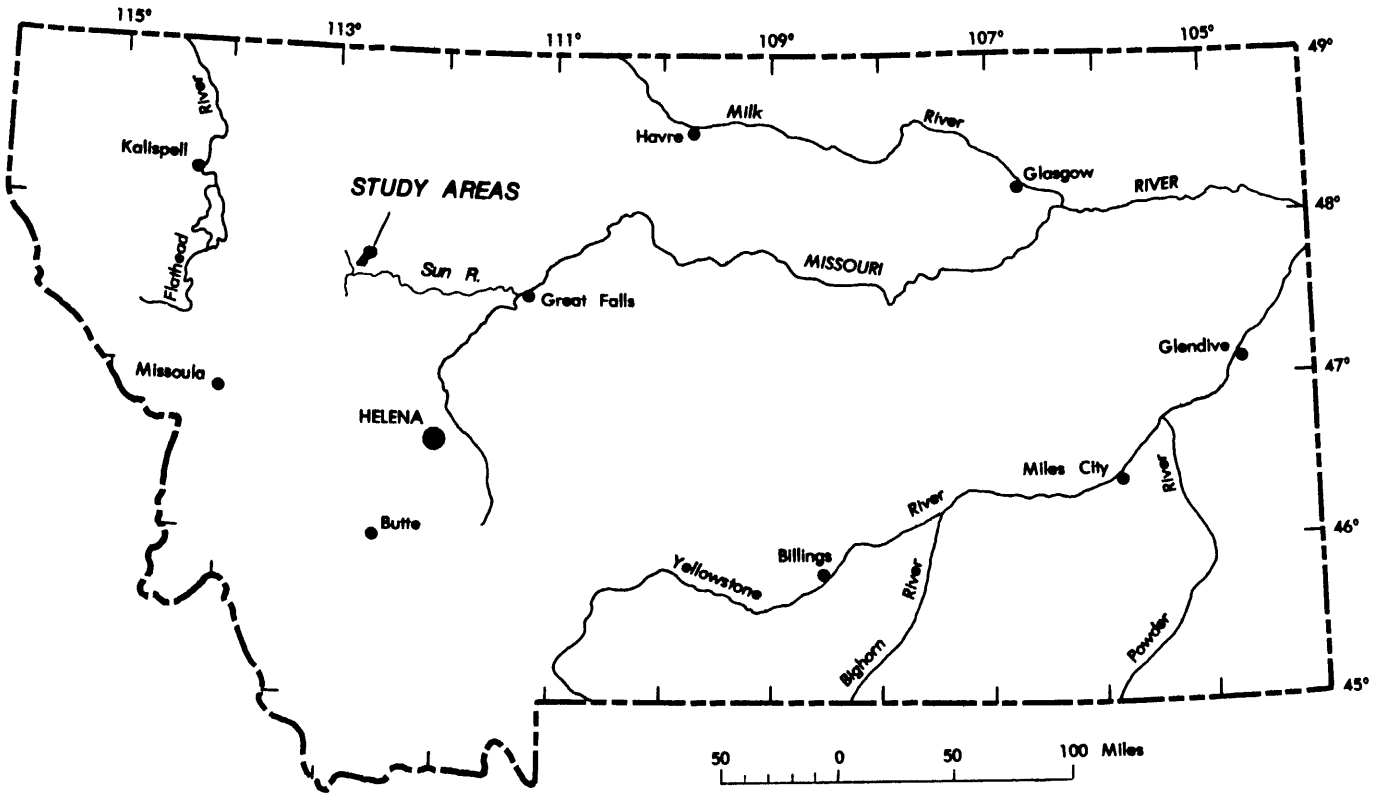

Figure 1.--Index map of Montana showing location of the Reservoir-North and the Deep Creek Roadless Areas.

GEOLOGY

The study areas are in the northern disturbed belt, a zone of northerly trending, closely spaced thrust faults and small associated folds. The rocks range in age from Cambrian to Late Cretaceous and consist mostly of limestone, dolomite, sandstone, and mudstone (fig. 2). The thrust faults and the rocks strike north and mostly dip to the west. The only igneous body in the area is a trachyandesite sill of Late Cretaceous or early Tertiary age that is exposed along the western boundary of the Reservoir-North Roadless Area. Descriptions of the rocks in the area are included in Mudge (1972a) and Mudge and others (1978), and are only briefly summarized here.

