http://pubs.usgs.gov/ha/ha744a/ha744aIntro.html

The title is:

Altitude of the Top of the Inyan Kara Group in the Black Hills Area, South Dakota By Janet M. Carter, U.S. Geological Survey; and Jack A. Redden, South Dakota School of Mines and Technology

U.S. GEOLOGICAL SURVEY
Hydrologic Investigations Atlas HA-744-A

Prepared in cooperation with the
South Dakota Department of Environment and Natural Resources and the West Dakota Water Development District

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

By Janet M. Carter, U.S. Geological Survey; and Jack A. Redden, South Dakota School of Mines and Technology

U.S. GEOLOGICAL SURVEY
Hydrologic Investigations Atlas HA-744-A

Prepared in cooperation with the
South Dakota Department of Environment and Natural Resources
and the West Dakota Water Development District

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 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 (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 was 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 Fuson Shale Members. The Lakota Formation consists of a yellow, brown, and reddish-brown massive to thinly bedded sandstone, pebble 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 Fuson 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, Carlile 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 semiconfining unit of Jurassic-age rocks including the Gypsum Spring Formation, Sundance Formation, Unkpapa 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

Carter, J.M., 1999, Selected data for wells and test holes used in structure-contour maps of the Inyan Kara Group, Minnekahta Limestone, Minnelusa Formation, Madison Limestone, and Deadwood Formation: U.S. Geological Survey Open-File Report 99-260, 51 p.

Driscoll, D.G., 1992, Plan of study for the Black Hills Hydrology Study, South Dakota: U.S. Geological Survey Open-File Report 92-84, 10 p.

Feldman, R.M., and Heimlich, R.A., 1980, The Black Hills: K/H Geology Field Guide Series, Kendall/Hunt Publishing Company, Kent State University, Kent, Ohio, 190 p.

Gott, G.B., Wolcott, D.E., and Bowles, C.G., 1974, Stratigraphy of the Inyan Kara Group and localization of uranium deposits, southern Black Hills, South Dakota and Wyoming: U.S. Geological Survey Professional Paper 763, 57 p.

Hortness, J.E., and Driscoll, D.G., 1998, Streamflow losses in the Black Hills of western South Dakota: U.S. Geological Survey Water-Resources Investigations Report 98-4116, 99 p.

Redden, J.A., 1994, Structural contours and Phanerozoic structures in the Rapid City and Mount Rushmore, South Dakota 1:100,000 scale quadrangles: U.S. Geological Survey Open-File Report 95-81, 4 sheets, scale 1:100,000.

Strobel, M.L., Jarrell, G.J., Sawyer, J.F., Schleicher, J.R., and Fahrenbach, M.D., 1999, Distribution of hydrogeologic units in the Black Hills area, South Dakota: U.S. Geological Survey Hydrologic Investigations Atlas HA-743, 3 sheets.

Map Sheets

Note to users with visual disabilities: The PDF files presented here have not been optimized for use with screen readers that support this format. All map sheets measure 36x48 inches and will print on a large-format color plotter.

Sheet 1 of 2 (PDF, 9.1MB), Northern part of area | Sheet 2 of 2 (PDF, 11.5MB), Southern part of area

---

If you do not have the Adobe Acrobat PDF Reader, it is available for free download from Adobe Systems Incorporated.

Document Accessibility: Adobe Systems Incorporated has information about PDFs and the visually impaired. This information provides tools to help make PDF files accessible. These tools convert Adobe PDF documents into HTML or ASCII text, which then can be read by a number of common screen-reading programs that synthesize text as audible speech. In addition, an accessible version of Acrobat Reader 5.0 for Windows (English only), which contains support for screen readers, is available. These tools and the accessible reader may be obtained free from Adobe at Adobe Access.

Send questions or comments about this report to J.M. Carter (605) 355-4560 ext. 215.

