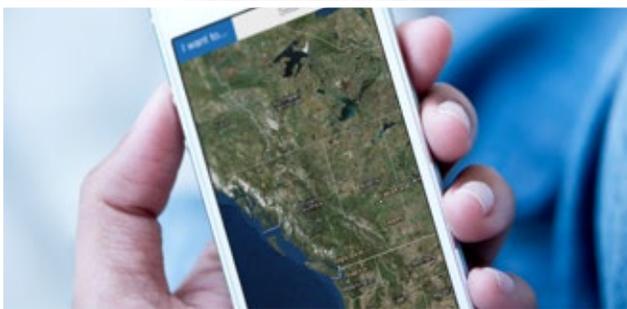
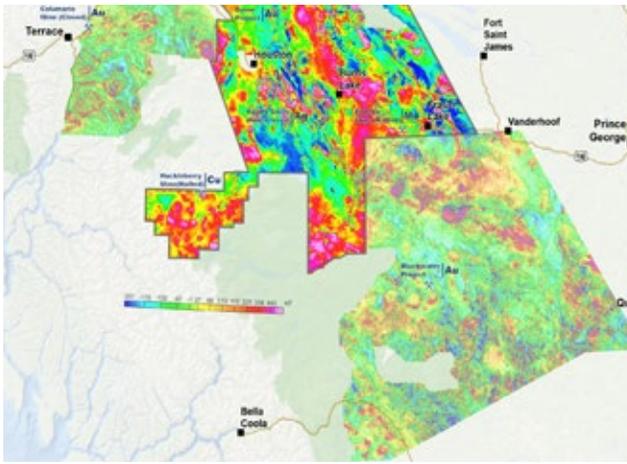




2017 Annual Report



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Chair's Welcome



Mike Cathro, Chair

Geoscience BC has been delivering high-quality, innovative and credible earth science for more than 12 years. It benefits all British Columbians, including communities, First Nations, the resource sectors and all levels of government. We collaborate with these partners and our work enables balanced decisions to be made to attract investment and ensure natural resource development is done responsibly.

While Geoscience BC continues the minerals, energy and water inventory work that we've always been relied on for, we also provide a breeding ground for innovation to blossom. In a rapidly changing world, new thinking and technologies are at the heart of what we do. I am pleased to see an exciting and wide range of new projects involving partners ranging from NASA's Jet Propulsion Laboratory to the BC Oil and Gas Commission to the Fort Nelson First Nation.

On behalf of the Geoscience BC Board, I would like to welcome Gavin C. Dirom as our new President and CEO. He brings with him a strong background in minerals research, public policy and economic development work with the federal government, mining companies and exploration and mining associations. The Board would also like to thank former President and CEO Robin Archdekin for his service to the organization, and recently promoted Executive Vice President and Chief Scientific Officer Carlos Salas for taking the reins so capably as Acting President and CEO for much of the year.

In addition to our fantastic staff and consultants, Geoscience BC relies on the dedication, ideas and endless energy of our volunteer Board and Technical Advisory Committees. We are especially grateful to outgoing directors Jared Kuehl, Randy Smallwood and Dallas Smith for their service and thoughtful input, and to current TAC members Peter Bradshaw, Brad Hayes, Jacques Houle and Jules Lajoie who have served the organization since its inception. We would also like to welcome Christine Ogryzlo of the Smithers Exploration Group and Donna Phillips of Canbriam Energy Inc. to the Board.

Of course, none of this would be possible without the continued support and funding from the provincial government and an increasingly diverse range of new funding partners. In 2017, this has included the federal government's Western Economic Diversification program and the Northern Development Initiative Trust.

2018 brings genuinely exciting opportunities: Geoscience BC remains well positioned to provide the earth science needed to encourage investment and make evidence-based natural resource decisions for the health and prosperity of all British Columbians.

A handwritten signature in black ink, appearing to read 'Mike Cathro'. The signature is fluid and cursive, written on a white background.

Mike Cathro
Chair of the Board, Geoscience BC

President & CEO's Welcome

As I reflect on my first few weeks at Geoscience BC and view the remainder of 2017, it is truly my privilege to build on the solid foundation laid down by my predecessors, and contribute to such a well-respected and capable earth science organization.

Since 2005, the earth science data we have generated from more than 160 mineral and mining, oil and gas and geothermal projects is valued by many in the resource sectors, communities, First Nations and governments because it has improved technical understanding, encouraged innovation and sparked investment in British Columbia.

