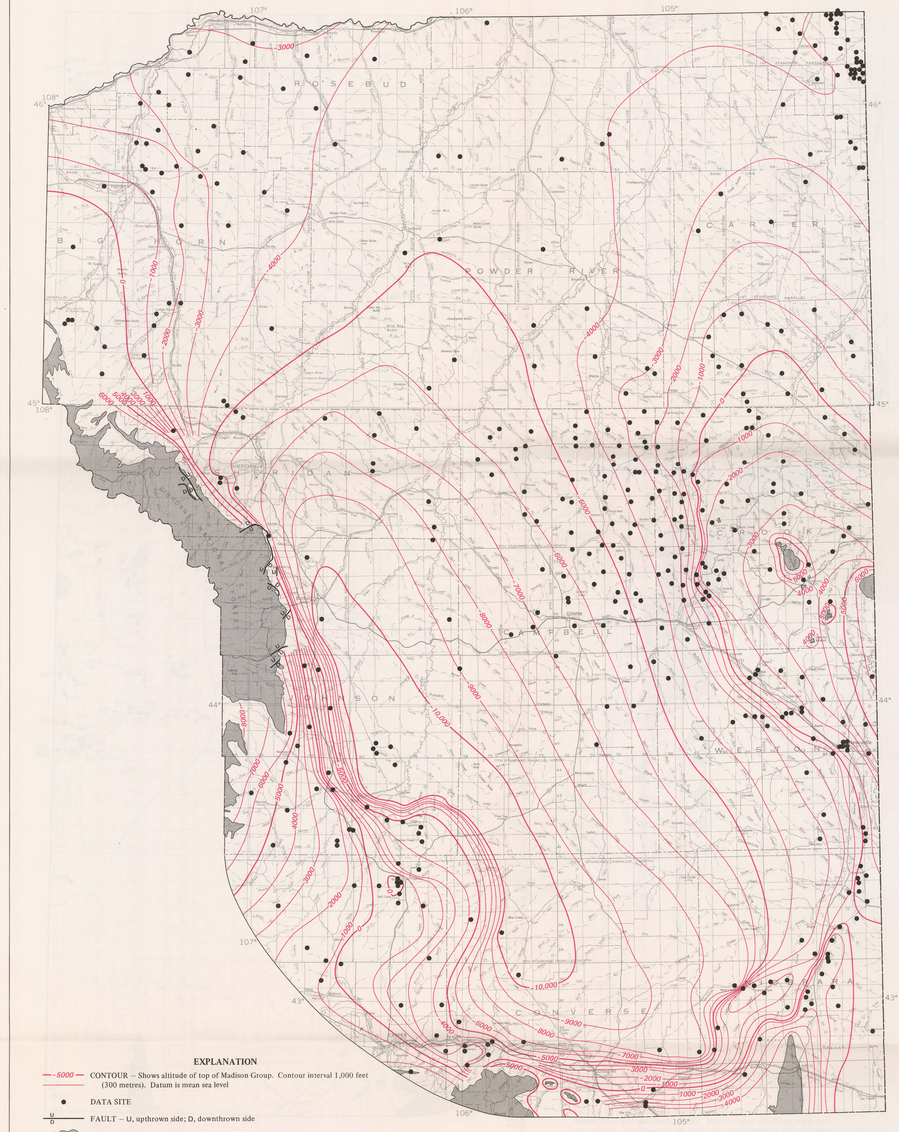
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Prepared in cooperation with the
MONTANA BUREAU OF MINES AND GEOLOGY
AND THE WYOMING STATE ENGINEER

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-847-C (SHEET 1 OF 2)



EXPLANATION

-5000- CONTOUR – Shows altitude of top of Madison Group. Contour interval 1,000 feet (300 metres). Datum is mean sea level

DATA SITE

U/D FAULT – U, upthrown side; D, downthrown side

AREA WHERE MADISON GROUP IS ABSENT

Contours by F. A. Swenson, W. R. Miller, W. G. Hodson, and F. N. Visher, 1975

MAP SHOWING CONFIGURATION OF THE TOP OF THE MADISON GROUP

INTRODUCTION

With development of the coal resources of the Powder River Basin of Wyoming and Montana the demand for water will increase greatly. The study upon which this report is based was designed to make a preliminary evaluation of the available geohydrologic data for the Madison Group, which is an extensive aquifer underlying the Powder River Basin. Large yields from a few wells tapping the Madison indicate that the aquifer possibly could be utilized as one source of water for development of the coal resources of the area.