The oldest rocks in the study areas are Middle Cambrian in age, and are mostly dolomitic limestone with some dolomite, limestone, and shale. The uppermost Cambrian unit is a relatively pure dolomite that is 125 ft (38 m) thick. The rocks are exposed in a thrust plate in the southwestern part of the area (fig. 2). The total thickness of the exposed Cambrian rocks in the study area is about 950 ft (285 m); however, the base of the Cambrian section is not exposed.

Devonian rocks unconformably overlie the Cambrian strata in the western part of the area. They consist of limestone, dolomitic limestone, and dolomitic mudstone; limestone solution breccia, the Three Forks Formation, is at the top of the Devonian section. The total thickness of the Devonian sequence in these areas is about 1,400 ft (425 m).

Mississippian strata are widespread in the areas, but the only complete section is in the southwestern part of figure 2. They consist of limestone, dolomite, argillaceous dolomite, and shale; the total thickness is about 2,000 ft (610 m).

Rocks assigned to the Ellis Group of Jurassic age unconformably overlie the Mississippian strata. The Ellis Group consists of, from oldest to youngest, the Sawtooth, Rierdon, and Swift Formations, and is composed of sandstone, siltstone, shale, and claystone. The Ellis is about 700 ft (90 m) thick. The Ellis Group is unconformably overlain by the Morrison Formation, also of Jurassic age, which consists of very fine grained sandstone, claystone, and minor limestone of lacustrine origin and is about 400 ft (120 m) thick. The Morrison is overlain by the unnamed formation of Early Cretaceous age, which is composed of about 200 ft (60 m) of sandstone and conglomerate.

The Kootenai Formation of Early Cretaceous age lies unconformably on the unnamed formation. The Kootenai, which consists of mudstone, sandstone, and conglomeratic sandstone is about 1,000 ft (305 m) thick.

The Blackleaf Formation, the youngest formation in the area, overlies the Kootenai and crops out in the western part of figure 2. It is divided into three members in this area which are, from oldest to youngest, the Flood, Taft Hill, and Vaughn. The Blackleaf consists of sandstone, mudstone, and shale, and is as much as 600 ft (180 m) thick; the upper contact of the Blackleaf is not exposed. The Blackleaf is intruded by a Cretaceous or Tertiary trachyandesite sill that is about 550 ft (168 m) thick. The sill forms a prominent ridge that makes up the west boundary of the Reservoir-North Roadless Area.

