Land Forms and Ground-Water Regions - Map 1

The shaded relief map of Montana depicts the land surface from an aerial view. Western Montana is dominated by mountain ranges with intervening valleys that are often referred to as intermontane basins or western alluvial basins. The mountains are part of the Rocky Mountain chain that extends northwest and southeast through the state. East of the Rocky Mountain Front and west of the Little Rocky Mountains, the land is relatively flat with small isolated mountain ranges scattered throughout the area. These isolated mountains include; the Sweetgrass Hills, Bearpaws, Little Rocky Mountains, Highwoods, Moccasins, and Judiths. East of the Little Rocky Mountains out to the Montana-North Dakota border, there is a large area consisting almost solely of lowland plains. This area is part of the Northern Great Plains that extends over much of the upper midwestern United States.

Montana's land forms differ significantly from one part of the state to the other (Map 1). The different land forms reflect differences in geology and climate. These factors strongly influence where ground water can be found, the volume of water that is readily accessible, and the natural quality of the water. Montana can be divided into three ground-water regions based on the different land forms and geology (Heath, 1984). Ground-water regions are helpful in understanding the kinds of sedimentary deposits and rocks that are available as potential aquifers in a given area. For more detail on the ground-water regions see Heath, 1984. Differences among the three regions in Montana are highlighted in the following paragraphs.

The western third of Montana and the Bighorn Mountains that cross the Montana-Wyoming border south of Billings, lies within the Western Mountain Ranges Region (Map 1). As the name implies, this region is dominated by mountains. The mountains are geologically complex, and consist of metamorphic and igneous rocks, and are often flanked by consolidated sedimentary rocks. Many mountain ranges were heavily glaciated about 10,000 years ago. When the glaciers melted, they left behind deposits composed of a complex mixture of coarse and fine grained unconsolidated sediments. Most of these deposits are restricted to valleys within the mountain ranges but some glacial deposits extend well into the intermontane basins. For the most part, the intermontane basins are filled with thick deposits of unconsolidated sediments (alluvium) deposited by streams. Aquifers within these unconsolidated deposits are by far the most productive and most intensively used for water supply in this region. Other sources of ground water within this region include the fractured metamorphic and igneous rocks, fractured consolidated sedimentary rocks, and some permeable glacial deposits.

The Glaciated Central Region includes an area in northern Montana that extends east roughly from the Rocky Mountain Front to the North Dakota border (Map 1). Continental glaciers extended into this region during several episodes of glaciation. Deposits of till and outwash sediments were left behind as the continental glaciers retreated. In some places glacial debris buried older stream valleys and the alluvium within the valleys. Buried alluvial deposits represent potentially significant sources of ground water when they can be located. Overall, the glacial deposits in this region are not as well developed or as extensive as those in the upper midwestern United States and are not highly productive sources of ground water. Most of the Glaciated Central Region in Montana is underlain by relatively flat-lying sedimentary rocks that are important sources of ground water in some areas (Heath, 1984). Rivers and smaller streams have cut down through glacial sediments and sedimentary rocks. These modern day rivers and streams have accumulated significant deposits of alluvium. Aquifers within the alluvial sediments are the most productive sources of ground water in the region.

A large portion of Montana lies within the Non-Glaciated Central Region (Map 1). This region lacks large mountain ranges and was not covered by continental glaciers. Small isolated mountain ranges are scattered throughout the west-central part of the region. Sedimentary rocks crop out on the flanks of many of the ranges and plunge into the subsurface away from the mountain front. East of the isolated ranges the sedimentary rocks are relatively flat-lying. Terrace gravels, and substantial alluvial deposits in major stream valleys, are also present. Alluvial aquifers are the most productive sources of ground water.

It is important to note that Montana's mountains play an important role in providing water to recharge aquifers within bedrock (including sedimentary rocks). Mountains in the western U.S. have been aptly described as moist islands in a sea of desert to semidesert land (McGuinness, 1963). Montana's mountains can receive two to three times as much precipitation as nearby lowland areas. This happens because mountains force clouds containing moist air to higher and cooler altitudes where water condenses and falls as rain or snow. Many of the sedimentary rocks that extend beneath eastern Montana are folded upward and exposed along the Rocky Mountain Front, and along the flanks of isolated ranges, such as the Little Rocky Mountains in central Montana. Part of the rainfall and snowmelt generated in the mountain areas seeps into the bedrock and flows away from the mountains. As a result, some ground water in eastern Montana comes from mountainous areas to the west.