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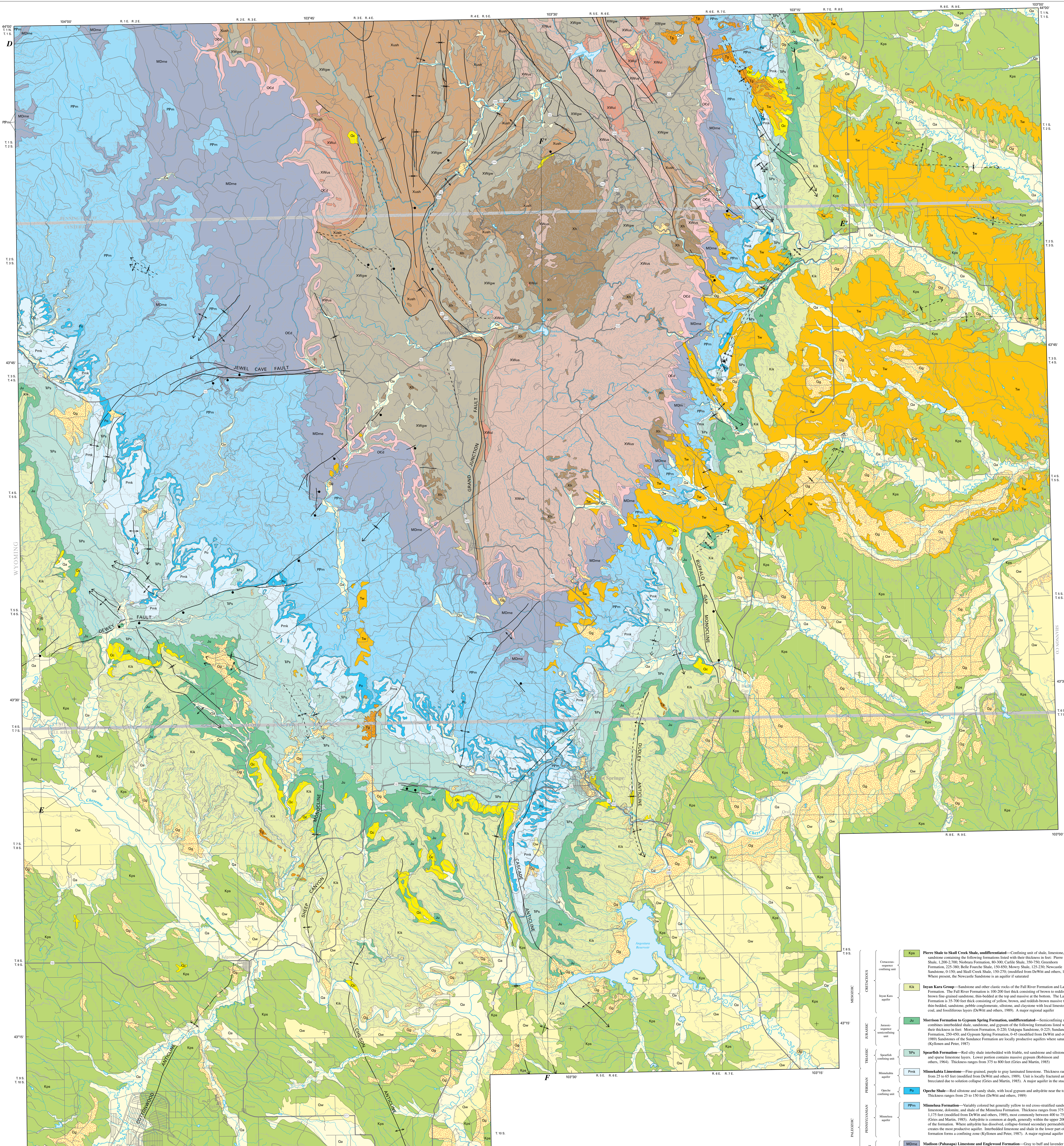
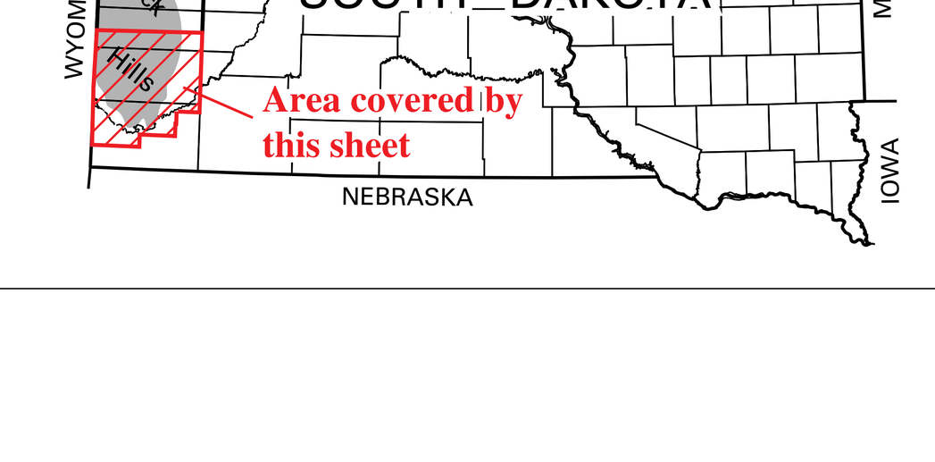
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
SOUTH DAKOTA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
AND THE WEST DAKOTA WATER DEVELOPMENT DISTRICT