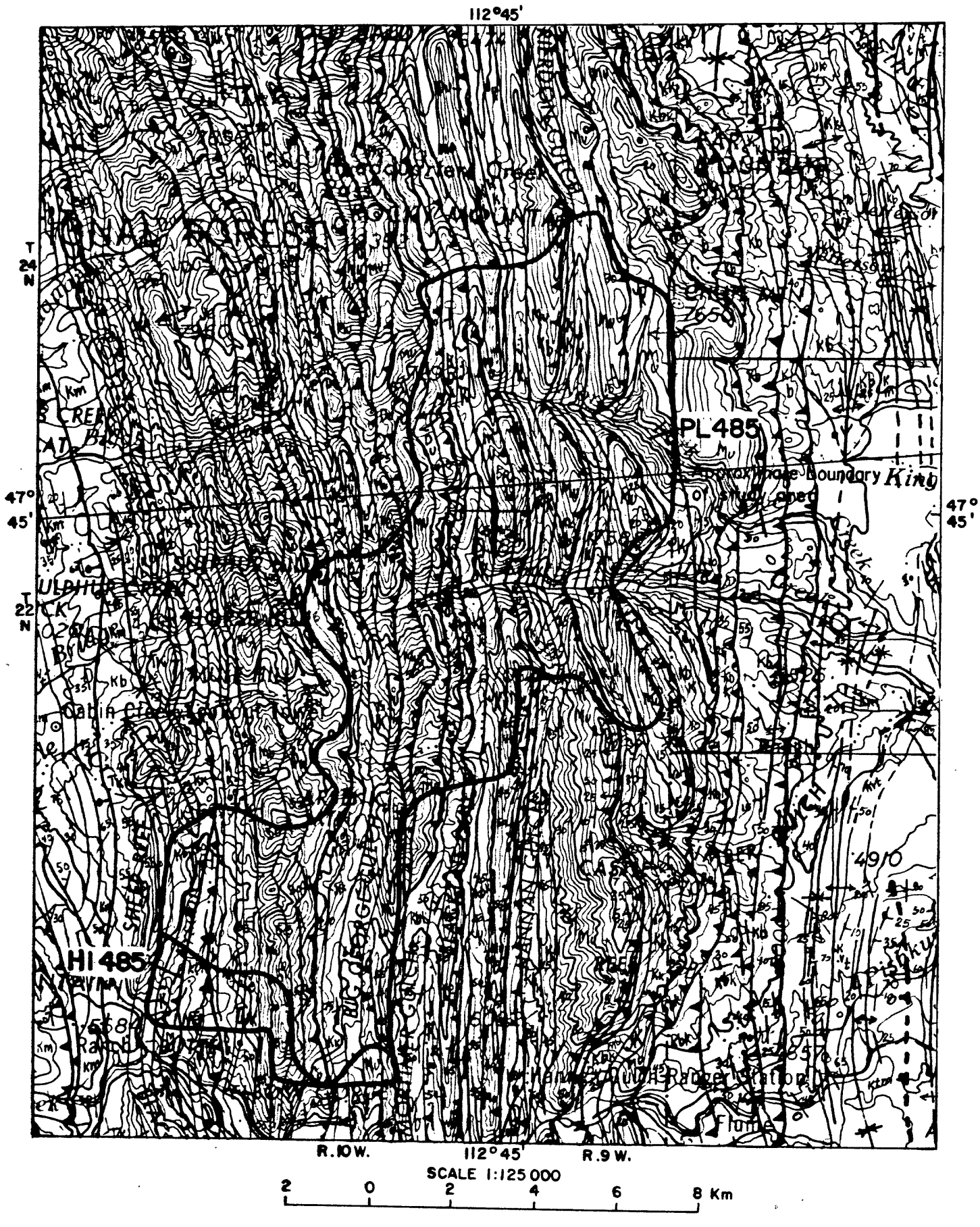

Figure 2.--Geologic map of the Reservoir-North Roadless Area (HI-485) and Deep Creek Roadless Area (PL-485), Lewis and Clark National Forest, Montana. Boundaries of roadless areas shown in heavy solid line.

