

- EXPLANATION**
- Outcrop of the Inyan Kara Group
  - Inyan Kara Group present, but overlain directly by surficial deposits
  - Inyan Kara Group 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.
  - Structure contour—Shows approximate altitude of the top of the Inyan Kara Group. Contour interval 100 feet. Dashed where inferred. Datum is sea level.
  - Control point—Location of water well or oil, gas, or water test hole. Number is known altitude in feet above sea level.

Photometric base from U.S. Geological Survey digital data, 1:100,000, Devils Tower and Sundance, 1975; 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 cooperatives. 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 top 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, Minnekahta, 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 artesian springs that originate from confined aquifers are common around the periphery of the Black Hills. The purpose of this map is to show the altitude of the top of the structure contours of the Inyan Kara Group within the area of the Black Hills Hydrology Study. The depth to the top of the Inyan Kara Group can be estimated at a specific site by subtracting the altitude of the top of the formation from the topographic elevation. However, caution is urged in determining the depth to the top of the formation in areas on the map where the contours are approximately located.

**SOURCES OF DATA**

The outcrops shown on the map are from Strobel and others (1999), and the structural features are modified from Redden (1994) and Strobel and others (1999). The data points shown on this map were compiled from interpretation of drillers' logs and geophysical logs of water wells and oil, gas, and water test holes, and from information stored in the ground-water database of the USGS National Water Information System. Many of the site locations were field verified during the study. The altitudes of subsurface contacts were data compiled by J. Paul Gries (South Dakota School of Mines and Technology), the South Dakota Geological Survey, and the USGS. In some areas, data were either unavailable or insufficient to adequately determine the depth to the top of the Inyan Kara Group, even though information about deeper formations was available and used for other maps of this series. Additional information for the wells and test holes used for this map are presented in Carter (1999).

**DESCRIPTION OF THE INYAN KARA GROUP**

The Cretaceous-age Inyan Kara Group consists of the Lakota Formation and overlying Fall River Formation. The Lakota Formation consists of the Chilson, Minnewaste Limestone, and Fison Shale Members. The Lakota Formation consists of a yellow, brown, and reddish-brown massive to thinly bedded sandstone, pebbly conglomerate, siltstone, and claystone of fluvial origin (Gott and others, 1974); locally there are lenses of limestone and coal. The Minnewaste Limestone Member, where present, overlies the Chilson Member and is a fine-grained limestone of lacustrine origin (Gott and others, 1974). The overlying Fison Member consists mostly of red, green, and gray siltstone and mudstone, probably of lacustrine origin, with interbedded sandstones (Gott and others, 1974). The Fall River Formation is a brown to reddish-brown, fine-grained sandstone, thin bedded at the top and massive at the bottom (Strobel and others, 1999). The thickness of the Inyan Kara Group ranges from 135 to 900 feet in the study area. The Inyan Kara Group is overlain by a confining unit of Cretaceous-age rocks including the Skull Creek Shale, Newcastle Sandstone, Mowry Shale, Belle Fourche Shale, Greenhorn Formation, Cattle Shale, Niobrara Formation, and Pierre Shale (Strobel and others, 1999). The upper contact of the Inyan Kara Group typically is intertongued with sandstones and black shales of the Skull Creek Shale as the depositional environment transitioned to marine. The Inyan Kara Group is underlain by a semi-confining unit of Jurassic-age rocks including the Gypsum Spring Formation, Sundance Formation, Uinkapa Sandstone, and Morrison Formation (Strobel and others, 1999).

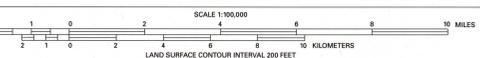
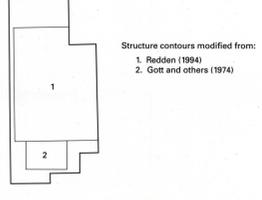
**ALTITUDE OF THE TOP OF THE INYAN KARA GROUP**

The Inyan Kara Group generally dips away from the core of the Black Hills. The dip of the top of the Inyan Kara Group generally is steepest near the outcrop, where it can exceed 15 degrees, and gradually decreases with increasing distance from the outcrop to less than 1 degree near the study area boundary. The altitude of the top ranges from 3,800 feet above sea level (based on the National Geodetic Vertical Datum of 1929) in the southwestern part of the study area to 100 feet above sea level in the southeastern part.

**REFERENCES**

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**INDEX TO STRUCTURE MAPPING**



**Altitude of the Top of the Inyan Kara Group in the Black Hills Area, South Dakota**

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