INTRODUCTION

In 1976 the U.S. Geological Survey began a 4-year study of aquifers in the northern Great Plains. The purpose of this map, which is a product of that study, is to show the cumulative thickness of sandstone in the Fox Hills-lower Hell Creek aquifer. Other maps show the altitude of the top (Feltis, 1982a), total thickness (Feltis, 1982b), and potentiometric surface of water (Levings, 1982) of the Fox Hills-lower Hell Creek aquifer. These maps are part of a series that describes the geology and potentiometric surface of selected rock units of Jurassic or younger age in the plains area of Montana.

SOURCE OF DATA

Most geologic data used to compile the map have been obtained from records of oil and gas exploration wells on file in offices of the Montana Department of Natural Resources and Conservation and the U.S. Geological Survey. The data were derived from interpretation of geophysical logs of oil or gas test wells. One site per township was the optimum density of data selected for map compilation; however, geophysical logs were not available for all townships.

FOX HILLS-LOWER HELL CREEK AQUIFER

Sandstone beds of the Upper Cretaceous Fox Hills Sandstone and the lower part of the Hell Creek Formation are widely used as a source of water in eastern Montana and generally are hydraulically connected. Sandstone beds of the Fox Hills Sandstone were deposited during a marine regression and are overlain by fluvial and deltaic sediments of the Hell Creek Formation. The source material for these and other Cretaceous formations was mostly from a north-trending cordilleran highland in western Wyoming and Montana. The stratigraphy and geologic history of the Fox Hills Sandstone are described by Gill and Cobban (1973), who show by stratigraphic diagrams and strandline maps the relationship of the sandstone to other Cretaceous rocks and the position and directions of strandline movement. The Fox Hills Sandstone is mostly tabular, but the sandstone beds of the Hell Creek are more lenticular and intertongue with siltstone and shale beds. The top of the sandstone beds in the lower Hell Creek varies in vertical stratigraphic position; therefore, the correlation of the top of the aquifer from well to well may not be consistent in some areas. Stoner and Lewis (1980) indicate that the upper boundary of the Fox Hills-lower Hell Creek aquifer may range from 0 to 600 feet above the base of the Hell Creek Formation and the variability in thickness of the Hell Creek is attributed to coincidental stacking of channel sands.

The Fox Hills Sandstone and the Hell Creek Formation crop out around the Bearpaw Mountains of north-central Montana, but no attempt was made to determine the thickness of the aquifer in that complexly faulted area. The outcrops are shown on a geologic map by Hearn (1976). In the Hogeland basin, an erosional remnant of the formations is partly covered by a Tertiary terrace deposit. South of the Big Snowy Mountains in central Montana, the formations also are covered by terrace deposits and the areal extent of the rocks is not known. In the southwest part of the area, the aquifer is tentatively extended into the east edge of the Crazy Mountains basin where the various formations of the Livingston Group intertongue with the Fox Hills Sandstone and the Hell Creek Formation (Roberts, 1972). In the northwest part of the study area, the Horsethief Sandstone and the St. Mary River Formation correlate with the Fox Hills and Hell Creek units; however, they are not included in this report.

CUMULATIVE SANDSTONE THICKNESS

As shown on the map, the accumulation of sandstone is thickest (400 to 500 feet) in southeast Montana and thinnest (less than 100 feet) in the northeast. This distribution in thickness reflects the concept that sediments moved along the east-trending Sheridan delta near the Montana-Wyoming border and were transported to the north and east into northeastern Montana and the Dakotas. The thickest accumulation of sandstone is near the source area and the thinnest is downgradient where more fine-grained silt and clay deposits have accumulated.

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_____1982b, Map showing total thickness of the Fox Hills-lower Hell Creek aquifer, Montana: U.S. Geological Survey Water-Resources Investigations 80-4042, scale 1:1,000,000.

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Levings, G. W., 1982, Potentiometric-surface map of water in the Fox Hills-lower Hell Creek aquifer in the northern Great Plains area of Montana: U.S. Geological Survey, Open-File Report 82-564, scale 1:1,000,000.

Roberts, A. E., 1972, Cretaceous and early Tertiary depositional and tectonic history of the Livingston area, southwestern Montana: U.S. Geological Survey Professional Paper 526-C, 120 p.

Ross, C. P., Andrews, D. A., and Witkind, I. J., 1955, Geologic map of Montana: U.S. Geological Survey, scale 1:500,000, 2 sheets.

Stoner, J. D., and Lewis, B. D., 1980, Hydrogeology of the Fort Union coal region, eastern Montana: U.S. Geological Survey Miscellaneous Investigations Map I-1236, scale 1:500,000, 2 sheets.

