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Depth to Deep Alluvium of the Deep Aquifer in the Kalispell Valley: Flathead County, Montana

by

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Author’s Note: This map is part of the Montana Bureau of Mines and Geology (MBMG) Ground-Water Assessment Atlas for the Flathead Lake Area ground-water characterization. It is intended to stand alone and describe a single hydrogeologic aspect of the study area, although many of the area’s hydrogeologic features are interrelated. For an integrated view of the hydrogeology of the Flathead Lake Area the reader is referred to Part A (descriptive overview) and other Part B maps of the Montana Ground-Water Assessment Atlas No. 2.

INTRODUCTION

The Kalispell valley (upper Flathead River valley) is bordered on the east by the Swan and Mission Ranges, on the north by the Whitefish Range, on the west by the Salish Mountains, and on the south by Flathead Lake. Valleys along the lower reaches of major tributaries to the Flathead River, the Swan River, Ashley Creek, and Stillwater River, are included in this discussion. Elevations range between 7,528 ft on the crest of the Swan Range to 2,892 ft, the summer pool elevation of Flathead Lake.

The map shows depth below ground surface to laterally continuous sand and gravel deposits (deep alluvium) that occur below a confining unit made up of glaciolacustrine silt and clay and till (fig. 1). The deep alluvium and fractured bedrock greater than about 100 ft below ground surface host the deep aquifer (LaFave, 2002). The deep aquifer includes a similar interval described by Konieski and others (1968) as the “deep confined aquifer.”

Geologic units exposed in the Kalispell valley area include the Proterozoic Belt Supergroup rocks (Belt rocks) in the mountains and glacial and post-glacial sediments in the mountains, foothills, and valley (Johns, 1970; Harrison and others, 1986, 1992; Smith, 2002c; Smith and others, 2000). Tertiary sedimentary rocks and alluvial sand and gravel correlatives to the deep aquifer are exposed below till in small areas north of Hungry Horse (Smith, 2002c). Except in those few localities north of Hungry Horse, the deep alluvium is only known from drill-hole data.

![Map of Kalispell Valley showing depth to deep alluvium of the deep aquifer.](image-url)
Figure 1. Diagrammatic cross section showing the stratigraphy of basin-fill units in the Kalispell valley.

### BASIN-FILL STRATIGRAPHY

The Kalispell valley is a structurally down-dropped area compared with the uplifted mountains that border the valley. Belt rocks are about 3,000 ft below the surface in the structurally deepest parts of the valley (Smith, 2002a). Above the Belt rocks, consolidated silt, clay, carbonaceous material, and minor sandstone of probable Tertiary age fill part of the valley, and have been encountered in drill holes north of the latitude of Columbia Falls (48° 22' 30"). The deep alluvium is above the Tertiary deposits, consists of gravel, sand, and minor silt, generally produces large volumes of water, and is Kalispell valley’s primary aquifer. Away from the valley margins, no wells completely penetrate the deep alluvium, although the deepest wells on record reach about 750 ft in the Kalispell valley and 1,100 ft in the Swan River valley west of Bigfork. Some wells within a few miles of valley margins penetrate clayey gravel below the deep alluvium, suggesting the existence of buried older till(s), alluvial fan(s), or Tertiary sedimentary rocks. Cementation of either gravel clasts or sand grains in the deep alluvium is not common; it was not present in cuttings examined during the drilling of nine Department of Natural Resources and Conservation observation wells (Ulhman and others, 2000). However, cementation was observed in drill cuttings collected about 3 miles west of Lake Blaine (Shapley, 1990) and has been reported in some drillers logs of water wells.

The deep alluvium overlies by silty and clayey gravel deposits of glaciers (tilt) and by thick beds of silt, clay, silty sand, and local gravel deposits of lakes associated with glaciers (glaciolacustrine sediments) (fig. 1). Locally, alluvium interfingers with till and glaciolacustrine deposits especially along the northern and eastern edges of the valley. In these areas sand and gravel are apparently at intermediate depths between the deep alluvium and “shallow” (surficial) alluvium (as sketched on the west side of fig. 1). Where the beds of intermediate alluvium occur (shown by yellow shading on the map) interpreting relationships between the alluvial units in the subsurface is difficult because few wells penetrate the entire sequence. In some areas the intermediate alluvial units can be shown to either be separated from, or connected to the deep aquifer by differences in hydraulic heads. However, in many areas hydraulic interconnections are unknown. Glaciolacustrine deposits and till are overlain by alluvium along river valleys, glacial meltwater deposits (outwash), and wind-blown (olian) sand, which may contain shallow ground water that is generally not hydraulically connected to the deep aquifer.

