Regional Aquifers and Petroleum in the Williston Basin Region of the United States

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At least five major aquifers underlie the northern Great Plains of the United States. These aquifers form a hydrologic system that extends for more than 600 miles (965 km) from the recharge areas in the Rocky Mountains to discharge areas in eastern North Dakota and the Canadian provinces of Manitoba and Saskatchewan. The regional groundwater flow system in the aquifers has had a major effect on the water composition within the Williston basin. Hydrodynamic forces involved with the flow system may contribute to the accumulation of petroleum within the basin.

INTRODUCTION

The northern Great Plains region (Figure 1), except for the Black Hills, is a fairly flat, gently rolling surface, underlain mostly by sandstone and shale. The surface is interrupted at places by several hundred feet of topographic relief where streams have dissected relatively soft rock. The northern Great Plains has an area of about 230,000 sq miles (647,500 km²) in the Great Plains and Central Lowlands physiographic provinces of the United States. The area is bounded on the west by the central and northern Rocky Mountains, on the east by the Red River, on the south by the Central Plains, and on the north by the United States-Canadian border. The rocks underlying the area consist of sediment that were eroded from present and ancestral mountains to the west and deposited in the subsiding Williston and Powder River basins and surrounding areas to thicknesses of more than 16,000 ft (4880 m). Several hundred feet of these sedimentary rocks were subsequently eroded, leaving remnants of more resistant rock. The principal aquifers, which are areally extensive, crop out along the flanks of two major basins and along other structural features.

Rocks of Paleozoic and Mesozoic age (Figure 2) form at least five regional aquifers that underlie the northern Great Plains. These aquifers constitute one of the largest confined aquifer systems in the United States (Downey, 1984) with a groundwater flow system extending more than 600 miles (965 km) from mountainous recharge areas in Montana, Wyoming, and South Dakota to discharge areas in eastern North Dakota, eastern South Dakota, and the Canadian provinces of Manitoba and Saskatchewan. The major aquifers are also petroleum reservoirs within much of the region.

The work presented here is based on the data collected by the Northern Great Plains Regional Aquifer-System Analysis Program of the U.S. Geological Survey. Geohydrologic data supporting the various maps, figures, and interpretations in this paper are available in computer-readable form from the U.S. Geological Survey (Downey, 1982).

GEOHYDROLOGIC SETTING

Present-day geologic structure (Figure 1) of the northern Great Plains is related directly to the geologic history of the Cordilleran platform, which is a part of the stable interior of the North American continent. During geologic time, many structural features developed that affected the deposition of the various sedimentary units. Most of these structural features exist today and are important in determining the present hydrologic regime existing in all the aquifer systems underlying the northern Great Plains (Downey, 1984).

On a regional basis, little is known about the water-bearing properties of the Precambrian rocks. Available data indicate they contain only small amounts of water in joints and fractures. These rocks generally are not considered to be water bearing. Along major fractures, however, Precambrian rocks may produce