CORRELATION OF MAP UNITS

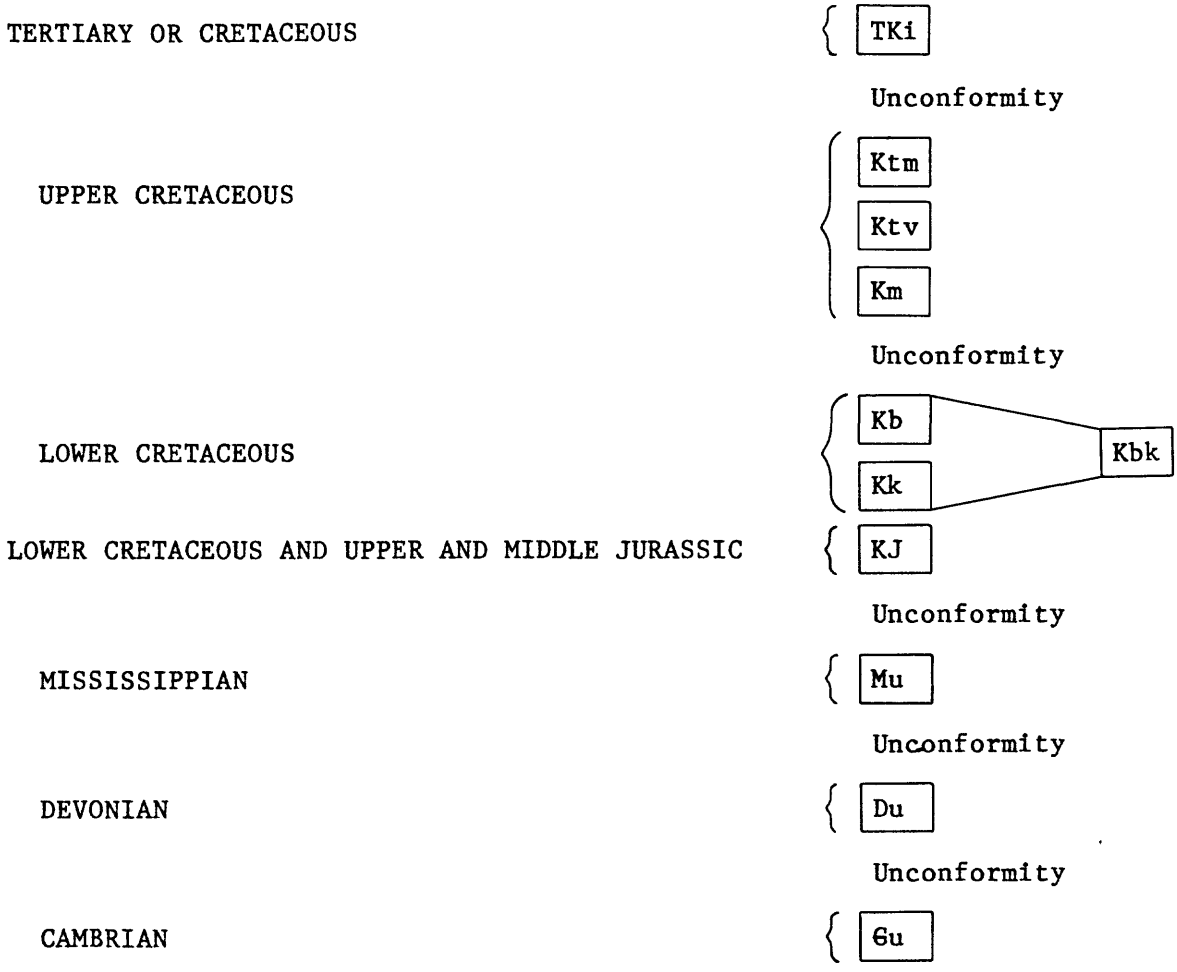

Figure 2.--Geologic map of the Reservoir-North Roadless Area (HI-485) and Deep Creek Roadless Area (PL-485), Lewis and Clark National Forest, Montana--Continued.

DESCRIPTION OF MAP UNITS

TKi TRACHYANDESITE (PALEOCENE OR UPPER CRETACEOUS)--Sills, dark-grayish-brown, aphanitic groundmass, phenocrysts of plagioclase, orthoclase, pyroxene, and quartz

Ktm TWO MEDICINE FORMATION (UPPER CRETACEOUS)--Gray-green to gray mudstone with interbeds of sandstone and conglomeratic sandstone, carbonaceous shale and coal in lower part. About 670 m thick

Ktv TWO MEDICINE FORMATION-VOLCANIC FACIES (UPPER CRETACEOUS)--Green, grayish-green, brownish-gray, and maroon volcanic flows, tuffs, sandstones, and conglomerate. Interbedded mudstone and sandstone of sedimentary origin. Ranges from 640 m to 1,500 m thick

Km MARIAS RIVER SHALE (UPPER CRETACEOUS)--Dark-gray mudstone with some thin sandstone beds; locally abundant thin bentonite beds; limy concretions locally. Ranges from 365 m to 395 m thick

Kb BLACKLEAF FORMATION (LOWER CRETACEOUS)--Light-gray, green-gray, and dark-gray sandstone, mudstone, and fissile shale. Some coal and carbonaceous shale in upper part. Ranges from 200 m to 490 m thick

Kk KOOTENAI FORMATION (LOWER CRETACEOUS)--Gray-green to dark-reddish-brown mudstone and sandstone; limestone nodules locally; thin coquinoid limestone near top. Ranges from 198 m to 245 m thick

