2024 Birdsall-Dreiss Distinguished Lecturer

Schedule 2024 lecture:

Institutions can schedule a visit by completing the request form at Ben Rostron Request Form

The GSA Hydrogeology Division has selected Dr. Ben Rostron as its 2024 Birdsall-Dreiss Distinguished Lecturer. Ben is a Professor Emeritus of Earth & Atmospheric Sciences at the University of Alberta and the President of Isobrine Solutions Inc. He has a BASc in Geological Engineering (1986) from the University of Waterloo, and an MSc (1990) and PhD (1995) in Geology from the University of Alberta. Ben received his graduate training under the supervision of Dr. József Tóth. Ben's PhD thesis on the regional hydrogeology and hydrochemistry of the Phanerozoic strata in west-central Alberta demonstrated how regional groundwater flow impacted oil migration/entrapment in economically significant units in the basin.

Ben started his academic career teaching Geological Engineering at the University of Saskatchewan in 1994. While there, he started mapping the hydrogeology and hydrochemistry of the Williston Basin, work that continues to this day. He collected his first wellhead formation-water sample in 1996 and since then there are very few deeper formations/areas in Saskatchewan that he hasn't sampled. Ben was lured back to join the newly created Department of Earth & Atmospheric Sciences at the University of Alberta in 1997, where he taught Regional and Petroleum Hydrogeology until retiring the end of 2021. His academic career leaned towards applied research: applying hydrogeology and hydrochemistry to tackle numerous significant real-world problems.
Early field-sampling programs led to the creation of a University spin-off company (Isobrine Solutions Inc.) in 2004. In 1999, Ben helped found the IEA-GHG Weyburn-Midale CO_2 Monitoring and Storage Project, one of the first large-scale CO2 sequestration projects in the world. Ben served as the Hydrogeology Coordinator and his research group was one of 80+ research providers throughout Phase 1 of the project (2001–2004). Ben continued as the Geology/Hydrogeology Theme Leader for the Final Phase (2005–2011). Following the Weyburn project, Ben helped create the Aquistore CO_2 Monitoring and Storage Project, part of SaskPower's Boundary Dam Project, the world's first zero-emission coal-fired power plant. He drilled the two 3400 m deep CO_2 injection and monitoring wells, and designed and implemented the shallow groundwater monitoring program. In parallel, his 2002 publication on "Economic Potential of Formation Brines" and follow-up publications have provided most of the lithium concentration data for brines in Saskatchewan. That work led to an understanding of the unique distribution of lithium in the subsurface, a rush for mineral brine permits in Saskatchewan, and ultimately, in part to the creation of several new lithium exploration/production companies attempting to exploit a new type of lithium-brine resource in the province.

Ben is a Fellow of GSA, of Engineers Canada, and of Geoscientists Canada and has won several awards for oral/poster presentations and volunteer service. Ben is married to Catherine (34+ years) and has two children, Alex and Sarah.

Ben is pleased to offer three talks (abstracts below):
1) Lithium in brines (Duperow Aquifer) in southeast Saskatchewan: a modern-day gold rush.
2) Geology and hydrogeology at Aquistore: Canada's first CO_2 storage project associated with a commercial-scale coal-fired power plant.
3) Groundwater and native orchids: is there a link (and why might anyone care)?

Each of these talks fits within an overall theme of manifestations of regional groundwater flow. A secondary message in all three talks is that hydrogeology plays a fundamental role in each of these diverse disciplines (economic geology, carbon capture and storage, and ecohydrology). Students should continue to pursue careers in hydrogeology. We will need them.

Abstracts

1: Lithium in brines (Duperow aquifer) in southeast Saskatchewan: a modern-day gold rush

There is currently an enormous exploration interest in brine-hosted lithium from the Duperow/Leduc aquifer in Western Canada. Published concentrations of lithium up to 259 mg/L are found in southeast Saskatchewan, significantly higher than those currently being exploited further west in west central Saskatchewan and Alberta. Yet, the origin of this difference within a single formation has received little attention in the open literature. The question remains: what controls the distribution of lithium in subsurface brines? A second question is: why are there extreme variations in lithium concentrations mapped very close together?

An exploration and testing program was conducted in 2020-2022 to better understand the distribution of lithium in the Duperow aquifer in southeast Saskatchewan. First, a refined lithostratigraphy was developed subdividing the Duperow Formation into 24 mappable units across the area. Second, lithium concentration data were inserted into this refined lithostratigraphy. This led to the identification of widespread continuous zones with correlatable lithium concentrations across the area. Furthermore, putting multiple measurements from a single well (or nearby wells) in their correct stratigraphic position explains the origin of some of the large differences in concentration measurements from the same well: different zones in the Duperow aquifer in the same location can have different lithium concentrations. An exploration program followed, which included drilling one new well, re-completing a nearby well, and re-entering and deepening a third well.

