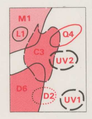
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

BULLETIN 1580
PLATE 3

EXPLANATION



Areas having mineral resource potential—Boundaries are dashed or dotted where necessary to show limits of overlapping areas. Areas are labeled by letter and number corresponding to entries in table 3, this plate. Where two or more overlapping areas have different levels of potential, the overlapping area is colored to show the highest potential determined.

In the example at left, C3 is an area of high mineral resource potential that is overlapped by Q4, an area of low potential, and by UV2, an area of unknown potential. Area M1, which has moderate potential, overlaps area C3 and also contains an area of low potential, L1. Area D6, which has high potential, overlaps C3 and is overlapped by area D2, which has low potential. Area UV1 is an area of unknown potential.

The map must be used together with table 3 to correctly interpret the potential of overlapping areas. An asterisk next to an area symbol on the map means that some mineral resource potential of the smaller area coincides with some mineral resource potential of the surrounding area.

OG6 — High mineral resource potential

CO2 — Moderate mineral resource potential

CO1 — Low mineral resource potential

Oil and gas well—Total depth, in feet, and unit at bottom of hole shown where known. Depth and unit queried where uncertain. Where more than one depth is given for a well, the greatest depth given is the total depth, and the other depth is for the top of the given unit. For some wells, the map shows units encountered in a well other than the bottom-hole unit. Wells are not all shown separately in outlined, named oil and gas fields, but symbols for producing units are given in parentheses

● Mp 3,300 — **Producing well**

○ Kik 2,405 — **Dry test well**

List of rock units shown at well locations

Kp **Pierre Shale (Cretaceous)**
Kn **Niobrara Formation (Cretaceous)**
Kb **Belle Fourche Shale (Cretaceous)**
Km **Mowry Shale (Cretaceous)**
Kt **Thermopolis Shale (Cretaceous)**
Knc **Newcastle Sandstone (Cretaceous)**
Ksc **Skull Creek Shale (Cretaceous)**
Kik **Inyan Kara Group (Cretaceous)**
Kmd **Mowry Shale and Dakota Sandstone (Cretaceous)**
Jm **Morrison Formation (Jurassic)**
Js **Sundance Formation (Jurassic)**
TrPs **Spearfish Formation (Triassic-Permian)**
Pm **Minnekahta Limestone (Permian)**
PPm **Minnelusa Formation (Permian-Pennsylvanian)**
Mp **Pahasapa Limestone (Mississippian)**
Ow **Winnipeg Formation (Ordovician)**
Cd **Deadwood Formation (Cambrian)**
pЄ **Undivided Precambrian rocks**

Sources of well data

South Dakota:

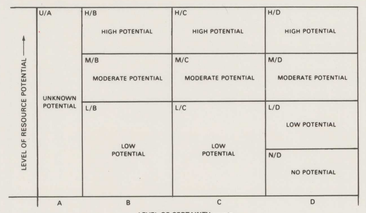
South Dakota Geological Survey, 1984: South Dakota Geological Survey Oil and Gas Tests [unnumbered series of county maps available as blueline prints from the South Dakota Geological Survey, Western Field Office, 36 East Chicago, Rapid City, SD 57701; updated periodically], scale 1 in. equals 2 mi

1. Butte County Oil and Gas Tests
2. Custer County Oil and Gas Tests
3. Fall River County Oil and Gas Tests
4. Meade County Oil and Gas Tests
5. Pennington County Oil and Gas Tests

Wyoming:

Petroleum Information Corp., 1984, Wyoming structure contour map (northeastern quadrant): Denver, Colo., Petroleum Information Corp., pl. 1 of 4, scale 1:250,000.

Stephenson, T. R., VerPloeg, A. J., and Chamberlain, L. S., 1984, Oil and gas map of Wyoming: Geological Survey of Wyoming Map Series 12, scale 1:500,000.