METRIC CONVERSION TABLE

The following factors can be used to convert inch-pound units in this report to the International System of units (SI):

Multiply inch-pound unit	By	To obtain SI unit
foot	0.3048	meter
mile	1.609	kilometer

EXPLANATION

CRETACEOUS

HELL CREEK FORMATION--Pattern shows general area of outcrop

FOX HILLS SANDSTONE--Pattern shows general area of outcrop. In some areas the Fox Hills was not mapped as a separate unit from the overlying Hell Creek Formation or was not recognized as being present

CONTACT--Dashed where concealed by alluvium or terrace deposits

THRUST FAULT--Sawteeth on upper plate

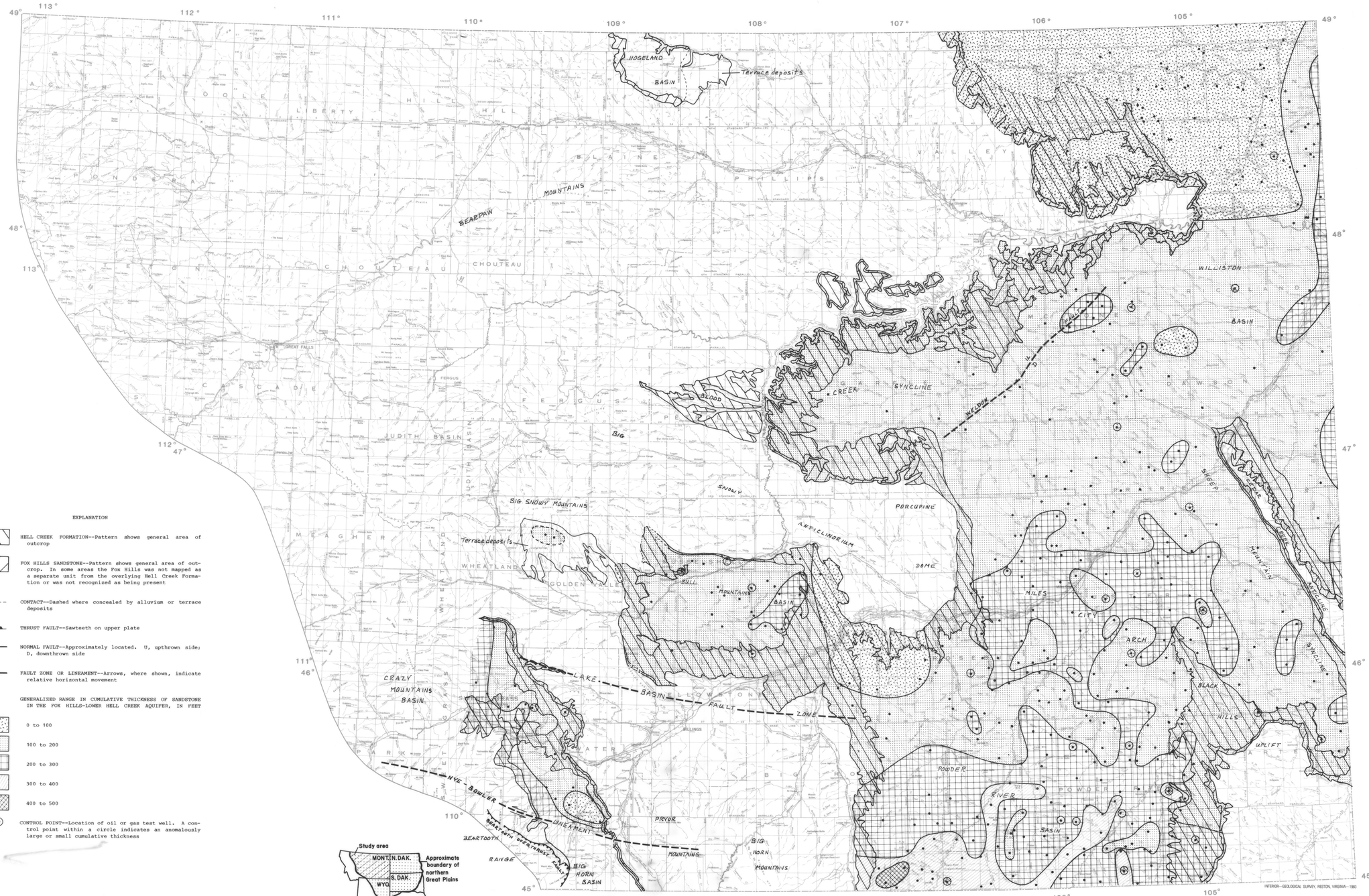
NORMAL FAULT--Approximately located. U, upthrown side; D, downthrown side

FAULT ZONE OR LINEAMENT--Arrows, where shown, indicate relative horizontal movement

GENERALIZED RANGE IN CUMULATIVE THICKNESS OF SANDSTONE IN THE FOX HILLS-LOWER HELL CREEK AQUIFER, IN FEET

- 0 to 100
- 100 to 200
- 200 to 300
- 300 to 400
- 400 to 500

CONTROL POINT--Location of oil or gas test well. A control point within a circle indicates an anomalously large or small cumulative thickness



Base from U.S. Geological Survey State base map, 1968

Scale 1:1 000 000

0 10 20 30 40 MILES

0 10 20 30 40 KILOMETERS

Geologic contacts from Ross, Andrews, and Witkind (1955). Structural features from Dobbin and Erdmann (1955)

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1983

MAP SHOWING CUMULATIVE THICKNESS OF SANDSTONE IN THE FOX HILLS-LOWER HELL CREEK AQUIFER, MONTANA

by
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1982

Helena, Montana