The 2017 annual report documents a year of change, and I would like to thank our dedicated volunteers and staff for their steadfast commitment to Geoscience BC, exemplified in the production and sharing of high quality work. I would especially like to recognize Carlos Salas for taking on the role of Acting President and CEO for much of 2017 while continuing to lead our oil and gas and geothermal activities.

Our work continues to evolve through the consistent application of innovative technologies, equipment and methods. For example, the aerial survey conducted over north central and northeastern BC for the Search Phase III project in 2017 will provide more beneficial and useful information and data than has ever been possible to collect before.

We are currently developing a strategic plan for 2018 to 2022 to ensure Geoscience BC continues to provide the most needed and best research at the right time. This effort includes listening to the diverse groups that take an interest in our work. From this, we will build a strategic plan that will lay out our priorities and objectives and guide our research work into the future.

I am excited to look ahead to 2018 and see the new earth science work we can do to increase the knowledge-base that will help to create opportunity, build capacity and inspire confidence in British Columbia for years to come.

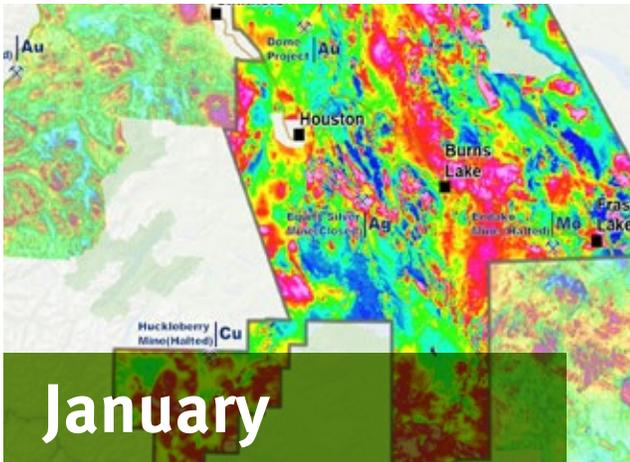


Gavin C. Dirom
President & CEO, Geoscience BC



Gavin C. Dirom, President & CEO

Geoscience BC in 2017



January

New data for west central BC is made available with the announcement of results from the 2016 Search Phase II aerial survey at the Roundup conference in Vancouver.

\$ January

The provincial government announces \$10m of new funding for Geoscience BC to continue the independent collection, interpretation and public dissemination of earth science in BC.

February

We report on work with 20 communities in BC to raise awareness about the potential for 'direct-use' geothermal throughout BC. This includes online tutorials, which are linked from the Geoscience BC website.



May

Upgrades to Geoscience BC's Earth Science Viewer mapping app make it easier and faster to access our earth science.



May

The Search Phase III aerial survey is announced with additional funding confirmed by Northern Development Initiative Trust. Geoscience BC then meets with community and First Nations leaders to discuss the project.

September

Media, politicians and community leaders join us at the Union of BC Municipalities (UBCM) Convention as we launch the GHGMap project. This innovation mounts NASA-developed sensors to drones to measure and map greenhouse gas emissions.

September

A Geoscience BC-funded team begins using a monitoring station near Hudson's Hope as part of a project to understand how fugitive emissions from natural gas development affect fresh water aquifers.

August

While the sun shines, we talk about snow! New results from a project on Vancouver Island show how made-in-BC techniques use trees, soil and even snow to identify buried mineral opportunities.

October

Gavin C. Dirom joins Geoscience BC as President and CEO. The announcement follows Donna Phillips (Canbriam Energy Inc.) and Christine Ogryzlo (Smithers Exploration Group) joining the Board in September.

June

Seven outstanding post-graduate students are selected to receive 2017 Geoscience BC Scholarship Awards.

November

Fort Nelson First Nation (FNFN) signs an agreement with Geoscience BC to take on management of a network of hydrometric stations in its territory in northeastern BC. The stations are an important part of the infrastructure used to understand the impacts of oil and gas development in the region.

Our Team

Geoscience BC is made possible by a strong team with a clear structure and governance. We are governed by a volunteer Board of Directors that represents a wide range of interests. The Board is supported by the staff and by volunteer Technical Advisory Committees for each specialist area: minerals and mining; oil and gas; and geothermal*.