Kbk BLACKLEAF AND KOOTENAI FORMATIONS UNDIVIDED

KJ LOWER CRETACEOUS AND JURASSIC ROCKS UNDIVIDED

Lower Cretaceous Mount Pablo Formation--Sandstone, mudstone, and some limestone

Upper Jurassic Morrison Formation--Grayish-green to olive-gray claystone and siltstone, and pink, maroon, purple, and yellowish-gray mudstone. Minor limestone in lower and middle parts

Upper and Middle Jurassic Ellis Group--Gray, gray-brown, yellowish-brown, and olive-drab sandstone, siltstone, and mudstone; some conglomerate in lower part. Ranges from 193 m to 314 m thick

Figure 2.--Geologic map of the Reservoir-North Roadless Area (HI-485) and Deep Creek Roadless Area (PL-485), Lewis and Clark National Forest, Montana--Continued.

Mu MISSISSIPPIAN ROCKS UNDIVIDED--Light-gray to gray dolomite and limestone. Highly fossiliferous, locally cherty; includes dark-gray mudstone in lower part. Ranges from 275 m to 520 m thick

Du DEVONIAN ROCKS UNDIVIDED--Gray, brownish-gray to pale-yellowish-brown limestone, dolomite, and dolomitic mudstone. Limestone solution breccia in upper part. Ranges from 300 m to 458 m thick

Ꞓu CAMBRIAN ROCKS UNDIVIDED--Light-gray, gray, and greenish-gray dolomite, limestone, and shale; coarse-grained, poorly sorted sandstone at base. Ranges from 439 m to 681 m thick

Figure 2.--Geologic map of the Reservoir-North Roadless Area (HI-485) and Deep Creek Roadless Area (PL-485), Lewis and Clark National Forest, Montana--Continued.

EXPLANATION OF MAP SYMBOLS

CONTACT

FAULT--Ball and bar on downthrown side

THRUST FAULT--Showing direction and amount of dip. Sawteeth on upper plate. Dashed where approximately located

SYNCLINE--Dashed where approximately located

ANTICLINE--Dashed where approximately located

OVERTURNED SYNCLINE--Showing direction of dip of limbs

25 STRIKE AND DIP OF BEDS

DRY HOLE--Abandoned

Figure 2.--Geologic map of the Reservoir-North Roadless Area (HI-485) and Deep Creek Roadless Area (PL-485), Lewis and Clark National Forest, Montana--Continued.

HYDROCARBON AND MINERAL RESOURCES

The study area has a high potential for hydrocarbons and a low potential for metallic mineral resources. The area contains high purity dolomite (greater than 40 percent $MgCO_3$) and high calcium limestone (greater than 95 percent $CaCO_3$).

Mining claims, mines, or prospects are not known in the area. Conditions in the study area do not appear favorable for metallic mineral deposits. The only metallic mineral that occurs in anomalous concentrations in the study areas is molybdenum. Rocks and stream sediments collected in and near the study areas were analyzed spectrographically for 30 elements (Earhart, 1978). Anomalous molybdenum is in samples collected in the upper reaches of the South Fork Deep Creek. The molybdenum occurs in very small iron-rich nodules along an unconformity between the Mississippian and Jurassic rocks. The occurrences are small and of too low grade to be of economic importance. Sand and gravel, limestone, dolomite, and sandstone suitable for construction materials do occur, but deposits of equal or better quality are available closer to major markets.

The study areas contain hydrocarbon source rocks, reservoir rocks, and structural traps favorable for the accumulation of hydrocarbons (Mudge and others, 1978). Rocks equivalent to those in the area were sampled near the boundaries to the north and south of the Reservoir-North Roadless Area, and also from within the Deep Creek Roadless Area to the north (fig. 3). These samples were analyzed for organic carbon and pyrolitic hydrocarbon yield (table 1). The results indicate that most of the samples have organic carbon content well in excess of 0.4 percent and thus are potential source rocks. Other analyses listed on table 1 indicate that most of the potential source rocks have a thermal history of generating gas rather than oil (Mudge and others, 1978).