Domestic and stock-water supplies have been developed from sandstone and coal aquifers at shallow depths in the basin, but these aquifers do not appear to be capable of supplying the large amounts of water required for coal development without endangering existing water supplies.

Surface-water supplies in most of the Powder River Basin are insufficient to meet present demands for water. The largest streams are the North Platte River, which borders the southern edge of the basin, and the Bighorn and Yellowstone Rivers, which cross the northern part (index map). Other perennial streams are relatively small.

An estimated 1.5 trillion tons (1.4 trillion t) of coal (Northern Great Plains Resources Program), is in the Fort Union Formation of Tertiary age in eastern Montana, northeastern Wyoming, and adjacent North Dakota. Much of it is low-sulfur subbituminous coal that is suitable for use in steam powerplants, coal-gasification plants, and probably synthetic liquid-fuel plants. The thickest coal beds are in the Powder River Basin (Keefer and Schmidt, 1973), a deep structural trough that occurs between the Black Hills on the east and the Bighorn and Pryor Mountains on the west, and extends from the north end of the Laramie Mountains on the south into central Montana.

The original version of this report was prepared by F. A. Swenson for the Northern Great Plains Resource Program. It was released in July 1974 under the title "Possible Development of Water from Madison Group and Associated Rocks in Powder River Basin, Wyoming-Montana." Investigations of the hydrology of the Madison Group were underway concurrently in Montana in cooperation with the Montana Bureau of Mines and Geology, and in Wyoming with the Wyoming State Engineer. The investigations in Montana and Wyoming were by W. R. Miller and W. G. Hodson, respectively.

Following the release of the original version of this report, additional geologic and hydrologic data became available through the investigations by Miller and Hodson in Montana and Wyoming. Their data and interpretations were applied to Swenson's report with assistance from F. N. Visher. Modifications to the original report in the Montana part of the Powder River Basin were made by Miller and in the Wyoming part of the basin by Hodson. The current report, a collaborative effort of Swenson, Miller, Hodson, and Visher, includes the results of cooperative studies with the Montana Bureau of Mines and Geology and with the Wyoming State Engineer.

NOMENCLATURE AND STRATIGRAPHIC RELATIONS

Rocks of the Madison Group of Mississippian age are exposed on the flanks of the mountains surrounding the area and are present in the subsurface of the basin. The term "Madison Group" as used here includes rocks from the base of the Mississippian System upward to the base of the Amsden Formation of Mississippian and Pennsylvanian age or, in places in the northern part of the basin, upward to the base of the Big Snowy Group of Mississippian age. In Montana the rocks are called Madison Group and three formations are recognized: Lodgepole Limestone (base), Mission Canyon Limestone, and Charles Formation (top). In Wyoming the rocks are called Madison Limestone and the three units, if present, cannot be distinguished. The Madison Limestone is equivalent, in part, to the Pahasapa Limestone in the Black Hills area and to the Guernsey Formation in the Hartville Uplift area.

Rocks overlying the Madison that are of interest to this report are the Amsden Formation, the Big Snowy Group, the Minnelusa Formation, and the Tensleep Sandstone—the latter two of Pennsylvanian and Permian age. Rocks underlying the Madison are principally of Devonian and Silurian age; however, in the south part of the Powder River Basin these rocks are absent and the Madison overlies the Bighorn Dolomite or Red River Formation of Ordovician age.

AQUIFER DESCRIPTION

The Madison Group and the underlying carbonate rocks are fractured and, in places, cavernous where exposed. Evidence that similar conditions occur in the subsurface consists of records of lost circulation during drilling of oil tests and the large quantities of water that some Madison water wells yield in parts of the basin.

Erosion and karst development occurred in the Madison Group before deposition of the overlying beds. Sando (1974) recognized two prominent solution and collapse-breccia zones in the Madison over a wide area of north-central Wyoming. The upper zone is generally within the upper 100 feet (30 m) of the Madison. The more widespread and uniform lower breccia zone, which is 10 to 50 feet (3 to 15 m) thick, is as much as 360 feet (110 m) below the top of the Madison.

Locally on the flanks of the Black Hills east of Newcastle, Wyo., collapse-breccia zones extend into overlying beds, which indicate that cavern roofs collapsed after deposition of the beds overlying the Madison Group. Because of karst development, plus the fracturing and jointing of the brittle limestone and dolomite beds, porous and permeable zones have probably developed in the thick section of Madison and underlying carbonate rocks.

