

GEOSCIENCE BC SUMMARY OF ACTIVITIES 2019: ENERGY AND WATER

© 2020 by Geoscience BC.

All rights reserved. Electronic edition published 2020.

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/s/SummaryofActivities.asp>.

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 (2020): Geoscience BC Summary of Activities 2019: Energy and Water; Geoscience BC, Report 2020-02, 160 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: Helicopter transporting University of Alberta magnetotelluric researchers from extensive pyroclastic tuff–lapillistone field on Devastator Peak (Mount Meager), southwestern British Columbia (C.J. Salas, 2019).

Back cover photo and credit: R. Bryant laying out magnetotelluric sensors along a ridge on Mount Meager, southwestern British Columbia, to help image geothermal reservoirs in the subsurface (S.E. Grasby, 2019).

Foreword

Geoscience BC is pleased to once again present results from our ongoing projects and scholarship winners 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 2019: Energy and Water

This volume, *Summary of Activities 2019: Energy and Water*, contains 15 papers from Geoscience BC-funded projects or scholarship recipients that are within Geoscience BC's strategic focus areas of energy (including oil and gas, and geothermal) and water. The papers are divided into four sections, based on Geoscience BC's strategic objectives of

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

The five papers in the 'Facilitating Responsible Natural Resource Development' section focus on induced seismicity in northeastern British Columbia (BC). Monahan et al. present interim results from work done in the Fort St. John–Dawson Creek area to map the potential for near-surface geological materials to amplify seismic waves. Babaie Mahani assesses the results of earthquake monitoring in the area to identify source mechanisms and the regional stress field. Wozniakowska and Eaton use machine learning to begin to identify factors affecting the occurrence of induced seismicity using existing data, while Bustin et al. deployed accelerographs to provide additional monitoring data for seismicity. Roth et al. use tomographic double-difference analysis to look at pore pressure increase as a potential contributor to induced seismicity.

In the 'Advancing Science and Innovative Geoscience Technologies' section, Chalmers et al. discuss the results of their ongoing research into the distribution of hydrogen sulphide in the Montney Formation, while González et al. assess the depositional setting of the Lower Montney Formation using drillcore, thin-section analysis and wireline data. Silva and Bustin present the results of sampling to assess the thermal history of the Doig Formation by determining the kerogen activation energy of samples.

Under 'Enabling Clean Energy', Whitaric and Evans present the results of a multiyear project to compile publicly available information and generate additional data on gas chemistry and gas-isotope chemistry, in order to generate geochemical signatures for natural gases in northeastern BC; and Whitaric et al. detail the use of drone-mounted scientific equipment to assess methane leakage at a variety of sites in Alberta during a field trial.

Also under 'Enabling Clean Energy' are three papers that address geothermal potential and settings in the province. Grasby et al. detail the monitoring and data-collection program that was initiated in the Mount Meager area during the summer of 2019, while Van Acken and Gleeson present preliminary results from a geological, structural and hot-spring mapping exercise as the first steps in understanding the geothermal regime in the Sloquet Hot Springs area. Finley et al. completed an assessment of geothermal resources in southeastern BC, looking at kinematic influences on a regional scale to help focus future geothermal investigations in the area.

The final two papers, in the 'Understanding Water' section, describe work conducted in northeastern BC. Ladd et al. present the details of several field campaigns that were undertaken to install a network of 29 groundwater monitoring wells in the Peace Region for the purpose of monitoring methane in groundwater, while Cahill et al. show the preliminary results from a field investigation conducted to observe the effects and migration of natural gas in a shallow confined aquifer.

Geoscience BC Energy and Water Publications 2019

In addition to the two *Summary of Activities* volumes, Geoscience BC releases interim and final products from our projects as Geoscience BC reports. The following five Energy and Water reports and maps were published in 2019:

- Thirteen technical papers in the *Geoscience BC Summary of Activities 2018: Energy and Water* volume (Geoscience BC Report 2019-02)
- **Mapping the Susceptibility to Amplification of Seismic Ground Motions in the Montney Play Area of Northeast British Columbia**, by P.A. Monahan, V.M. Levson, B.J. Hayes, K. Dorey, Y. Mykula, R. Brenner, J. Clarke, B. Calambos, C. Candy, C. Krumbiegel and E. Calderwood (Geoscience BC Report 2018-16)

- **Quantification of the Gas and Liquids in Place and Flow Characteristics of Shale and Other Fine-Grained Facies in Western Canada**, by R.M. Bustin, A.A.M. Bustin, S. Hazel, A. Hosseinian, M. LeMessiuer, E.A. Letham, M. Longobardi, E. Munson, J. Owen, T. Wilson and P.L. Silva (Geoscience BC Report 2019-06)
- **South Meager Geothermal Project: New Perspectives from Recently Unearthed Data**, by J. Witter (Geoscience BC Report 2019-07)
- **Clarke Lake Geothermal Pre-Feasibility Study**, by Associated Engineering (Geoscience BC Report 2019-11)

All releases of Geoscience BC reports, maps and data are published on our website and are announced through our website and e-mail updates. Most final reports and data can also 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. 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 information that we collect and distribute.

