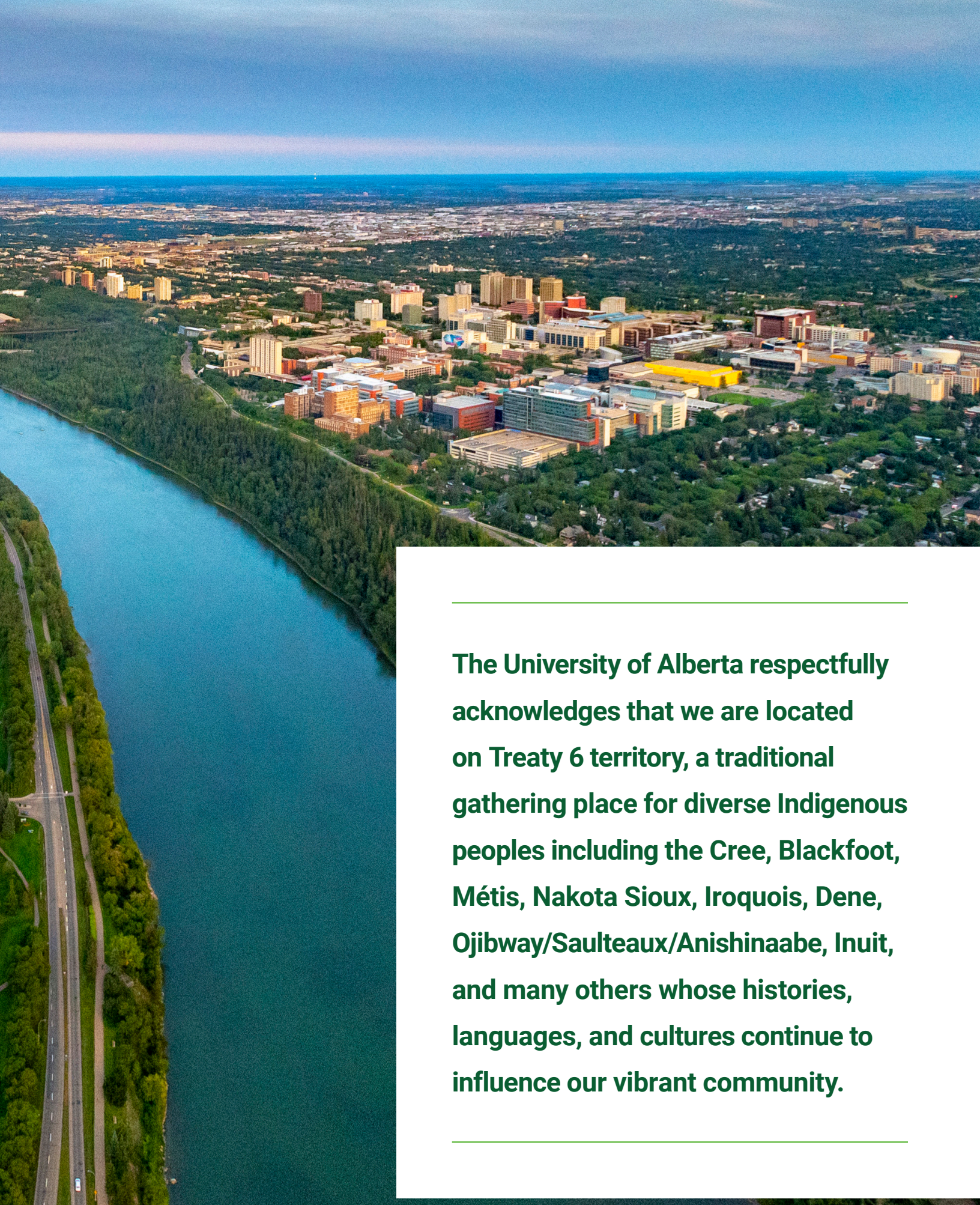
UNIVERSITY OF ALBERTA

May 2023

Encana Chair in Water Resources

Dr. Daniel Alessi | 2023 Chair Report
Faculty of Science, College of Natural + Applied Sciences



The University of Alberta respectfully acknowledges that we are located on Treaty 6 territory, a traditional gathering place for diverse Indigenous peoples including the Cree, Blackfoot, Métis, Nakota Sioux, Iroquois, Dene, Ojibway/Saulteaux/Anishinaabe, Inuit, and many others whose histories, languages, and cultures continue to influence our vibrant community.