Board of Directors

| | |
|---|---|
| Mike Cathro, Chair , Cathro Resources Corp | John Milne CPA CA, Treasurer , Audit Partner, KPMG LLP |
| Stephanie Killam, Vice Chair , District of Mackenzie (retired Mayor) | Nalaine Morin , Principal, ArrowBlade Consulting Services |
| Gavin C. Dirom , President and CEO, Geoscience BC | Christine Ogryzlo , President, Smithers Exploration Group |
| Brad Armstrong , QC, Partner, Lawson Lundell LLP | Donna Phillips , Executive Vice President, Corporate Development, Canbriam Energy Inc. |
| Richard Dunn , Vice President, Canadian Government Relations, Encana Corporation | Robert Quartermain , Chairman and CEO, Pretium Resources Inc. |
| Doug Konkin , Adjunct Professor, UBC | Alan Winter , President, Winteck Consulting Inc. |

Technical Advisory Committees

Oil & Gas

| | |
|--|--|
| Dan Allan , Canadian Society for Unconventional Resources | Brad Hayes , Petrel Robertson Consulting Ltd. |
| Marc Bustin , UBC | Scott Hillier , Cenovus Energy |
| Gavin C. Dirom , Geoscience BC | Jeff Johnson , BC Oil and Gas Commission |
| Fil Ferri , BC Ministry of Energy, Mines and Natural Gas | Carlos Salas , Geoscience BC |
| Bruce Hancock , Encana | Clint Tippett , Consultant |

Minerals & Mining

| | |
|---|---|
| James Barr , Tetra Tech Canada Inc. | Julie Hunt , UBC |
| Peter Bradshaw , FPX Nickel Corp | Steve Irwin , Natural Resources Canada |
| Greg Dipple , BRIMM Initiative, UBC | Fiona Katay , BC Ministry of Energy and Mines |
| Gavin C. Dirom , Geoscience BC | Jim Lang , Hunter Dickinson Inc. |
| Pim van Geffen , VanGeochem | Jules Lajoie , Can Alaska Uranium Ltd., Consultant |
| Craig Hart , Mineral Deposits Research Unit, UBC | Bruce Madu , Geoscience BC |
| Adrian Hickin , BC Geological Survey | Nalaine Morin , Arrowblade Consulting |
| Alf Hills , Consultant | Carlos Salas , Geoscience BC |
| Jacques Houle , Consultant | Diana Sollner , Consultant |
| | Alastair Still , Goldcorp |

Geothermal

| | |
|--|--|
| David Chapman , University of Utah (Professor Emeritus) | Tim Sadlier-Brown , Sadlier-Brown Consulting Ltd. |
| Gavin C. Dirom , Geoscience BC | Carlos Salas , Geoscience BC |
| Grant Ferguson , University of Saskatchewan | Nathalie Vigouroux-Caillibot , Douglas College/SFU (adjunct) |
| Stephen Grasby , Natural Resources Canada | Warren Walsh , BC Ministry of Energy, Mines and Petroleum Resources |
| Sarah Kimball , BGC Engineering Inc. | Jeff Witter , Innovate Geothermal Ltd. |
| Jasmin Raymond , INRS-ETE | |