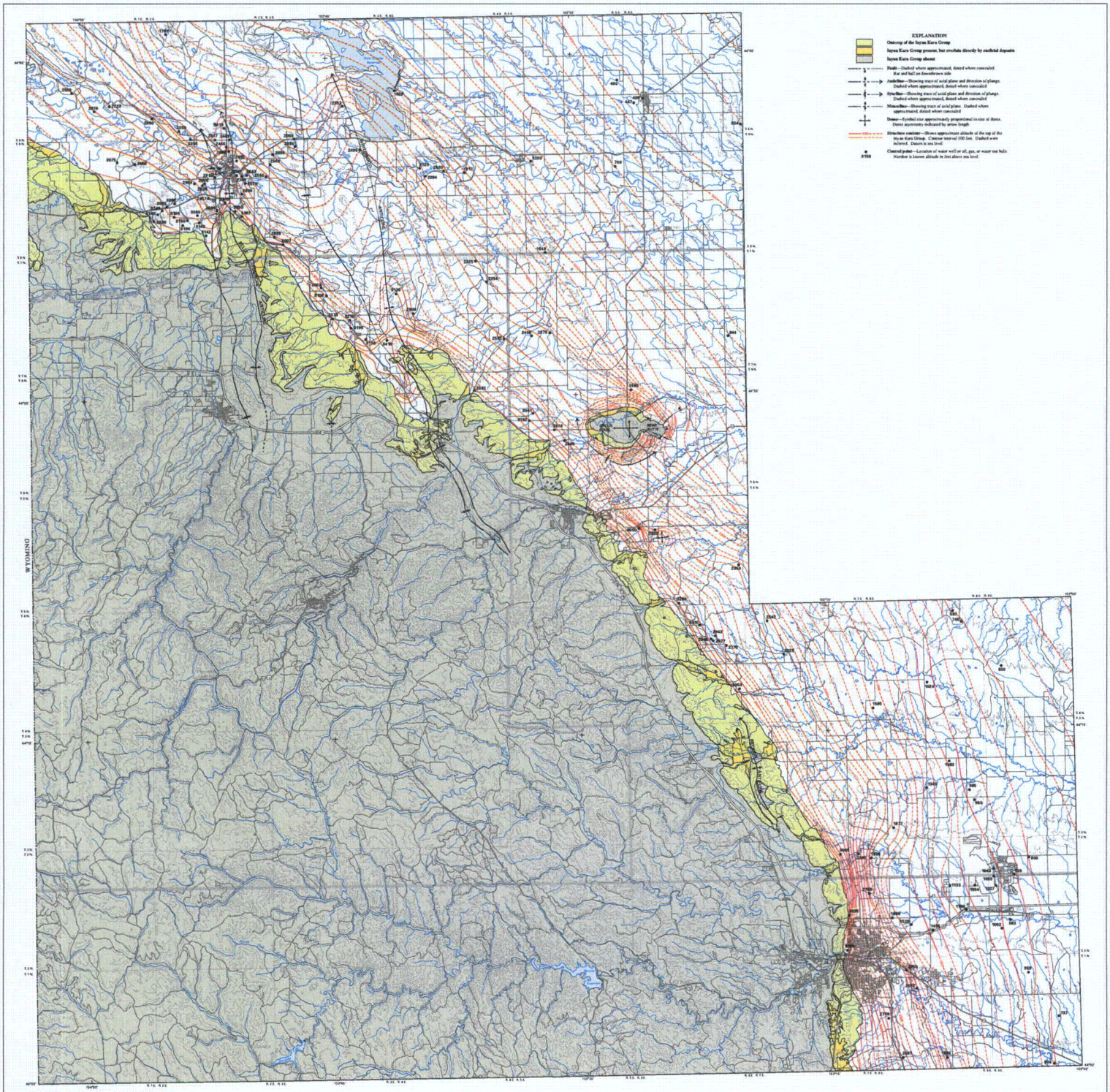
For more information about USGS activities in South Dakota, visit the USGS South Dakota District home page.

Return to HA-744-A

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-744-A
Northern part of area — SHEET 1 OF 2



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, 1:100 maps dated 1990-94
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 the five formations that contain major aquifers in the study area, and potentiometric maps for these five major aquifers (the Inyan Kara, Minnelusa, 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 Heinrich, 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 (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 (1984) 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 was 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 Fuson 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 Fuson 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, Carlile 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 semiconfining unit of Jurassic-age rocks including the Gypsum Spring Formation, Sundance Formation, Unkpapa 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

Carter, J.M., 1999, Selected data for wells and test holes used in structure-contour maps of the Inyan Kara Group, Minnekahta Limestone, Minnelusa Formation, Madison Limestone, and Deadwood Formation: U.S. Geological Survey Open-File Report 99-260, 51 p.

Driscoll, D.G., 1992, Plan of study for the Black Hills Hydrology Study, South Dakota: U.S. Geological Survey Open-File Report 92-64, 10 p.

Feldman, R.M., and Heinrich, R.A., 1980, The Black Hills: KM Geology Field Guide Series, Kendall/Hunt Publishing Company, Kent State University, Kent, Ohio, 190 p.

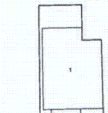
Gott, G.B., Wolcott, D.E., and Bowles, C.G., 1974, Stratigraphy of the Inyan Kara Group and lithofacies of uranium deposits, southern Black Hills, South Dakota and Wyoming: U.S. Geological Survey Professional Paper 763, 57 p.

Hortness, J.E., and Driscoll, D.G., 1998, Streamflow losses in the Black Hills of western South Dakota: U.S. Geological Survey Water-Resources Investigations Report 98-4116, 99 p.