CONFIGURATION OF TOP OF MADISON GROUP

The configuration of the top of the Madison Group (configuration map) is based largely on data from oil tests drilled to the Madison and on data from water wells developed in the Madison. Additional control used to construct the contours was extrapolated from oil tests drilled to the overlying Minnelusa Formation or Tensleep Sandstone and from altitudes in outcrop areas.

The contours show that the Madison dips steeply off the flanks of the Bighorn and Pryor Mountains on the west side of the basin and the Laramie Mountains at the south end of the basin. In places major faulting is present with the downfaulted beds toward the basin. Except for a monoclinal flexure, the Madison dips gently southwestward from the flanks of the Black Hills to the southwest part of the basin, where the Madison is more than 10,000 feet (3,000 m) below sea level. The Madison rises gently northward and the top is 4,000 to 6,000 feet (1,200 to 1,800 m) below sea level under much of the strippable coal.

In areas where the data are closely spaced the configuration of the top of the Madison indicates considerable relief, which may be due to erosion and possibly karst development before overlying beds were deposited. For this reason the contours at the top and the thickness of the Madison are necessarily generalized.

THICKNESS OF MADISON GROUP

The Madison Group is about 100 feet (30 m) thick at the south end of the basin, about 1,000 feet (300 m) thick at the Montana and Wyoming line, and more than 1,400 feet (430 m) thick near the Yellowstone River (thickness map). Where data are available, the combined thickness of the Madison and the underlying carbonate rocks is shown on the map in addition to the Madison thickness. Almost 3,000 feet (900 m) of Madison and underlying carbonate rocks is present in the northeastern part of the basin. The underlying carbonate rocks become progressively thinner southward; the Madison rests on Cambrian rocks in the Casper area and on Precambrian rocks in the Hartville and Lusk areas.

SELECTED REFERENCES

Hodson, W. G., 1974, Records of water wells, springs, oil- and gas-test holes, and chemical analyses of water for the Madison Limestone and equivalent rocks in the Powder River Basin and adjacent areas, northeastern Wyoming: Wyoming State Engineer, 27 p.

Keefer, W. R., and Schmidt, P. M., 1973, Energy resources map of the Powder River Basin, Wyoming and Montana: U.S. Geol. Survey Misc. Geol. Inv. Map I-847-A.

Love, J. D., Weitz, J. L., and Hose, R. K., 1955, Geologic map of Wyoming: U.S. Geol. Survey.

Northern Great Plains Resources Program, 1975, Effects of coal development in the Northern Great Plains: Denver, Colo., 165 p.

Sando, W. J., 1974, Ancient solution phenomena in the Madison Limestone (Mississippian) of north-central Wyoming: U.S. Geol. Survey Jour. of Research, March-April 1974, p. 133–141.

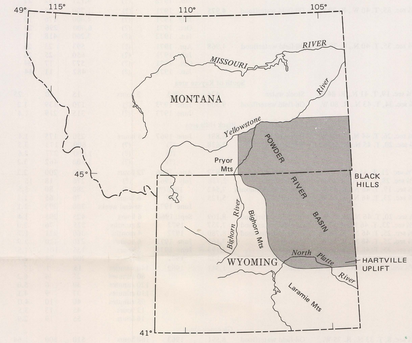
U.S. Bureau of Reclamation, 1972, Report on resources of eastern Montana basins: Spec. rept., 91 p., Aug. 1972 (Groundwater, p. 52–57).

Wyoming State Engineer, 1974, Underground water supply in the Madison Limestone, northeastern Wyoming: Cheyenne, Wyo., prepared for Wyoming State Legislature, 117 p.