Laura Wytrykush
Manager, Energy and Water
Geoscience BC
www.geosciencebc.com

Carlos Salas
Executive Vice President & Chief Scientific Officer
Geoscience BC

Contents

Facilitating Responsible Natural Resource Development

- P.A. Monahan, B.J. Hayes, M. Perra, Y. Mykula, J. Clarke, B. Galambos, D. Griffiths, O. Bayarsaikhan and U. Oki:** Amplification of seismic ground motion in the Fort St. John–Dawson Creek area, northeastern British Columbia 1
- A. Babaie Mahani:** Systematic study of earthquake source mechanism and regional stress field in the southern Montney unconventional play of northeastern British Columbia. 13
- P. Wozniakowska and D.W. Eaton:** Determination of factors controlling geological susceptibility to induced seismicity in the Montney Formation, northeastern British Columbia and northwestern Alberta, based on a machine-learning approach 19
- A.M.M. Bustin, D.J. Jones, J. Ou and G.R.L. Chalmers:** Monitoring induced seismicity in the Montney play, northeastern British Columbia. 27
- M.P. Roth, R.M. Harrington and Y. Liu:** Velocity-structure imaging based on seismological observations close to hydraulic fracturing sites near Dawson Creek, northeastern British Columbia. 33

Advancing Science and Innovative Geoscience Technologies

- G.R.L. Chalmers, R.M. Bustin and A.A. Bustin:** Hydrogen sulphide within the Triassic Montney Formation, northeastern British Columbia and northwestern Alberta. 41
- P.D. González, C.M. Furlong, M.K. Gingras and J.-P. Zonneveld:** Facies analysis and depositional setting of the Lower Triassic Montney Formation in northeastern British Columbia, Western Canada Sedimentary Basin 53
- P.L. Silva and R.M. Bustin:** Hydrocarbon-generation kinetics of the Doig Formation, northeastern British Columbia and west-central Alberta. 65

Enabling Clean Energy

- M.J. Whiticar and C. Evans:** BC Natural Gas Atlas: creation of the geochemical database for northeastern British Columbia 77
- M.J. Whiticar, D. Hollenbeck, B. Billwiller, C.J. Salas and L.E. Christensen:** Application of the BC GHGMapper™ platform for the Alberta Methane Field Challenge 87
- S.E. Grasby, S.M. Ansari, A. Calahorrano-Di Patre, Z. Chen, J.A. Craven, J. Dettmer, H. Gilbert, C. Hanneson, M. Harris, J. Liu, M. Muhammad, K. Russell, R.O. Salvage, G. Savard, V. Tschirhart, M.J. Unsworth, N. Vigouroux-Caillibot and G. Williams-Jones:** Geothermal resource potential of the Garibaldi volcanic belt, southwestern British Columbia. 103
- A. Van Acken and T. Gleeson:** Preliminary field investigations of Sloquet Hot Springs, southwestern British Columbia 109
- T.D. Finley, S.T. Johnston, M.J. Unsworth, J. Banks, D. Pana and C. Hanneson:** Structural settings of convective hydrothermal systems in southeastern British Columbia 115

Understanding Water

- B. Ladd, A.G. Cahill, M. Goetz, A. Allen, L. Welch, B. Mayer, C. van Gelovan, D. Kirste and R.D. Beckie:** Installation of a purpose-built groundwater monitoring well network to characterize groundwater methane in the Peace Region, northeastern British Columbia. 131
- A.G. Cahill, B. Ladd, J. Chao, J. Soares, T. Cary, N. Finke, C. Manning, C. Chopra, K.U. Mayer, A. Black, R. Lauer, C. van Geloven, L. Welch, S. Crowe, B. Mayer and R.D. Beckie:** Controlled natural gas release experiment in a confined aquifer, northeastern British Columbia: activity report 2018–2019. 145

