Shallow subsurface geological mapping applied to groundwater resource management in Saskatchewan

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Introduction

In Saskatchewan, with its arid climate, water is a scarce and precious commodity. The occurrence of surface water bodies of significant size is limited. Many of these water bodies are not a reliable water source because of inadequate supply and/or water quality. In the absence of reliable surface water, groundwater has, and continues to play, a significant role in the socio-economic development of the Province. As a result, one of the main driving forces behind shallow subsurface geological investigations in Saskatchewan has been the delineation of groundwater resources.

Southern Saskatchewan has been glaciated at least 6 times, and except for its utmost southern part, is covered by up to 300 m of drift (till and stratified deposits). The Quaternary deposits form large flat-lying deposits, which overlie Late Cretaceous (bedrock) sediments. Potable water supplies are found in both the bedrock and Quaternary sediments.

Quaternary Stratigraphic Framework

While the bedrock stratigraphy was well established in the 1960s, this was not the case for the Quaternary deposits. From 1963 to 1972 the Saskatchewan Research Council (SRC) carried out a testhole drilling program which provided the basis for the province's regional Quaternary geological framework. However, it was not until the establishment of the Quaternary stratigraphy in the late 1960's that systematic regional mapping of these sediments was possible (Christiansen, 1968, 1992).

The development of the stratigraphic framework for the southern portion of the province is relatively unique. The framework is based primarily on testhole data rather detailed sections. Mud rotary drilling has been the most common method to investigate the subsurface Quaternary geological conditions. The stratigraphy of the Quaternary deposits is based on the identification of till units. This is done using texture, carbonate content, presence of oxidation zones, single-point electrical resistance characteristics, on electrical logs (E-logs), and geochemical characteristics.

The regional stratigraphic framework forms the basis for site-specific investigations related to water-supply, geo-technical and environmental studies.

History of Subsurface Geological Mapping Program

In response to the need to characterize and manage the groundwater resources, the Province, through the Saskatchewan Research Council (SRC), has prepared geology and groundwater maps since the mid 1960s. From the onset it was realized that mapping of the Quaternary hydrostratigraphic units needed to be based on stratigraphy rather than lithology.

The first generation of geology and groundwater maps was produced during the period from the mid 1960s to1980. A total of 23 maps at a scale of 1:250,000 were prepared for southern Saskatchewan. These maps show the bedrock geology and surface topography. Each

map is accompanied by four cross sections. Bedrock and regional buried-valley aquifers (predominantly occurring between bedrock and the first till) are identified but the aquifers within the drift are not differentiated.

When Quaternary stratigraphy was established in the late 1960s and applied on a regional scale, it was possible to map aquifers and aquitards within the drift by stratigraphic context. A new generation of geology and groundwater maps by NTS map sheet was initiated in the mid 1980s, using the "stacked-layers" approach to depict the various hydrostratigraphic units within the drift and shallow bedrock. Digitized groundwater maps and associated geological cross sections are now being produced. The location of as many as 20 cross section lines is based predominantly on the distribution of testhole sites for which an E-log (electric log) and geologist log is available. These cross sections establish a three-dimensional picture of the regional hydro-stratigraphic setting. The regional mapping approach does not allow for mapping of small aquifers. These "local" aquifers are important, however, since many communities in Saskatchewan depend on them for their water supply. Site-specific mapping is required to delineate these local aquifers.

A third generation of maps is planned which will utilize GIS and web-site technology to assist with updating, increased public access, visualization, data interpretation and thematic mapping. Digital geology and groundwater data are increasingly used for the preparation of thematic maps, which are used in the development, management, and protection of groundwater resources.