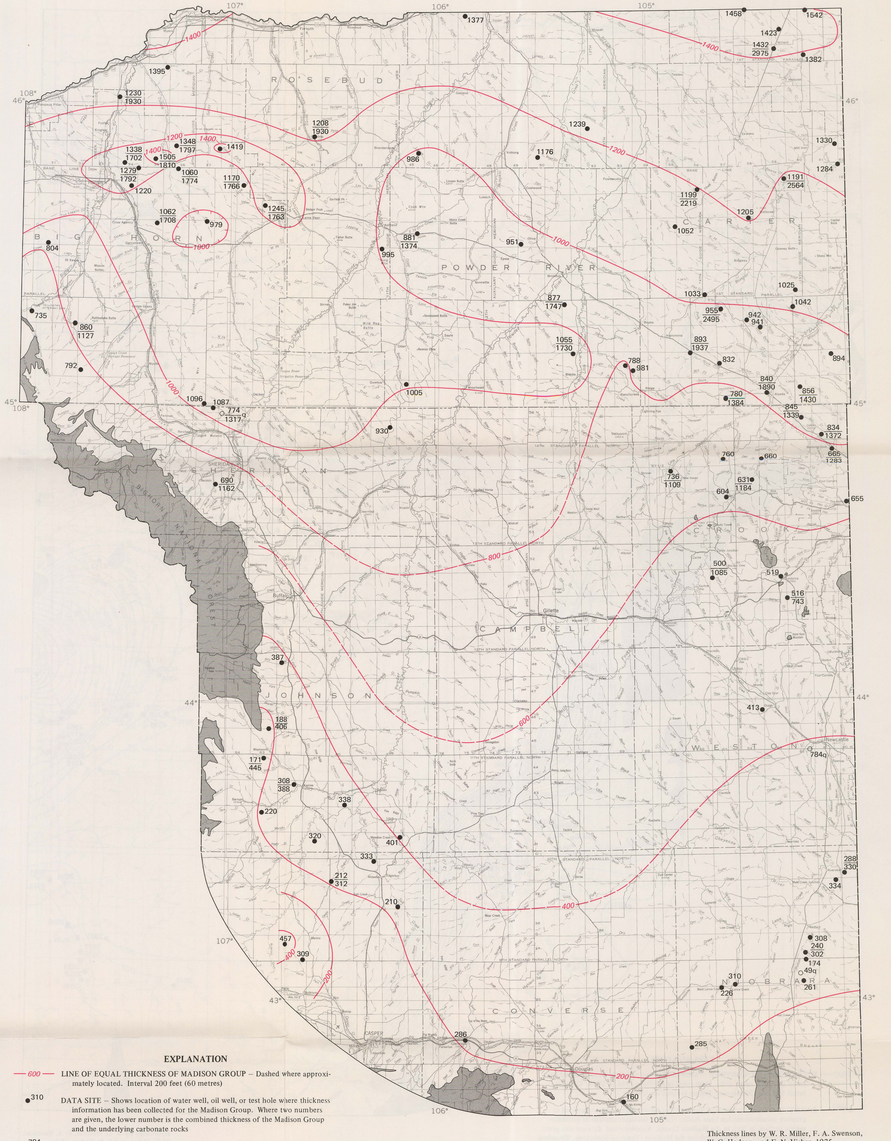
METRIC UNITS

English units used in this report may be converted to metric units by the following conversion factors:

feet (ft)	×	0.3048	=	metres (m)
gallons per minute (gal/min)	×	.06309	=	litres per second (l/s)
gallons per minute per foot [(gal/min)/ft]	×	.207	=	litres per second per metre [(l/s)/m]
acre-feet (acre-ft)	×	1233.	=	cubic metres (m^3)
pounds per square inch (lb/in^2)	×	.07031	=	kilograms per square centimetre (kg/cm^2)
tons (short)	×	.9072	=	tonnes (t)
cubic feet per day per foot [(ft^3/d)/ft]	×	.0929	=	cubic metres per day per metre [(m^3/d)/m]



INDEX MAP SHOWING LOCATION OF STUDY AREA



EXPLANATION

-600- LINE OF EQUAL THICKNESS OF MADISON GROUP – Dashed where approximately located. Interval 200 feet (60 metres)

310 DATA SITE – Shows location of water well, oil well, or test hole where thickness information has been collected for the Madison Group. Where two numbers are given, the lower number is the combined thickness of the Madison Group and the underlying carbonate rocks

784q Questionable data; not used to construct lines

AREA WHERE MADISON GROUP IS ABSENT

Thickness lines by W. R. Miller, F. A. Swenson, W. G. Hodson, and F. N. Visher, 1975

MAP SHOWING GENERALIZED THICKNESS OF THE MADISON GROUP WITH SUPPLEMENTAL DATA ON TOTAL THICKNESS OF THE CARBONATE-ROCK AQUIFER

Interior—Geological Survey, Reston, Va.—1976

Base from U.S. Geological Survey
State base maps, Montana and Wyoming, 1:500,000

SCALE 1:1 000 000

25 0 25 50 75 100 MILES

25 0 25 50 75 100 KILOMETRES

MAP SHOWING CONFIGURATION AND THICKNESS OF THE MADISON GROUP, POWDER RIVER BASIN, WYOMING AND MONTANA

By

F. A. Swenson, W. R. Miller, W. G. Hodson and F. N. Visher

1976

For sale by U.S. Geological Survey
Denver, Colo. 80225 and Reston, Va. 22092, price $1.25 per set.