

INTRODUCTION

In 1978 the U.S. Geological Survey began a 4-year study of aquifers of Cenozoic and Mesozoic age in the northern Great Plains to define the hydrologic system, to determine the availability and chemical quality of ground water, and to predict the effects of various water-use management plans on the system. The purpose of this map is to show the generalized potentiometric surface of water in the Lakota Formation and equivalent units—Cut Bank Sandstone Member, Sunburst Sandstone Member, and Moulton Member of Kootenai Formation; Third Cat Creek sandstone of Kootenai Formation; and Pryor Conglomerate Member of Kootenai Formation. For convenience in this report, this interval is referred to as the Lakota Formation.

Data used in compiling the map were collected from water wells and oil or gas test wells (Levings, 1981a, 1981b). The altitude of the potentiometric surface in the water wells was determined from measured or reported depths to water level or was calculated from pressure-gauge readings on flowing wells. The water-well data range in age from 1925 to 1980. The altitude of the potentiometric surface of oil and gas test wells was determined by drill-stem test. The drill-stem-test data range in age from 1957 to 1980.

GROUND-WATER MOVEMENT AND DISCHARGE

Water in the Lakota Formation occurs under water-table and artesian conditions. The areal distribution of wells is shown on the map. Recharge to the aquifer is mainly from infiltration of precipitation on the outcrops. Smaller amounts of recharge may occur from infiltration of streamflow across the outcrops and from leakage across confining beds.

The map shows that the general direction of regional ground-water movement is east and north from the recharge areas in the Little Belt and Big Snowy Mountains. No discharge points are known in the Lakota Formation. Vertical leakage, either upward or downward, is possible in some areas where faults provide avenues for movement. No data are available to determine leakage direction or magnitude.

The Lakota Formation yields water to wells in a large part of the study area. The average reported or measured discharge from 20 wells is about 29 gal/min. The discharge ranges from 1 to 93.5 gal/min, with six wells having discharges greater than 20 gal/min. The specific capacity of 18 wells ranges from 0.004 to 5.88 (gal/min)/ft and averages 0.75 (gal/min)/ft.

REFERENCES CITED

- Levings, G. W., 1981a, Selected drill-stem-test data from the northern Great Plains area of Montana: U.S. Geological Survey Water-Resources Investigations Open-File Report 81-326, 20 p.
- 1981b, Selected hydrogeologic data from the northern Great Plains area of Montana: U.S. Geological Survey Open-File Report 81-534, 241 p.
- Oil and Gas Conservation Division, 1981, Annual review for the year 1980 relating to oil and gas: Helena, Montana, Montana Department of Natural Resources and Conservation, v. 24, 44 p.
- Ross, C. P., Andrews, D. A., and Witkind, I. J., 1955, Geologic map of Montana: U.S. Geological Survey, scale 1:500,000.

METRIC CONVERSION TABLE

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

Multiply inch-pound unit	By	To obtain SI unit
foot	0.3048	meter
gallon per minute (gal/min)	0.06309	liter per second
gallon per minute per foot [(gal/min)/ft]	0.2070	liter per second per meter
mile	1.609	kilometer
pound per square inch	6.895	kilopascal

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) by the following formula:

$$^{\circ}\text{F} = 1.8^{\circ}\text{C} + 32$$

POTENTIOMETRIC SURFACE

During 1980, production from 39 oil and gas fields in Montana was obtained solely or partly from the Lakota Formation (oil and gas Conservation Division, 1981). Many drill-stem-tests were conducted on oil or gas test wells. These tests were used to calculate an altitude of the potentiometric surface at each test well using the following equation:

$$h = (FSIP \times C) - PRD + LSD \quad (1)$$

where

h is hydraulic head, in feet above NGVD of 1929;

FSIP is final shut-in pressure, in pounds per square inch, measured by a pressure-recording device;