HYDROLOGIC INVESTIGATIONS ATLAS HA-743
Southern part of area —SHEET 2 OF 3
Strobel, M.L., Jarrell, G.J., Sawyer, J.F., Schleicher, J.R., Fahrenbach, M.D., 1999,
Distribution of Hydrogeologic Units in the Black Hills Area, South Dakota



Planimetric base from U.S. Geological Survey digital data 1:100,000, Hot Springs, 1985; Lance Creek, 1981; Mt. Rushmore, 1977; Newcastle, 1979
Topographic base modified from U.S. Geological Survey digital data, 1:24,000, from maps dated 1950-84
Universal Transverse Mercator projection
Zone 13
North American Horizontal Datum 1927



EXPLANATION

Fault—Dashed where approximated, dotted where concealed. Bar and ball on downthrown side

Anticline—Showing trace of axial plane and direction of plunge. Dashed where approximated, dotted where concealed

Syncline—Showing trace of axial plane and direction of plunge. Dashed where approximated, dotted where concealed

Monocline—Showing trace of axial plane. Dashed where approximated, dotted where concealed

Dome—Symbol size approximately proportional to size of dome. Dome asymmetry indicated by arrow length

DESCRIPTION OF UNITS

Erathem	System	Hydrogeologic Units	Stratigraphic Units	Description
CENOZOIC	QUATERNARY	Unconsolidated units	Qa	**Alluvium**—Moderately to well-sorted clay, silt, sand, and gravel deposited by streams. Thickness ranges from 0 to 50 feet (DeWitt and others, 1989). A local aquifer where saturated
			Qc	**Colluvium**—Poorly to well-sorted, massive to stratified, clast-free to boulder rubble and talus produced by mass wasting. Thickness ranges from 0 to 50 feet (DeWitt and others, 1989). The hydrogeologic character of colluvial material varies considerably depending on the degree of sorting, and primary type material. Generally not an aquifer even if saturated
			Qg	**Gravel deposits**—Moderately sorted, heterogeneous, generally stratified, clay, silt, sand, and well-rounded gravel of paleochannels, pediments, and stream terraces along former flood plains. Three Quaternary terraces are identifiable in the northern portion of the study area and between six and eight terraces in the southern portion (Kempton and Laury, 1994). Thickness ranges from 0 to 60 feet thick (DeWitt and others, 1989). A local aquifer where saturated
			Qw	**Wind-blown deposits**—Moderately to well-sorted, poorly to well-stratified, well-rounded, commonly calcareous, and frosted silt and fine to medium-grained sand. Thickness ranges from 0 to 50 feet thick (DeWitt and others, 1989). A local aquifer where saturated
	TERTIARY		Tg	**Gravel deposits**—Heterogeneous gravel deposits derived primarily from igneous and metamorphic rocks of the central Black Hills. Clast size is dominantly pebble or cobble, but ranges from clay to boulder. Thickness ranges from 0 to 30 feet (J.F. Sawyer and J.E. Martin, South Dakota Geological Survey, written commun., 1997). A local aquifer where saturated
		White River aquifer	Tw	**White River Group**—Consists of the Brule and Chadron Formations. Sandstone, claystone, and siltstone with channel fillings and limestone lenses (Rahn, 1985). Thickness ranges from 0 to 300 feet (DeWitt and others, 1989). A minor aquifer where saturated