A special thank you

The Encana Chair in Water Resources continues to provide a platform to improve the sustainable use of water resources in Canada, and supports the training of the next generation of leaders in water science.

Dr. Daniel Alessi

North Saskatchewan River near Abraham Lake

Overview

53,573
Reads of 231 documents on *ResearchGate*

7,076
Citations on *ResearchGate*

Our primary focus in the 2022-23 academic year was on continuing to develop sorbents to recover lithium from brines, including those derived from oil and gas operations in western Canada. Research funds provided by the Encana Chair endowment and the Future Energy Systems program at the University of Alberta supported a team of five students and researchers who quickly developed, tested, and optimized several promising direct lithium extraction (DLE) ion exchange materials that are highly selective towards lithium and robust after repeated use. Both of these metrics are essential to the successful scale-up and implementation of the technology at commercial scale.

An exciting development in the lithium extraction space has been the growth of a budding collaboration with Barkley Project Group and with Deh Tai Limited, an economic development corporation wholly owned by the Fort Nelson First Nation. This team is developing energy resources at the Tu Deh-Kah Geothermal site in northeastern British Columbia. Using endowment funding, we conducted preliminary geochemical testing of deep sedimentary brines from that geothermal resource to identify if it is prospective for critical mineral resources such as lithium, in anticipation of conducting lithium extraction testing with our optimized DLE sorbents. Additionally, we continued a collaboration with EPCOR, the utility company that provides water to over 1.5 million residents of the Edmonton region. This program, aimed at understanding the hydrology and hydrogeology of the Edmonton region and identifying alternative groundwater sources, is nearing completion in 2023. Due to the success of this research program, EPCOR supported a new three-year project that builds on knowledge gained over the past three years. To support the program, we applied to the Alberta Innovates – Water Innovation Program for financial support, which was awarded in early 2023. Our applied research promises to ensure stable and sustainable water resources to the Edmonton region that considers land use, climate change, and water use challenges in the future.

Impact + Outcomes

17
Students and researchers in the Alessi Lab

A primary focus of my group in 2022-23 was the further development of ion exchange materials for direct lithium extraction (DLE) in brines, a line of research that supported a research associate, a PhD student, and three MSc students. Among the most critical barriers to the commercialization of brine resources in western Canada is the development of DLE sorbents that are resistant to chemical and mechanical degradation, are constructed from easy-to-source reagents, and can be scaled up to perform economically in a commercial extraction plant. To this end, we continued to develop a class of lithium manganese oxide (LMO) spinel synthetic minerals that are known to have high selectivity towards the relatively low concentrations of lithium present in many sedimentary brines.