RELATIONSHIPS BETWEEN LEVELS OF RESOURCE POTENTIAL AND LEVELS OF CERTAINTY

Levels of resource potential

H **High mineral resource potential**
M **Moderate mineral resource potential**
L **Low mineral resource potential**
U **Unknown mineral resource potential**

Levels of certainty

D **Data define geologic environment and level of resource potential and indicate resource-forming processes in all or part of the area**
C **Data partially define geologic environment and indicate a resource potential and indicate resource-forming process in some of the area**
B **Data partially define geologic environment and suggest level of resource potential**
A **Available data not adequate for evaluation of resource potential**

TYPES OF DEPOSITS

OG Oil and gas deposits in Phanerozoic rocks: stratabound deposits formed in marine environment about 100-400 Ma when organic remains were modified into kerogen and petroleum-related substances.

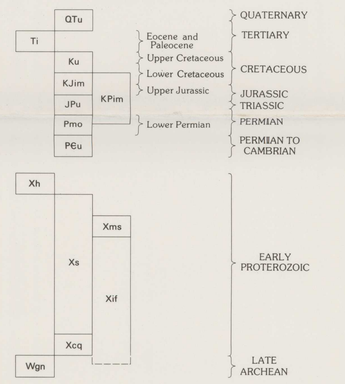
CO Coal deposits in Phanerozoic rocks: stratabound deposits formed in fresh-water environment about 100-150 Ma when organic remains were modified into carbon-rich sedimentary rocks.

GE Geothermal deposits: thermal springs formed in terrestrial environment at the present time when groundwaters are heated at depth and returned to the surface.

COMMODITIES PRESENT IN THE BLACK HILLS NATIONAL FOREST

Oil and gas
Subbituminous coal
Geothermal or hot water

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

QTu **Unconsolidated and surficial deposits (Quaternary and Tertiary —** Includes map units Qu and Tw from plate 1 and terrace gravel and windblown sand not shown on plate 1: Quaternary alluvium, Oligocene White River Group, including some Brule Formation, and some Miocene Ogalalla Formation

Ti **Intrusive rocks (Eocene and Paleocene)—**Includes map units Tq and Tn from plate 1: stocks, laccoliths, plugs, sills, and volcanic pipes composed of rhyolite, latite, trachyte, phonolite, and a variety of minor rock types

Ku **Undivided sedimentary rocks (Upper and Lower Cretaceous)—**Includes seven map units from plate 1: Lance Formation (Kl), Fox Hills Sandstone (Kfh), Pierre Shale (Kp); Niobrara Formation, Carlile Shale, and Greenhorn Limestone (Kng); Belle Fourche Shale (Kb); Mowry Shale, Newcastle Sandstone, and Skull Creek Shale (Kms); and Belle Fourche to Skull Creek Shales (Kbs)

KJim **Inyan Kara Group (Lower Cretaceous), and Morrison Formation and Unkpapa Sandstone (Upper Jurassic)**

KPim **Inyan Kara Group (Lower Cretaceous), Morrison Formation and Unkpapa Sandstone (Upper Jurassic), Sundance Formation (Upper and Middle Jurassic), Gypsum Spring Formation (Middle Jurassic), Spearfish Formation (Triassic and Permian), and Minnekahta Limestone (Lower Permian)**

JPu **Undivided sedimentary rocks (Jurassic, Triassic, and Permian)—**Includes two map units from plate 1: Sundance Formation and Gypsum Spring Formation (Jsg), and Spearfish Formation (TrPs)

Pmo **Minnekahta Limestone and Opeche Shale (Lower Permian)**

PEu **Undivided sedimentary rocks (Permian, Pennsylvanian, Mississippian, Devonian, Ordovician, and Cambrian** — Includes three map units from plate 1: Minnelusa Formation (PPm); Pahasapa Limestone and Englewood Formation (MDpe); and Whitewood Dolomite, Winnipeg Formation, and Deadwood Formation (OCwd)

Xh **Harney Peak Granite (Early Proterozoic)**

Xs **Undivided metasedimentary and metavolcanic rocks (Early Proterozoic)—**Includes map units Xsh, Xgw, Xbs, Xcg, Xgb, Xb, Xsi, Xsc, Xq, Xd, and Xc from plate 1. Unit is predominantly metasedimentary rock composed of mica schist, slate, phyllite, quartzite, and graywacke. Metavolcanic rocks include metamorphosed basalt and gabbro. Comprises parts of the Estes Formation, Poorman Formation, Roberts Draw Formation, Ellison Formation, Buck Mountain Formation, Moonshine Gulch Quartzite, Gingrass Draw Slate, Reausaw Slate, Poverty Gulch Slate, Nahant Schist, Irish Gulch Slate, Northwestern Formation, Flag Rock Formation, Hay Creek Greenstone, Rapid Creek Greenstone, Crow Formation, Vanderlehr formation, Loues Formation, Oreville Formation, Roubaix Formation, Mayo Formation, Bugtown Formation, Swede Gulch Formation, and many unnamed rock units