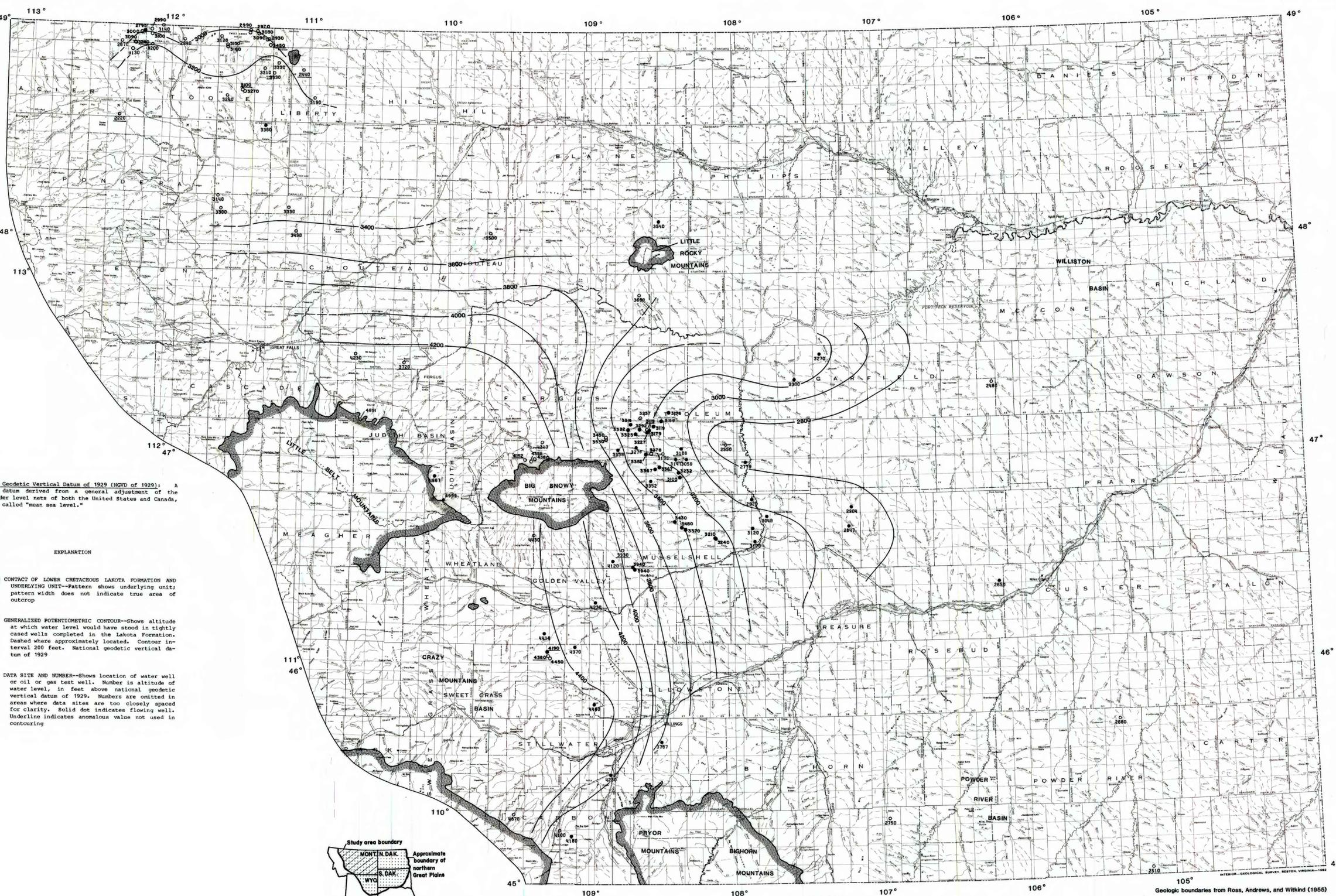
C is a factor to convert *FSIP* to equivalent feet of water;

PRD is depth of the pressure-recording device, in feet below the measuring point; and

LSD is altitude of the measuring point, in feet above NGVD of 1929.

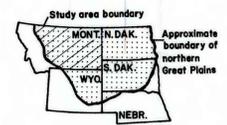
The factor *C* equals 2.307 feet of water per pressure increment of 1 pound per square inch. It assumes pure water at a temperature of 4°C having a density of 1.00 gram per cubic centimeter. Thus, the hydraulic-head values calculated from drill-stem tests reflect the potentiometric surface of water in the Lakota Formation if it contained a homogeneous fluid having a density of 1.00 gram per cubic centimeter. The density of water in the Lakota Formation at many of the oil and gas test wells is unknown.

Some of the inconsistencies in water levels may be the result of procedures used in conducting drill-stem tests. In some early tests the depth of the pressure-recording device, *PRD* of equation 1, was not always recorded. If the depth had to be estimated, it could have been in error by several tens of feet. The length of time for recording the final shut-in pressure, *FSIP* of equation 1, was variable and commonly was not sufficient to allow stabilization of hydrostatic pressure. If the test chart or record of increments of pressure recovery with time was not available, the estimated *FSIP* probably was too small.



National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "mean sea level."

- EXPLANATION**
- CONTACT OF LOWER CRETACEOUS LAKOTA FORMATION AND UNDERLYING UNIT—Pattern shows underlying unit; pattern width does not indicate true area of outcrop
 - 3200—GENERALISED POTENTIOMETRIC CONTOUR—Shows altitude at which water level would have stood in tightly cased wells completed in the Lakota Formation. Dashed where approximately located. Contour interval 200 feet. National geodetic vertical datum of 1929
 - DATA SITE AND NUMBER—Shows location of water well or oil or gas test well. Number is altitude of water level, in feet above national geodetic vertical datum of 1929. Numbers are omitted in areas where data sites are too closely spaced for clarity. Solid dot indicates flowing well. Underline indicates anomalous value not used in contouring



Base from U.S. Geological Survey State base map, 1988
Scale 1:1 000 000
0 10 20 30 40 MILES
0 10 20 30 40 50 KILOMETERS

POTENTIOMETRIC-SURFACE MAP OF WATER IN THE LAKOTA FORMATION AND EQUIVALENT UNITS IN THE NORTHERN GREAT PLAINS AREA OF MONTANA
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