In the first well, lithium concentrations from eight individual zones of the Duperow aquifer ranged from 48 to 173 mg/L. Three of the same individual zones were tested approximately 20 km away in the second well and results were between 53 and 170 mg/L. Zonal concentrations correlated between the wells, over a distance of approximately 20 km. These results support the newly-developed exploration model of a widespread layered distribution of lithium in the Duperow aquifer. The layered distribution of lithium was supported by the third well 7 km

further north, albeit with slightly lower concentrations (up to 137 mg/L). However, the final story remains to be told: recent results from a series of wells drilled by a different operator 40 km further northeast have yielded concentrations as high as 259 mg/L. Further drilling is underway.

This talk will review this new type of brine-hosted lithium resource from southeast Saskatchewan and provide the latest public results from this active exploration play.

2: Geology and hydrogeology at AQUISTORE: Canada's first CO_2 storage project associated with a commercial-scale coal-fired power plant

The Aquistore research project is part of SaskPower's Boundary Dam Integrated Carbon Capture and Storage project in Estevan, Saskatchewan, Canada. Carbon dioxide is captured from the Boundary Dam coal-fired power generation station and transported via underground pipeline to both the Weyburn oil field for EOR, and to a 3400 m deep injection well at Aquistore. Initial CO_2 injection at Aquistore took place in April 2015, and through August 2023 more than 500,000 tonnes have been injected.

Geology and hydrogeology have played a key role in the entire project using both pre-existing and newly-acquired data. Hydrogeological characterization efforts were divided into four parts: regional hydrogeological and hydrochemical mapping of the site; hydraulic characterization of the storage zone during drilling/testing of the 3400m deep injection and nearby 3400m deep observation well; installation of an extensive shallow groundwater monitoring network; and on-going hydrogeological and hydrochemical monitoring of the shallow groundwater in the area.

All of the geological and hydrogeological characterization results indicate strongly favorable conditions for geological storage at the site: there are no significant faults in the immediate area of the storage site; the regional sealing formation is continuous in the area; the reservoir is not adversely affected by knolls on the surface of the underlying Precambrian crystalline basement; and the shallow groundwater and soil gas horizons do not appear to be hydraulically connected to the deep injection horizons in the subsurface. These results were subsequently used for project planning, risk assessment, and permitting of the site; demonstrating the overall storage integrity; and for Measurement, Monitoring, and Verification of CO_2 storage for regulatory and public assurance.

This talk will highlight some of the geology and hydrogeology results from Aquistore, and provide an update on a couple of the more interesting outcomes of the project thus far.

3: Groundwater and native orchids: Is there a link (and why might anyone care)?

There are over 200 species of native orchids (*Orchidaceae*) found throughout North America. Many years of field observations of the type and abundance of orchid populations have revealed a striking (albeit qualitative) link to groundwater flow systems. There appears to be a correlation between orchid species and the ecosystem position within the "Unit Basin" of regional groundwater flow. A fourfold "classification" scheme for the native orchids of Alberta was

proposed: those found in discharge, recharge, and midline areas, and a group that shows no general preference.

To test the hypothesis that position in the groundwater flow system controls at least part of the distribution of (certain) orchid species, soil moisture conditions and topography were measured at flowering sites for three closely-related species of *Spiranthes* in Nova Scotia, Canada. Results showed a threefold distribution with species found in dry, intermediate to dry, and wet slope bottoms. At one site where all three species were found, there was a clear spatial demarcation based on soil moisture and topography. These three species would be located in the recharge, midline, and discharge areas, respectively.

Recognition of a linkage between the groundwater regime and native orchids is significant for a number of reasons. First, for locating orchid populations, it is often useful to make use of the relationship between topography and flow systems: if one can predict from the topography the position in the groundwater flow regime, it can be very helpful in locating previously unknown populations of plants. Second, for understanding habitat function, knowledge of the hydrogeology and hydrology of the ecosystem is of prime importance. Third, for habitat protection and/or restoration, it is critically important to understand the source of the groundwater flow system to ensure adequate protection of the entire flow system supporting the orchid population. For example, orchid populations near a spring might be protected at the actual point of groundwater discharge, but the recharge area feeding the spring often remains unprotected and open to disturbance. Thus, a knowledge of the linkage between groundwater flow systems and native orchids is important.