Xms **Metasedimentary rocks (Early Proterozoic)—**Muscovite schist and muscovite phyllite. Includes part of the Oreville Formation and unnamed muscovite schist

Xif **Iron-formation (Early Proterozoic and Late Archean?)** —Iron-formation and ferruginous chert. Includes the Homestake Formation, Rockford Formation, Montana Mine Formation, Nemo Iron-formation, Benchmark Iron-formation, and unnamed iron-formations

Xcq **Metaconglomerate and metaquartzite (Early Proterozoic)—**Conglomeratic and feldspathic schist, biotite schist, taconite conglomerate, conglomerate and phyllite. Includes the Boxelder Creek Formation

Wgn **Gneiss and granite (Late Archean)—**Granite, feldspathic gneiss, and mica schist. Includes map units Wgr and Wos from plate 1: Little Elk Granite and unnamed igneous and metasedimentary units

Table 3. Description of areas having mineral resource potential for leasable resources in and adjacent to the Black Hills National Forest

[Level of potential/level of certainty explained in schematic diagram, this plate; where variable sizes of deposits are shown, the most probable size is listed first]

Map area	Resource potential	Level of potential/ level of certainty	Commodities (by-products)	Size, type of deposit
CO1	Low-------	L/C	Subbituminous coal----	Small, bedded sedimentary.
CO2	Moderate--	M/D	Subbituminous coal----	Small, bedded sedimentary.
OG1	Moderate--	M/C	Oil and gas----------	Medium-large, stratabound.
OG2	Moderate--	M/D	Oil and gas----------	Small, stratabound.
OG3	Low-------	L/B	Oil and gas----------	Small-medium, stratabound.
OG4	Moderate--	M/C	Oil and gas----------	Small, stratabound.
OG5	Moderate--	M/B	Oil and gas----------	Large, stratabound.
OG6	High------	H/D	Oil and gas----------	Large, stratabound.
OG7	High------	H/D	Oil and gas----------	Small, stratabound.
OG8	Moderate--	M/D	Oil and gas----------	Medium, stratabound.
GE1	Low-------	L/D	Geothermal water------	Small, water.

Base from U.S. Geological Survey Gillette, 1955 (revised 1975); Hot Springs, 1955 (revised 1978); Newcastle, 1955 (revised 1975); Rapid City, 1953 (revised 1978)

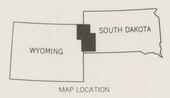
SCALE 1:250,000

5 0 5 10 MILES

5 0 5 10 KILOMETERS

NATIONAL GEODETIC VERTICAL DATUM OF 1929

1986 MAGNETIC DECLINATION FOR THIS SHEET VARIES FROM 11°00' EASTERLY IN THE SOUTHEASTERN CORNER TO 12°00' EASTERLY IN THE NORTHWESTERN CORNER. MEAN ANNUAL CHANGE IS 0°08.5' WESTERLY.



MAP LOCATION

Mineral resource data compiled by Ed DeWitt and J.A. Redden, 1985. Geology compiled by Ed DeWitt, Anna Burack Wilson, David Buscher and J.A. Redden, 1985. Oil and gas well data compiled by David Buscher, 1985

Contact—Dashed where approximately located

Fault—Dashed where approximately located; dotted where concealed. Bar and ball on downthrown side. Arrows show sense of displacement

Anticline—Dotted where concealed; arrow shows direction of plunge

Syncline—Dotted where concealed

Monocline—Axis located on steepest part of structure

Dome

MINERAL RESOURCE POTENTIAL MAP SHOWING LEASABLE COMMODITIES IN THE BLACK HILLS NATIONAL FOREST AND ADJACENT AREA, SOUTH DAKOTA AND WYOMING