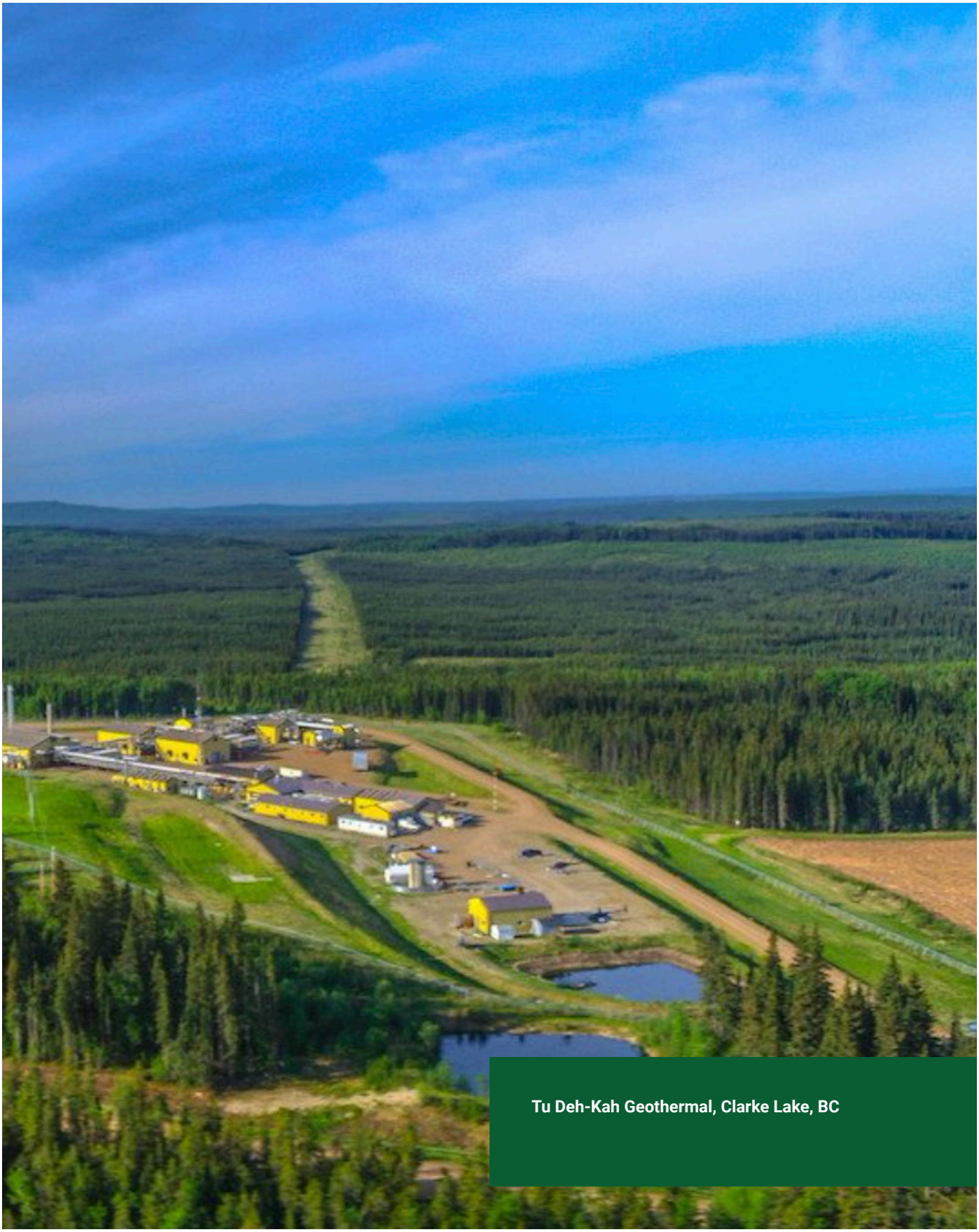
"I was inspired early on by an undergraduate mentor to study water, and as I've gone through my graduate degrees and become a faculty member, I've realized how important water is, and I'm inspired now to train a new generation of students." - Dr. Daniel Alessi, Jan. 10, 2023

Adam Seip

The research of a former MSc student, Adam Seip, found that LMOs are subject to gradual dissolution due to reactions with organic compounds and hydrogen sulphide found in many brines, issues that severely hamper the scale-up of LMOs and their application in industry. To address this problem, two graduate students, Karthik Shivakumar and Fangshuai Wu, continued to modify LMOs by coating them with a thin, porous veneer to prevent sorbent dissolution, as well as doping them with additional elements to stabilize the sorbent. Substantial progress was made over the past year, allowing us to move forward with laboratory-scale prototype testing of selected LMOs, a key next step in their commercialization.

To tackle the sorbent dissolution problem from a different angle, Bennett Braun has focused his MSc thesis research on the aeration of brines as a pre-treatment step to remove organic compounds prior to the DLE process. Building on past collaborative work that studied flowback and produced water (FPW) provided by Ovintiv, he found that aeration causes the oxidation of dissolved iron in FPW. This oxidation leads to the formation of iron rust particles that can adsorb organic compounds from solution. Upon filtration, the particles and adsorbed organics are removed from solution, improving the quality of the brine that is fed to LMOs for lithium extraction. We anticipate testing the modified LMOs on Canadian brines in 2023-2024.