		Tertiary intrusive units	Tui	**Undifferentiated shallow intrusive igneous rocks**—Includes rhyolite, latite, trachyte, and phonolite (see DeWitt and others, 1989, for a more thorough description). The hydrogeologic characteristics of these rocks vary with the degree of fracturing
MESOZOIC	CRETACEOUS	Cretaceous-sequence confining unit	Kps	**Pierre Shale to Skull Creek Shale, undifferentiated**—Confining unit of shale, limestone, and sandstone containing the following formations listed with their thickness in feet: Pierre Shale, 1,200-2,700; Niobrara Formation, 80-300; Carlile Shale, 350-750; Greenhorn Formation, 225-380; Belle Fourche Shale, 150-850; Mowry Shale, 125-230; Newcastle Sandstone, 0-150; and Skull Creek Shale, 150-270; (modified from DeWitt and others, 1989). Where present, the Newcastle Sandstone is an aquifer if saturated
		Inyan Kara aquifer	Kik	**Inyan Kara Group**—Sandstone and other clastic rocks of the Fall River Formation and Lakota Formation. The Fall River Formation is 100-200 feet thick consisting of brown to reddish-brown fine-grained sandstone, thin-bedded at the top and massive at the bottom. The Lakota Formation is 35-700 feet thick consisting of yellow, brown, and reddish-brown massive to thin-bedded, sandstone, pebble conglomerate, siltstone, and claystone with local limestone, coal, and fossiliferous layers (DeWitt and others, 1989). A major regional aquifer
	JURASSIC	Jurassic-sequence semiconfining unit	Ju	**Morrison Formation to Gypsum Spring Formation, undifferentiated**—Semiconfining unit combines interbedded shale, sandstone, and gypsum of the following formations listed with their thickness in feet: Morrison Formation, 0-220; Unkpapa Sandstone, 0-225; Sundance Formation, 250-450; and Gypsum Spring Formation, 0-45 (modified from DeWitt and others, 1989) Sandstones of the Sundance Formation are locally productive aquifers where saturated (Kyllonen and Peter, 1987)
	TRIASSIC	Spearfish confining unit	ŦPs	**Spearfish Formation**—Red silty shale interbedded with friable, red sandstone and siltstone, and sparse limestone layers. Lower portion contains massive gypsum (Robinson and others, 1964). Thickness ranges from 375 to 800 feet (Gries and Martin, 1985)
PALEOZOIC	PERMIAN	Minnekahta aquifer	Pmk	**Minnekahta Limestone**—Fine-grained, purple to gray laminated limestone. Thickness ranges from 25 to 65 feet (modified from DeWitt and others, 1989). Unit is locally fractured and brecciated due to solution collapse (Gries and Martin, 1985). A major aquifer in the study area
		Opeche confining unit	Po	**Opeche Shale**—Red siltstone and sandy shale, with local gypsum and anhydrite near the top. Thickness ranges from 25 to 150 feet (DeWitt and others, 1989)
	PENNSYLVANIAN	Minnelusa aquifer	PIPm	**Minnelusa Formation**—Variably colored but generally yellow to red cross-stratified sandstone, limestone, dolomite, and shale of the Minnelusa Formation. Thickness ranges from 375 to 1,175 feet (modified from DeWitt and others, 1989), most commonly between 400 to 750 feet (Gries and Martin, 1985). Anhydrite is common at depth, generally within the upper 200 feet of the formation. Where anhydrite has dissolved, collapse-formed secondary permeability creates the most productive aquifer. Interbedded limestone and shale in the lower part of the formation forms a confining zone (Kyllonen and Peter, 1987). A major regional aquifer