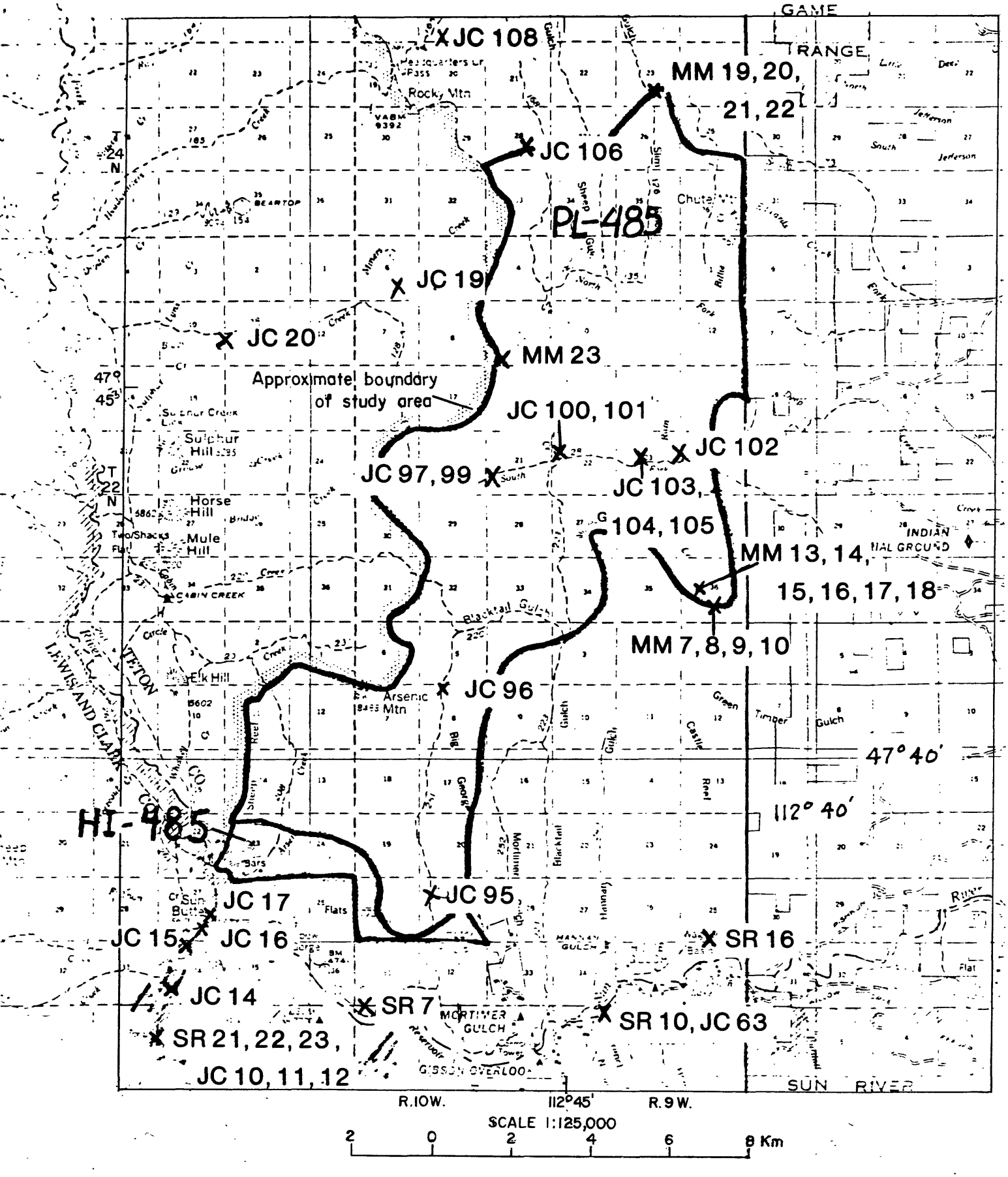

Figure 3.--Hydrocarbon source-rock sample localities in and adjacent to the Reservoir-North Roadless Area (HI-485) and Deep Creek Roadless Area (PL-485). See table 1 for analyses of samples.