Through a new collaboration with Dr. Nicholas Harris (Earth and Atmospheric Sciences, U of A), we began conversations with Barkley Project Group and Deh Tai Limited, who have partnered to develop energy resources at the Tu Deh-Kah Geothermal project in northeast British Columbia. Preliminary brine testing for lithium, supported by Encana Chair endowment funding, indicates there may be economic concentrations of lithium. We anticipate conducting bench-scale and laboratory prototype testing of lithium extraction from these brines to build a case for the development of lithium resources at Fort Nelson First Nation. In addition to these internal research pursuits, we collaborated with international colleagues to review and study methods to extract lithium from spent lithium-ion batteries. These collaborations resulted in two recent publications in the peer-reviewed journals *Renewable and Sustainable Energy Reviews* and E*nvironmental Science & Technology*.



Tu Deh-Kah Geothermal, Clarke Lake, BC

“Faced with continued growth, climate change, and the potential for increased use and contamination, the Edmonton region needs a plan to sustainably manage water resources in the coming decades.”

My group continued to have a fruitful collaboration with EPCOR, supported by the Alberta Innovates – Water Innovation Program, to study water resources in the greater Edmonton region. The emphasis of our work, involving several faculty members in the Department of Earth and Atmospheric Sciences at U of A, moved from data collection and fieldwork to modelling and the writing of theses and papers as the project is set to end in 2023. Several novel and useful results were obtained, including improved mapping of pre-glacial buried channels in and around Edmonton that may prove to be valuable resources for groundwater extraction; the identification of the most promising regions of these channels for water extraction; and the completion of a numerical groundwater model that constrains the maximum sustainable water extraction rates for a range of scenarios valuable to EPCOR’s operations.

As this program ends, we have trained one postdoctoral researcher, five graduate students, and several undergraduate research assistants, many of whom have moved on to the next steps in their careers or to further graduate studies. Because of the success of this program, we renewed our relationship with EPCOR for an additional three years and were awarded a new three-year grant from Alberta Innovates in 2023. Faced with continued growth, climate change, and the potential for increased use and contamination, the Edmonton region needs a plan to sustainably manage water resources in the coming decades. The renewed research program focuses on developing a better understanding of the urban water cycle in the City of Edmonton in order to optimize water use, protect the local watershed, and aid the city in economic planning. We anticipate that the tools developed for Edmonton can be applied to other communities in Alberta and Canada.

Additional Achievements

This year was marked by several student successes, with two students being awarded Natural Sciences and Engineering Research Council of Canada (NSERC) – Canada Graduate Scholarships with accompanying Walter H. John's Graduate Fellowships from the U of A, and a third winning the Aberdeen Graduate Award in Geology, also from the U of A. Dr. Cheng Zhong, a graduated PhD student, successfully landed a faculty position at the Southwest Petroleum University in Chengdu, China, while Dr. Ashkan Zolfaghari moved from his position as a Research Associate in my group to employment as a Senior Technology Development Advisor with Suncor in early 2023. I was fortunate to be selected for a 2022 Distinguished Alumni Award from my undergraduate alma mater, the University of Wisconsin – Parkside, and in November 2022, I was inducted as a member of the College of New Scholars, Artists and Scientists of the Royal Society of Canada. With pandemic restrictions lifted, most of my research group attended the Geological Society of America National Meeting in Denver, Colorado in October, where many students gave their first scientific presentations at an international professional conference.

What's next?

We will have two primary focuses in 2023-24 related to the Encana Chair endowment funding: the further development of ion exchange materials to recover lithium from brines, and studying water resources in the Edmonton region in collaboration with EPCOR and with renewed Alberta Innovates project funding. Over the past year, we have developed a subset of lithium ion exchange materials that are promising for use in oilfield brines, and we will proceed to the testing phase of these technologies at the laboratory prototype scale. In the project with EPCOR, we anticipate the completion of several peer-reviewed manuscripts from the research of prior graduate students, and will have an increased focus moving forward on finer-scale assessments of water resources in the Edmonton region. As in past years, research funding from the endowment will support student salaries and research costs, and the attendance of group members at international conferences.


Welcome To
FORT NELSON FIRST NATION
A NATION.A PEOPLE
STRONG, HEALTHY, PROUD & SELF RELIANT

Leading with Purpose.

UNIVERSITY OF ALBERTA

Office of the Vice-President (External Relations)

Ashleigh Baird
Corporate Relations
T. 780-995-6828
E. ambaird1@ualberta.ca

ualberta.ca/science