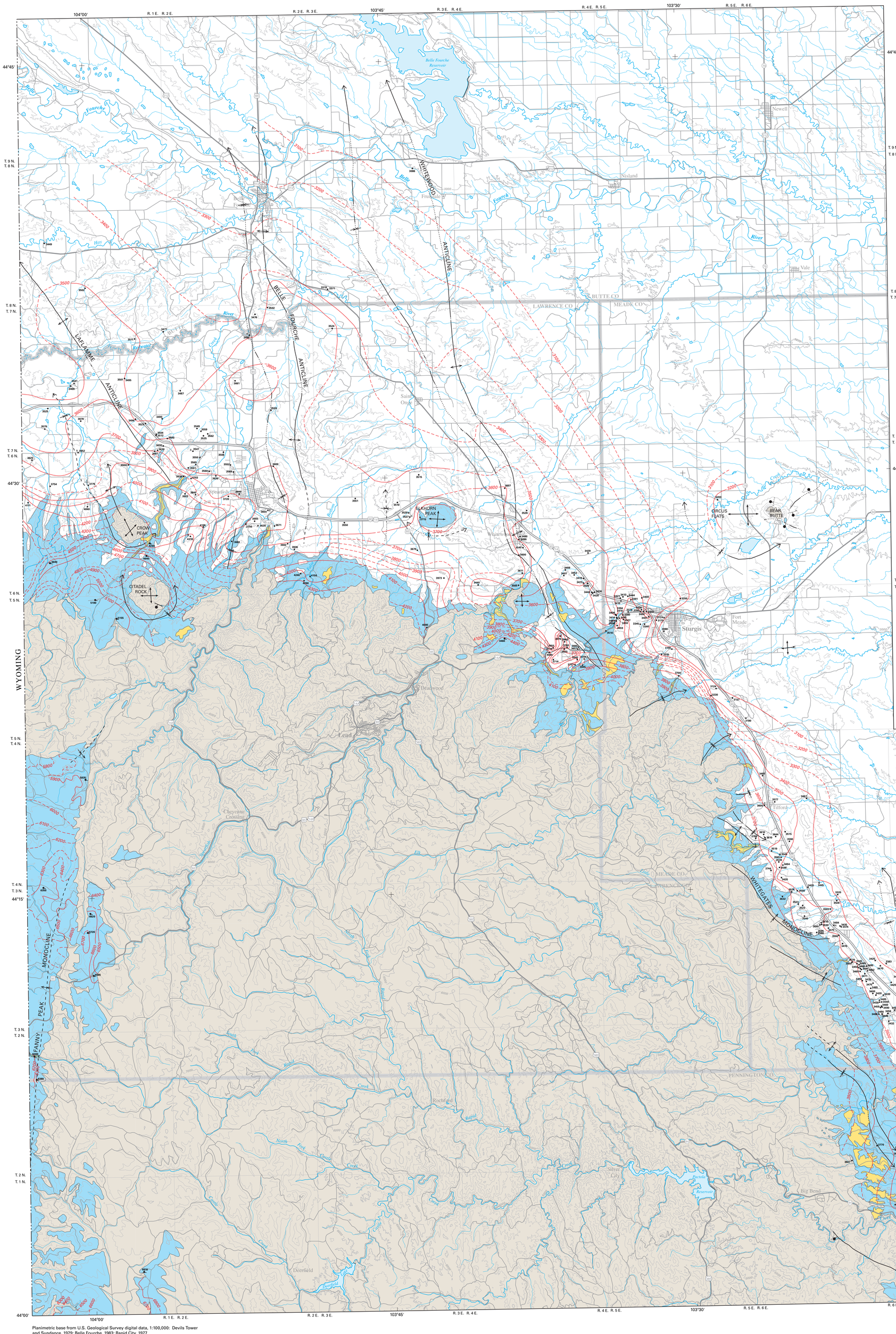
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

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

HYDROLOGIC INVESTIGATIONS ATLAS HA-745-C
Northern part of area —SHEET 1 OF 2
Strobel, M.L., Galloway, J.M., Hamade, G.R., and Jarrell, G.J., 2000,
Potentiometric Surface of the Minnelusa Aquifer in the Black Hills Area, South Dakota



EXPLANATION

- **Outcrop of the Minnelusa Formation**
- **Minnelusa Formation present, but overlain directly by surficial deposits**
- **Minnelusa Formation absent**
- **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
- 3500 **Potentiometric contour**—Shows altitude at which water would have stood in tightly cased, nonpumping wells. Contour interval 100 feet. Dashed where inferred. Datum is sea level[1]
- 3428 **Well**—Number is mean hydraulic head of the well, in feet above sea level. "R" indicates continuous recording wells
- 4460 **Spring originating from Minnelusa aquifer**—Number is altitude of the spring, in feet above sea level

[1]Sea level: In this report, the term "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)

Planimetric base from U.S. Geological Survey digital data, 1:100,000: Devils Tower and Sundance, 1979; Belle Fourche, 1983; Rapid City, 1977
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

INTRODUCTION

This map is a product of the Black Hills Hydrology Study, which was initiated in 1990 to assess the quantity, quality, and distribution of surface water and ground water in the Black Hills area of South Dakota (Driscoll, 1992). This long-term study is a cooperative effort between the U.S. Geological Survey (USGS), the South Dakota Department of Environment and Natural Resources, and the West Dakota Water Development District, which represents various local and county cooperators. This map is part of a series of 1:100,000-scale maps for the study. The maps include a hydrogeologic map, structure-contour maps (altitudes of the tops of formations) for five formations that contain major aquifers in the study area, and potentiometric maps for these five major aquifers (the Inyan Kara, Minnekahta, Minnelusa, Madison, and Deadwood aquifers).

