

GEOSCIENCE BC SUMMARY OF ACTIVITIES 2021: ENERGY AND WATER

© 2022 by Geoscience BC.

All rights reserved. Electronic edition published 2022.

This publication is also available, free of charge, as colour digital files in Adobe Acrobat® PDF format from the Geoscience BC website: <http://www.geosciencebc.com/updates/summary-of-activities/>.

Every reasonable effort is made to ensure the accuracy of the information contained in this report, but Geoscience BC does not assume any liability for errors that may occur. Source references are included in the report and the user should verify critical information.

When using information from this publication in other publications or presentations, due acknowledgment should be given to Geoscience BC. The recommended reference is included on the title page of each paper. The complete volume should be referenced as follows:

Geoscience BC (2022): Geoscience BC Summary of Activities 2021: Energy and Water; Geoscience BC, Report 2022-02, 102 p.

Summary of Activities: Energy and Water (Geoscience BC)

Annual publication

ISSN 2562-2757 (Print)

ISSN 2562-2765 (Online)

Geoscience BC

1101–750 West Pender Street

Vancouver, British Columbia V6C 2T7

Canada

Front cover photo and credit: Team from the Geoscience BC–funded GHGMap project prepare to demonstrate the GHGMapper™ aerial drone, which can detect and quantify methane emissions, at a FortisBC gas distribution plant in Metro Vancouver Regional District. Photo by D. Stenzel (March 2021).

Foreword

Geoscience BC is pleased to once again present results from our ongoing projects and scholarship recipients in our annual *Summary of Activities* publication. Papers are published in two separate volumes: *Minerals*, and this volume, *Energy and Water*. Both volumes are available in print and online via www.geosciencebc.com.

Summary of Activities 2021: Energy and Water

This volume, *Summary of Activities 2021: Energy and Water*, contains 10 papers from Geoscience BC–funded projects and scholarship recipients that are within Geoscience BC’s strategic focus areas of energy and water. The papers are divided into five sections, based on Geoscience BC’s strategic objectives of

- 1) Identifying New Natural Resource Opportunities,
- 2) Advancing Science and Innovative Geoscience Technologies,
- 3) Facilitating Responsible Natural Resource Development,
- 4) Enabling Clean Energy, and
- 5) Understanding Water.

In the ‘Identifying New Natural Resource Opportunities’ section, Wilson et al. introduce a new Geoscience BC project aimed at compiling an initial inventory dataset of lithium and other dissolved-metal brine data for northeastern British Columbia (BC). Zoshi et al. highlight another new project in the ‘Advancing Science and Innovative Geoscience Technologies’ section; it focuses on a pilot project to test a zero-liquid-discharge technology that could provide BC’s oil and gas sector with an economic and sustainable alternative for produced water disposal. Mackie et al. examine the local stratigraphic and facies context that coincides with elevated levels of hydrogen-sulphide distribution within the Montney Formation.

The ‘Facilitating Responsible Natural Resource Development’ section contains three papers focused on induced seismicity in northeastern BC. Mehrabifard and Eberhardt consider the effects of stiffness on injection-induced seismicity, and Wang et al. develop a model to better understand seismogenic behaviours of injection wells in the Kiskatinaw Seismic Monitoring and Mitigation Area. Esmaeilzadeh and Eaton evaluate the relationship between structural corridors, pressure terranes and geomechanical parameters in the Septimus field.

In the ‘Enabling Clean Energy’ section, Whitar and Wiebe summarize the wealth of information now available in the enhanced BC Natural Gas Atlas. Grasby et al. expand earlier geothermal studies in southwestern BC to Mount Cayley, and Hanneson and Unsworth discuss magnetotelluric investigations of geothermal systems in southeastern BC and at Mount Meager. Finally, in the ‘Understanding Water’ section, Lapp et al. provide an update on collaborative water monitoring work in northeastern BC.

Geoscience BC Energy and Water Publications 2021

Geoscience BC published the following eight Energy and Water reports in 2021:

- Sixteen technical papers in the **Geoscience BC Summary of Activities 2020: Energy and Water** volume (Geoscience BC Report 2021-02)
- **Garibaldi Geothermal Energy Project – Phase 1: Final Report**, by S.E. Grasby, S.M. Ansari, R.W. Barendregt, A. Borch, A. Calahorrano-DiPatre, Z. Chen, J.A. Craven, J. Dettmer, H. Gilbert, C. Hanneson, M. Harris, F. Hormozzade, S. Leiter, J. Liu, M. Muhammad, S.L. Quane, J.K. Russel, R.O. Salvage, G. Savard, V. Tschirhart, M.J. Unsworth, N. Vigouroux-Caillibot, G. Williams-Jones, A. Williamson and Z.E. Vestrum (Geoscience BC Report 2021-08)
- **Assessment of Fugitive Natural Gas on Near-Surface Groundwater Quality**, by B. Ladd, C.J.C. Van De Ven, J. Chao, J. Soares, T. Cary, N. Finke, C. Manning, A.L. Popp, C. Chopra, A.G. Cahill, K.U. Mayer, A. Black, R. Lauer, C. van Geloven, L. Welch, S. Crowe, B. Mayer and R.D. Beckie (Geoscience BC Report 2021-10)
- **Development of an Induced Seismicity Susceptibility Framework and Map for NEBC using an Integrated Machine Learning and Mechanistic Validation Approach**, by A. Amini, A. Mehrabifard and E. Eberhardt (Geoscience BC Report 2021-11)