	MISSISSIPPIAN AND DEVONIAN	Madison aquifer	MDme	**Madison (Pahasapa) Limestone and Englewood Formation**—Gray to buff and lavender limestone that is locally dolomitic. The Madison Limestone is 250 to 1,000 feet thick, and the Englewood Formation is 30 to 60 feet thick (modified from DeWitt and others, 1989). Generally massive, upper third is karstic with caves, solution collapse and enlarged conduits resulting in extensive secondary permeability and creating the potentially most productive aquifer in the Black Hills (Kyllonen and Peter, 1987). The lower portion of the Madison Limestone and the Englewood Formation form a lower confining zone (Greene, 1993). A major regional aquifer
	ORDOVICIAN AND CAMBRIAN	Ordovician-sequence semiconfining unit	Ou	**Whitewood Formation and Winnipeg Formation**—Undifferentiated semiconfining unit consists of limestone and dolomite of the Whitewood Formation, thickness ranges from 0 to 235 feet, and shale with interbedded siltstone of the Winnipeg Formation, thickness ranges from 0 to 150 feet (modified from DeWitt and others, 1989). The unit is found in the northern and western portion of the study area
		Deadwood aquifer	OЄd	**Deadwood Formation**—Brown to light-gray glauconitic sandstone, shale, limestone, and local basal conglomerate. Thickness ranges from 0 to 500 feet (modified from DeWitt and others, 1989). A major aquifer in the study area
EARLY PROTEROZOIC		Precambrian igneous and metamorphic units	Xh	**Harney Peak Granite**—Pink and tan coarse-grained and pegmatitic muscovite granite. Characterized geochemically from other granites in the area by high concentrations of boron, beryllium, lithium, and uranium (DeWitt and others, 1989)
			Xush	**Undifferentiated metamorphosed phyllite and schist**—Locally carbonaceous and tuffaceous. Geochemical and geophysical signatures vary with the tuffaceous zones having an anomalously high copper concentration and a magnetic nature (DeWitt and others, 1989)
EARLY PROTEROZOIC AND LATE ARCHEAN			XWui	**Undifferentiated igneous rocks**—Geochemical signature and geophysical nature vary depending on protolith (see DeWitt and others, 1989 for additional information)
			XWgw	**Metamorphosed graywacke**—Primarily a medium- to dark-gray siliceous mica schist and impure quartzite (DeWitt and others, 1989)
			XWus	**Undifferentiated metamorphosed sedimentary deposits**—Includes conglomerate, quartz sandstone, siltstone, and dolomite protoliths. Parts are characterized geochemically by anomalously high uranium, chromium, and gold concentrations and other parts by anomalous gold, silver, and arsenic concentration. The latter zones are magnetic in nature (DeWitt and others, 1989)

NOTE: Some thickness ranges given above are from the sources listed and from data on file at the U.S. Geological Survey, Rapid City, South Dakota

SCALE 1:100,000
2 1 0 2 4 6 8 10 MILES
2 1 0 2 4 6 8 10 KILOMETERS
CONTOUR INTERVAL 200 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

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1999

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