The study area consists of the topographically defined Black Hills and adjacent areas located in western South Dakota. The Black Hills area is an elongated, dome-shaped feature, about 125 miles long and 60 miles wide, which was uplifted during the Laramide orogeny (Feldman and Heimlich, 1980). The oldest geologic units in the study area are Precambrian metamorphic and igneous rocks, which are exposed in the central core of the Black Hills. Surrounding the Precambrian core is a layered series of sedimentary rocks including limestones, sandstones, and shales that are exposed in roughly concentric rings around the uplifted flanks of the Black Hills. The bedrock sedimentary units typically dip away from the uplifted Black Hills at angles that approach or exceed 10 degrees near the outcrops, and decrease with distance from the uplift. Many of the sedimentary units contain aquifers, both within and beyond the study area. Recharge to these aquifers occurs from infiltration of precipitation upon the outcrops and, in some cases, from infiltration of streamflow (Hortness and Driscoll, 1998). Artesian conditions generally exist within these aquifers where an upper confining layer is present. Flowing wells and springs that originate from the confined aquifers are common around the periphery of the Black Hills.

The purpose of this map is to show the potentiometric surface of the Minnelusa aquifer within the study area. The map provides a tool for evaluating ground-water flow directions and hydraulic gradients in the Minnelusa aquifer.

AQUIFER DESCRIPTION

The Minnelusa aquifer is comprised within the Pennsylvanian- and Permian-age Minnelusa Formation. The Minnelusa Formation consists mostly of yellow to red cross-stratified sandstone, limestone, dolomite, and shale (Strobel and others, 1999). In addition to sandstone and dolomite, the lower part of the formation consists of shale and anhydrite (DeWitt and others, 1986). The upper part of the Minnelusa Formation also may contain anhydrite, which generally has been removed by dissolution at or near the outcrop areas, forming collapse features filled with breccia (Braddock, 1963). The thickness of the Minnelusa Formation within the study area increases from north to south and ranges from 375 feet near Belle Fourche to 1,175 feet near Edgemont (Carter and Redden, 1999). Along the northeastern part of the central Black Hills, there is little anhydrite in the subsurface. Hence, the decreased thickness in this area is due to a change in the depositional environment. On the south and southwest side of the study area, there is a considerable increase in thickness of clastic units as well as a thick section of anhydrite. In the southern Black Hills, the Minnelusa Formation thins in areas very close to the upper contact due to leaching of anhydrite. The outcrop of the Minnelusa Formation shown on the map is from Strobel and others (1999).

The Minnelusa Formation is overlain by the Opeche Shale, which separates the Minnelusa aquifer from the Minnekahta aquifer. The Minnelusa aquifer often is hydraulically separated from the underlying Madison aquifer by shales in the lower portion of the Minnelusa Formation. However, in many areas the Minnelusa aquifer is in hydraulic connection with the Madison aquifer.

POTENTIOMETRIC SURFACE

The potentiometric surface was mapped by contouring altitudes of water levels in wells completed in the Minnelusa aquifer and altitudes of springs originating from the Minnelusa aquifer. The water-level and spring altitudes shown on the map are from the ground-water database of the USGS National Water Information System and are presented in Galloway (2000). The majority of wells in the study area have a single water-level measurement that usually was obtained at the time of well completion. Some wells, especially continuous-recording wells, have numerous water-level measurements available, in which case a mean value from all measurements was calculated and used for contouring purposes. Ranges in measured water levels for continuous-recording wells generally are less than the 100-foot contour interval used; thus, in most areas the configuration of the potentiometric surface during the period of water-level data collection (approximately 1930-98) probably does not deviate substantially from that which is shown. Deviations between the mapped and actual potentiometric surfaces may be larger for areas with dashed (inferred) contours than for solid contours. Many wells are completed in the upper 200 to 300 feet of the Minnelusa Formation, but sandstone beds in the middle to lower portion of the formation are utilized locally. No differentiation was made on the map to indicate the relative depth within the aquifer at which each well is completed.

Most of the springs used in contouring are on or near the outcrop area. The actual hydraulic head in the vicinity of the springs probably is higher than the spring altitudes. In outcrop areas, stream altitudes also were considered in contouring the potentiometric surface.

In general, ground-water flow in the aquifer is radially outward from the Black Hills. Structural features in the Minnelusa Formation (Carter and Redden, 1999), such as folds and faults, may have local influence on ground-water flow directions. Therefore, structural trends also were considered in the contouring of the potentiometric surface.

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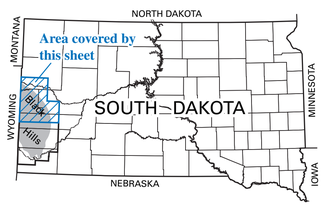

SCALE 1:100,000
2 1 0 2 4 6 8 10 MILES
2 1 0 2 4 6 8 10 KILOMETERS
LAND SURFACE CONTOUR INTERVAL 200 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

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By
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2000

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