- **Real-Time Monitoring of Seismic Activity in the Kiskatinaw Area, Northeastern British Columbia (NTS 093P, 094A)**, by D.W. Eaton, R.O. Salvage, K. MacDougall, T.H. Swinscoe, J. Dettmer, Z. Esmailzadeh, C. Furlong, M. Hamidbeygi, P. Igweze and P. Wozniakowska (Geoscience BC Report 2021-12)
- **Wastewater Disposal in the Maturing Montney Play Fairway of Northeastern British Columbia**, by Petrel Robertson Consulting Ltd. (Geoscience BC Report 2021-14)
- **Peace Region Scientific Groundwater Monitoring Network Installation Study**, by M. Goetz, A.J. Allen, B. Ladd, P.S. Gonzalez, A.G. Cahill, D. Kirste, L. Welch, B. Mayer, C. van Gelovan and R.D. Beckie (Geoscience BC Report 2021-16)
- **Monitoring Induced Seismicity in the Montney, Northeast British Columbia**, by A.M.M. Bustin, D. Jones, G. Chalmers, A. Amini and R.M. Bustin (Geoscience BC Report 2021-18)

All releases of Geoscience BC reports, maps and data are published on our website and announced through our website and e-mail updates. Most final reports and data can be viewed or accessed through our Earth Science Viewer at <https://gis.geosciencebc.com/esv/?viewer=esv>.

Acknowledgments

Geoscience BC would like to thank all authors and reviewers of the *Summary of Activities* for their contributions to this volume. COVID-19 once again made this a challenging year for all our field programs and laboratory research, and Geoscience BC continues to be grateful for the perseverance of our researchers and scholarship recipients in continuing their projects.

RnD Technical is also acknowledged for its work in editing and assembling both volumes. As well, Geoscience BC would like to acknowledge the Province of British Columbia and our project funding partners for their ongoing support of public geoscience, and express our appreciation for the leaders and volunteers in British Columbia's mineral exploration, mining and energy sectors who support our organization through their guidance, use and recognition of the data and information that we collect and distribute.

Carlos Salas
Chief Scientific Officer
Geoscience BC
www.geosciencebc.com

Contents

<h3>Identifying New Natural Resource Opportunities</h3>	
<p>T. Wilson, C. Williams, E. Pelletier, D. Murfitt, K. Rakhit and H. Abercrombie: Northeastern British Columbia lithium formation-water database: forging the plan, process and path.</p>	1
<h3>Advancing Science and Innovative Geoscience Technologies</h3>	
<p>J. Zoshi, B. Sparrow and H. Tsin: Novel zero-liquid-discharge pilot project for produced water management, northeastern British Columbia</p>	9
<p>S.J. Mackie, C.M. Furlong, P.K. Pedersen and O.H. Ardakani: Relation of stratigraphy and facies heterogeneities to hydrogen sulphide distribution in the Montney Formation of northeastern British Columbia.</p>	13
<h3>Facilitating Responsible Natural Resource Development</h3>	
<p>A. Mehrabifard and E. Eberhardt: Numerical study on the effects of Montney Formation stiffness on injection-induced seismicity in northeastern British Columbia.</p>	23
<p>B. Wang, H. Kao, H. Yu, R. Visser and S. Venables: Comprehensive physical model for the contrasting seismogenic behaviours of injection wells in the Kiskatinaw Seismic Monitoring and Mitigation Area, northeastern British Columbia.</p>	35
<p>Z. Esmailzadeh and D.W. Eaton: Investigating fault-sealing effects on induced seismicity and pore pressure distribution in northeastern British Columbia: observations.</p>	49
<h3>Enabling Clean Energy</h3>	
<p>M.J. Whitarcar and E. Wiebe: BC Natural Gas Atlas: description and visualization tools of gas geochemical database for northeastern British Columbia.</p>	61
<p>S.E. Grasby, A. Calahorrano-Di Patre, Z. Chen, J. Dettmer, H. Gilbert, C. Hanneson, M. Harris, S. Leiter, J. Liu, M. Muhammad, K. Russell, M.J. Unsworth, G. Williams-Jones and W. Yuan: Geothermal resource potential of the Garibaldi volcanic belt, southwestern British Columbia: Phase 2.</p>	75
<p>C. Hanneson and M.J. Unsworth: Magnetotelluric investigations of geothermal systems centred in southern British Columbia.</p>	81
<h3>Understanding Water</h3>	
<p>S.L. Lapp, E.G. Johnson, D.L. Cottrell, W.T. Van Dijk, B.P. Shepherd and R.L. Rolick: Pilot Collaborative Water Monitoring Program, northeastern British Columbia: year one update.</p>	95