Redden, J.A., 1984, Structural contours and Phanerozoic structures in the Rapid City and Moon Anthrosm, South Dakota 1:100,000 scale quadrangles: U.S. Geological Survey Open-File Report 95-81, 4 sheets, scale 1:100,000

Strobel, M.L., Jarrell, G.J., Sawyer, J.F., Schleicher, J.R., and Fahrenbach, M.D., 1999, Distribution of hydrogeologic units in the Black Hills area, South Dakota: U.S. Geological Survey Hydrologic Investigations Atlas HA-743, 3 sheets, scale 1:100,000

INDEX TO STRUCTURE MAPPING



Structure contours modified from:
1. Redden (1984)
2. Gott and others (1974)

SCALE 1:100,000
0 1 2 3 4 5 6 MILES
0 1 2 3 4 5 KILOMETERS
CONTOUR INTERVAL 100 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

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

By
Janet M. Carter and Jack A. Redden

1999

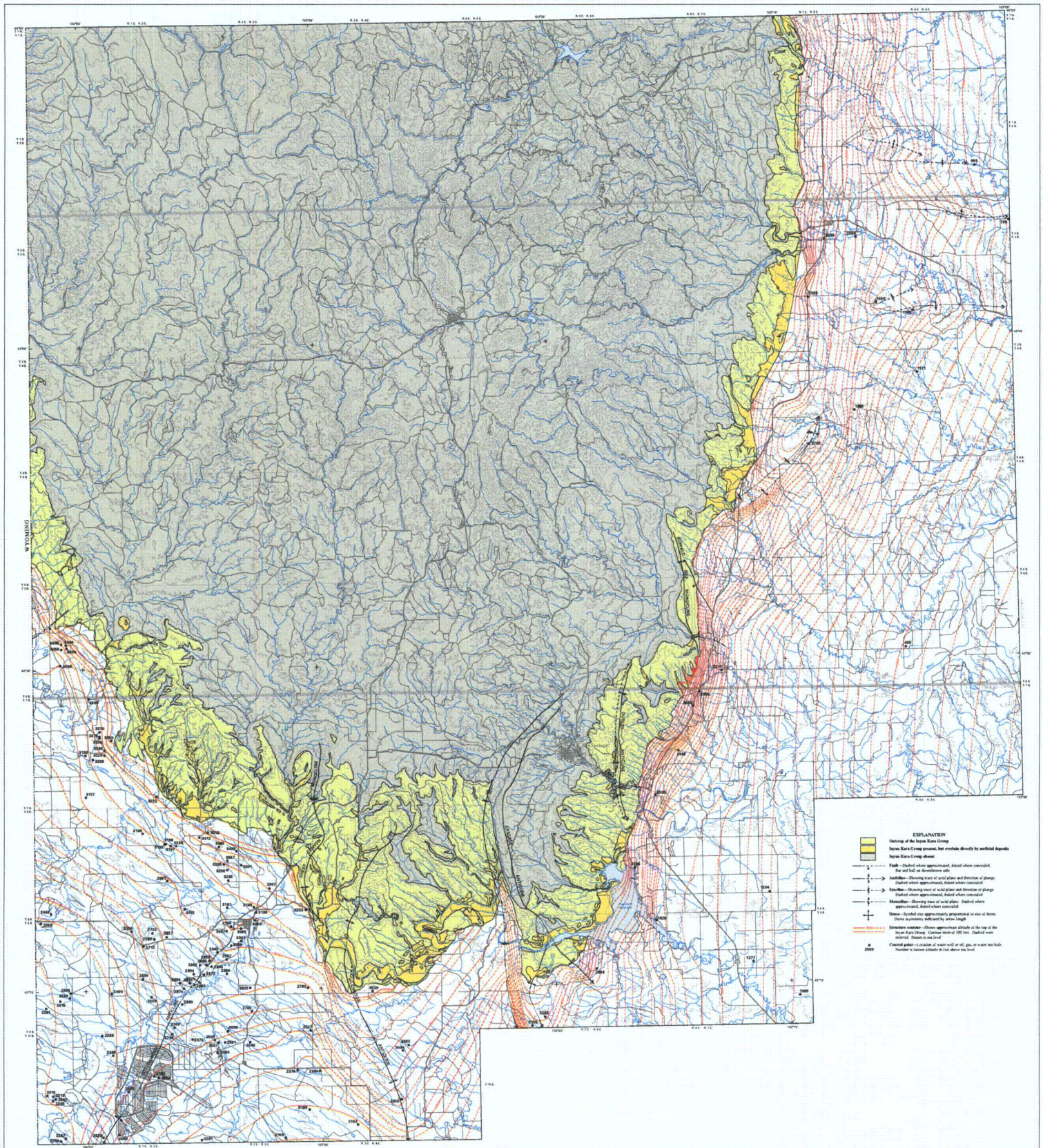
For sale by the U.S. Geological Survey
Branch of Information Services
Box 25286, Denver, Colorado 80225-0286

http://pubs.usgs.gov/ha/ha744a/ha744asheet1.pdf

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-744-A
Southern part of area — SHEET 2 OF 2



Photomosaic base from U.S. Geological Survey digital data, 1:100,000 Hot Springs, 1990; Lance Creek, 1991; Mt. Rushmore, 1977; Rapid City, 1978; Newcastle, 1979
Topographic base modified from U.S. Geological Survey digital data, 1:24,000, from maps dated 1992-94
Universal Transverse Mercator projection
Zone 13
North American Horizontal Datum 1927

SCALE 1:100,000
LAND SURFACE CONTOUR INTERVAL 200 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

For sale by the U.S. Geological Survey
Branch of Information Services
Box 25286, Denver, Colorado 80225-0286

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

By
Janet M. Carter and Jack A. Redden

1999