Table 1. Analytical results of organic carbon and pyrolitic hydrocarbon yield, and temperatures of pyrolysis yield of rock samples from near the Reservoir-North Roadless Area and from in and near the Deep Creek Roadless Area

[--, no data; ~, about; Fm., formation; Mbr., member]

Sample number	Sample interval in feet	Organic carbon wt. pct.	Pyrolitic hydrocarbon yield, wt. pct.	Volatile hydrocarbon content in ppm	Pyrolitic hydrocarbon organic carbon, pct.	Temperature of maximum pyrolysis yield, °C
UPPER CRETACEOUS MARIAS RIVER SHALE[1]						
Kevin Member						
JC-14	Grab	1.43	0.21	147	14.4	472
SR-23	Lower 50	1.18-1.20	0.18	170	14.8	484
Ferdig Member						
JC-12	Grab	0.67	0.04	29.3	5.6	492
SR-22	Lower 100	0.78-1.31	0.056	73	5.9	487
Cone Member						
JC-10	Grab	2.36	0.68	470.2	28.9	484
JC-11	Grab	3.39	1.21	1123.5	35.8	464
JC-15	Grab	3.05	1.03	1074.8	33.6	472
SR-21	Entire Mbr.	1.28-3.96	1.50	1960	37.9	480
LOWER CRETACEOUS BLACKLEAF FORMATION						
Vaughn Member						
JC-16	Grab	0.61	0.04	34.8	6.6	500
Taft Hill Member						
MM-16	50	0.93	0.027	55	3.0	--
MM-17	15	0.96	0.026	39	2.8	512
Flood Member						
MM-13	40	1.16	0.045	93	3.9	504
MM-14	65	0.95	0.036	73	3.9	504
MM-15	15	0.33	0.022	41	6.7	502
JC-63	Grab	1.43	0.08	22.9	5.8	494
JC-96	Grab	1.93	30.0	76	15.8	485
JC-102	Grab	1.52	0.11	108	7.6	517
SR-10	Grab	1.68	0.079	15	4.7	496
LOWER CRETACEOUS KOOTENAI FORMATION						
MM-18	Grab	0.55	0.023	34	4.3	508
UPPER JURASSIC SWIFT FORMATION						
MM-10	40	0.80	0.054	69	6.8	506
MM-22	40	0.69	0.023	28	3.4	540
JC-101	Grab	1.52	0.11	108	7.6	517
UPPER JURASSIC RIERDON FORMATION						
MM-8	Lower 55	0.32	0.018	29	4.4	504
MM-9	Upper 55	0.23	0.017	40	7.7	504
MM-21	Entire Fm.	0.22	0.011	26	5.3	520
JC-17	Grab	0.19	0.01	7.6	5.2	487
JC-19	Grab	0.27	0.01	13.8	4.8	500
JC-20	Grab	0.10	0.005	10.9	5.9	~500
JC-95	Grab	0.27	0.01	28	5.0	500
JC-100	Grab	0.41	0.04	74	8.8	499
JC-106	Grab	0.37	0.01	28	3.3	~520
SR-16	Entire Fm.	0.13-0.15	0.016	19	3.6	505
MIDDLE JURASSIC SHALE MEMBER, SAWTOOTH FORMATION						
MM-7	Entire Mbr.	0.31	0.021	43	7.3	502
MM-19	Lower 50	0.61	0.017	39	2.9	520
MM-20	Upper 10	0.39	0.022	71	5.8	500
JC-103	Grab	0.67	0.02	46	3.8	520
JC-104	Grab	0.56	0.02	27	2.8	550
JC-105	Grab	0.84	0.01	27	1.1	560
LOWER MISSISSIPPIAN LOWER MEMBER, ALLAN MOUNTAIN LIMESTONE						
MM-23	Lower 50	1.08	0.019	24	1.8	558
JC-97	Grab	1.03	0.02	31	2.1	~600
JC-108	Grab	0.87	0.01	30	1.1	--
SR-7	50	0.18-0.45	0.028	65	6.3	502
DEVONIAN THREE FORKS FORMATION						
JC-99	Grab	0.01	0.01	25	99.3	420

[1]Does not crop out in the study areas, but is present in the adjacent area to the east and could have contributed hydrocarbons to reservoir rocks in the study areas.

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