The sequence of unconsolidated geologic units in the Kalispell valley (from older to younger—deep alluvium, till, glaciolacustrine deposits, and shallow alluvium) represents deposition during one or more glacial advance and retreat cycles. Deep alluvium was likely deposited both before and during glacial advances. The uppermost beds of deep alluvium most likely were deposited as outwash by meltwater streams in front of the glacier that advanced southward to its terminus near Polson, Montana (Smith and others, 2000). Till was deposited by the glacier(s) forming a blanket-like deposit and a mantle over much of the bedrock in the foothills and mountains. Some areas of greater depth to the deep alluvium can be attributed to scouring of the alluvium, either by glacial ice or by meltwater, followed by backfilling with glacial sediments.

Silty and clayey glaciolacustrine sediments, now exposed locally at the surface, were deposited as the glacier receded. Glaciolacustrine deposits and underlying compact till may form confining units that extend across most of the Kalispell valley (Smith, 2002b). In two large areas along the valley margins, one between Lake Blaine and Echo Lake and the other southwest of the Stillwater River, the stratigraphy appears complex due to sand, gravel, silt, and clay deposited by sediment-laden ice within the glacial lake. These areas are characterized by irregular topography, small lakes, and inconsistent depths to sand and gravel deposits (some of which have been described as intermediate alluvium on the map). Thin alluvial fills within the incised modern valleys of the Flathead, Whitefish, Stillwater, and Swan Rivers were deposited on glaciolacustrine and till deposits after deglaciation.

### VARIATION IN THE DEPTH TO THE DEEP ALLUVIUM

Erosion and deposition at the top of the deep alluvium unit and variation in land-surface topography cause the top of the deep alluvium to be at different depths. In many areas the lateral limit of the deep alluvium is poorly constrained by well data; its approximate extent is shown by a dashed line. It does appear that the depth to the alluvium generally decreases near valley margins. Depths to the deep alluvium are greatest in the area south and east of Kalispell and beneath discontinuous tills that are apparently cut into the unit along the Stillwater Valley and southeast of Columbia Falls.

The existence of beds of alluvium within and below till and glaciolacustrine deposits (intermediate alluvium) makes definitive interpretations of the depths to the deep alluvium difficult in some areas, including from southwest of the Stillwater River to Kalispell and between Lake Blaine and Echo Lake. Well data are sufficient to show that some irregularity in depths to the deep alluvium near Whitefish is due to deposition of alluvial units over glaciolacustrine sediment and clay before deposition of till, possibly during glacial advance into the area. The influence of topography on the traces of contours is seen where hills or valleys are crossed, such as along the Flathead River valley south of Columbia Falls or around the glacially sculpted hills between the Stillwater and Whitefish Rivers.

### RELATIONSHIP BETWEEN THE DEEP AQUIFER AND THE DEEP ALLUVIUM

The deep aquifer refers to the laterally continuous sand and gravel deposits that are generally found at depths greater than 100 ft and fractured bedrock along the valley perimeter (LaFave, 2002). Therefore, the deep aquifer is generally coincident with, but extends beyond the boundaries of, the deep alluvium. In areas where the intermediate alluvium exists (shown by areas shaded yellow) water-level and water-chemistry data suggest that ground water in the intermediate alluvium is in most places part of the deep aquifer system. In areas where aquifer and non-aquifer geologic materials are interlayered, the complexity of the stratigraphy makes identifying a clear boundary between the deep and surficial ground-water flow systems difficult. It is possible that the deep aquifer may be encountered at depths less than 100 ft. The relationship between geologic units coincident with the “deep aquifer” and other geologic materials is shown diagrammatically in figure 1.
ACKNOWLEDGEMENTS

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REFERENCES


Smith, L. N., 2002c, Surficial geologic map of the upper Flathead River valley (Kalispell valley) area, Flathead County, Montana: Montana Bureau of Mines and Geology Ground-Water Assessment Atlas 2, part B, map 6, 1:70,000.


DATA SOURCES

Water-well driller logs and well locations are stored in the Ground-Water Information Center database at Montana Bureau of Mines and Geology (http://mbrngwic.mtech.edu). Ground-surface topographic data are from the 1:24,000-scale U.S. Geological Survey DEMs for western Montana. Public Land System Survey data, hydrography, and roads were obtained from Montana’s Natural Resources Information System, Helena (http://mris.state.mt.us/).