Canadian Achievements in Hydrogeology 1880 - 1980s

Searching for Groundwater (1880-1980s)

1880s: **Geological Survey of Canada (GSC)** began the search for groundwater in Canada.

Late 1800s: The first Canadian municipal systems supplied by groundwater were established.

1915: **GSC** publications began to include discussion and maps of groundwater conditions in northwest Ontario and part of the Prairies.

Early 1930s: **GSC** publications with a groundwater focus first appeared.

1930-1934: **GSC** responded to acute shortage in rainfall and surface water supply with an extensive groundwater investigation. Results were published in **Water Supply Papers** aimed at farm residents, municipal bodies and well drillers to assist in finding a groundwater source.

1936-1980s: Similar studies were conducted in other parts of Canada by the GSC and the **National Hydraulic Research Institute** focussing on processes and unique depositional environments (e.g., glaciers, deltas, saltwater intrusion).

Mid-1950s to Mid-1980s: Many provincial governments established agencies to study and manage groundwater. The first was the **Ontario Water Resource Commission**, under the direction of **Berry** and **Watt.** In eastern Canada, **Jones** was the first practicing groundwater specialist in the **Groundwater Section** of the **Nova Scotia Department of Mines** established in 1963. In Québec, a major expansion in mapping groundwater resources and their development, notably for municipal water supply, was led by the **Ministère des Ressources naturelles** and involved companies such as Foratek and Compagnie International des Eaux. In BC, the Groundwater Program was established in 1961 and led by **Livingston**.

1880

1915

1930

1940

1950

Research Councils (1950s)

1955: **Farvolden** led the formation of groundwater programs at the **Research Council of Alberta (RCA)**. Staff included **Toth**, **Meneley**, **Patton**, **Jones**, **LeBreton** and **Lennox**. In the early 1960s this group, along with others in Canada, developed fundamental understanding of groundwater theory and processes.[1]

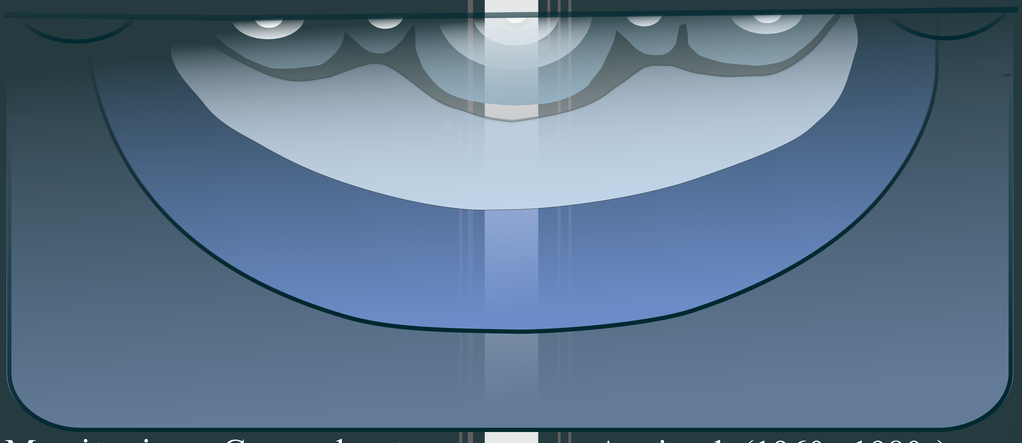
Late 1950s: A groundwater group was formed at the **Saskatchewan Research Council (SRC). Christiansen** and **Meneley** undertook extensive test drilling programs during the 1960s, establishing the geological framework for the major regional aquifers.

Regional Groundwater Flow (1955-1970)

Early 1960s: The Prairies were the focus of many groundwater studies by the **ARC,** including **Meyboom's** ground-breaking study of the Milk River Aquifer.[2] **Meyboom** and **Toth** conducted a famous field trip to inspect field phenomena associated with groundwater flow patterns in southern Alberta in 1961.[3] **Meyboom** then led the **GSC's Groundwater Section** in conducting additional Prairie hydrogeological studies. Staff included **Brandon**[4], **Freeze, van Everdingen** and **Banner.**

1962 & 1963: **Toth** published analytical solutions for steady-state flow through homogeneous, isotropic, media and presented concepts of local, intermediate and regional flow systems.[5,6]

1965: **Toth** received the first **Meinzer Award** from the Geological Society of America for his 1963 paper *A theoretical analysis of groundwater flow in small drainage basins.*[6]



Monitoring Groundwater (1946 to 1970s)

1946: First **provincial groundwater level observation well network** established by the Ontario Department of Mines. Provincial networks were later established in British Columbia, Alberta, Saskatchewan, Manitoba Nova Scotia, Prince Edward Island and Québec.

High Resolution Contaminant Mapping (1958-1985)

1958-1963: **Parsons**[11,12] and **Merritt**[13] conducted the earliest studies of contaminant plumes at **Chalk River Nuclear Laboratories** in Ontario. These studies were followed up by detailed investigations that have illuminated the processes of radionuclide transport and redox systems in shallow flow systems.

1975-1985: **Atomic Energy of Canada Ltd. (AECL)** investigated granitic plutons for deep geological disposal of high level nuclear waste in northern Ontario and established an Underground Research Laboratory in Manitoba. Initially led by **Gale** of the **GSC** and subsequently by **Grisak** at **Environment Canada**, detailed hydrogeological investigations resulted in a much improved understanding of groundwater flow systems and the hydrogeochemistry of fractured igneous rocks.

Publications

1967: The **GSC** published *Groundwater in Canada*[14], a milestone report that provided synthesis of available scientific knowledge of Canada's groundwater resources.[10]

University Research (1967-Present)

Cherry became Canada's first professor of hydrogeology in 1967. **Farvolden** became the second. Groundwater research programs have now expanded to more than a dozen universities across Canada.

1960

1970

Aquitards (1960s-1980s)

Early 1960s: Initial qualitative consideration of shale and till as aquitards likely dates to the early 1960s in Canada when **Meyboom** presented concepts of the Prairie profile.

1968: The first study of an aquitard in a contaminant hydrogeology context was initiated by **Cherry** at the Whiteshell Nuclear Research Establishment.

1970s: Field studies and quantitative analysis of flow and tracer movement in clay-rich Quaternary aquitards showed that fractures may be present even when they are not visible and increase the bulk permeability by orders of magnitude.[7,8] Solute transport is diffusion-dominated and pore waters contain a mixture late Pleistocene and modern water.[9]

Canada continues to be a leader in aquitard hydrogeology.

Field versus Theory (1962)

1962: **Hydrology Symposium No. 3** held at the University of Alberta, Calgary. The Proceedings[10] include discussions and provide an excellent summary of understanding of Canadian hydrogeology at the time. Discussions on field versus theoretical approaches to groundwater flow systems by **Toth** and **Meyboom** are legendary.

The Dawn of Numerical Modelling (late 1960s)

Late 1960s: Three Canadian hydrogeologists were simultaneously developing finite-difference models for application to groundwater flow and aquifer development issues. **Freeze** and **Witherspoon** developed numerical techniques to solve groundwater flow equations in heterogeneous and anisotropic areas of variable shape and water table configurations, i.e., the flow-pattern issue.[15,16,17] **Pinder** evaluated the **Musquodoboit Harbour Aquifer** near Halifax[18], which he had studied earlier during his work with the **Nova Scotia Government**. **Frind**[19] worked with **Farvolden** on the regional dewatering project for the re-development of the Welland Canal.