Staff

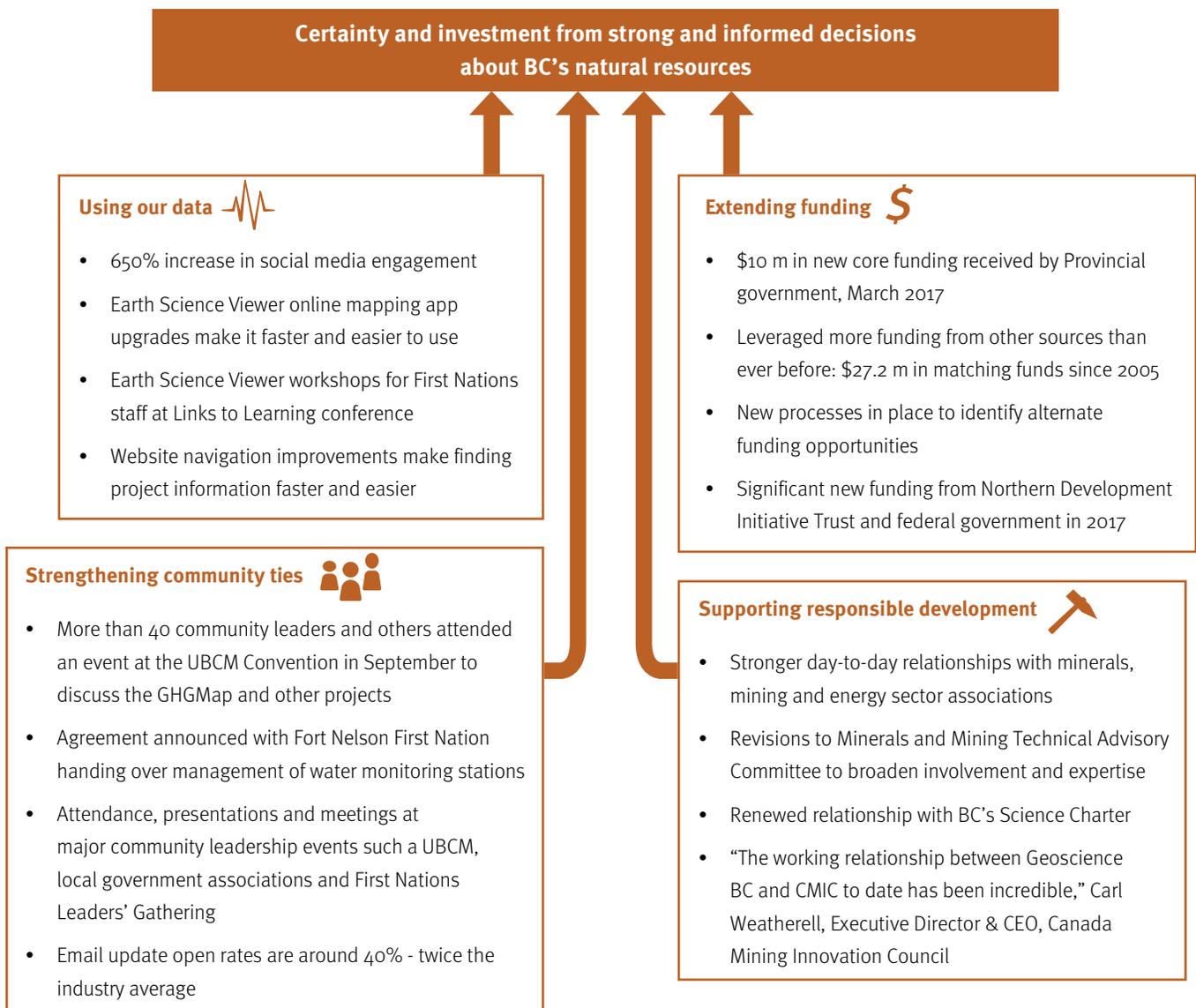
| | |
|--|--|
| Gavin C. Dirom, MSc, BSc, P.Ag. , President and CEO | Christa Pellett, MSc , Project Coordinator |
| Carlos Salas, MSc, PGeo , Executive Vice President and Chief Scientific Officer | Ron Prasad, BSc, Adv. Dip. GIS , GIS Specialist |
| Bruce Madu, PGeo , Vice President, Minerals and Mining | Candice Appleby , Office Manager and Communications Coordinator |
| Richard Truman , Director, External Relations | Rhonda Schultz , Accountant and Corporate Secretary |

Connecting with Communities

Working with community leaders, Indigenous groups, the resource sector and government to make sure they understand our work plays an important role in attracting investment and informing responsible resource development decisions.

“ Geoscience BC research is becoming a useful part of the toolkit Nak’azdli Whut’en uses.” *Councillor Harold Prince, Nak’azdli Whut’en*

“ We are big fans and supporters of Geoscience BC... we need a group like you to spur economic investment.” *Mayor Shane Brienen, Houston*



Minerals & Mining



**Bruce Madu, Vice President,
Minerals & Mining, Geoscience BC**

“ Geoscience BC’s approach to combine old and new technology to identify deposits has given Margaux Resources great new insights.” *Tyler Rice, President and CEO, Margaux Resources*

In 2017, Geoscience BC delivered new earth science that is being used by explorers, community leaders, and First Nations to make informed decisions about minerals and mining in our province. The delivery of innovative technologies, baseline data, new maps and value-add products will improve knowledge of some of BC’s least understood areas and breathe new life into mature exploration areas.

We have continued to focus on the baseline surveys we are known for, completing the Targeting Resources for Exploration and Knowledge (TREK) project while continuing the Search surveys and Regional Geochemical Sample re-analysis project.

The culmination of four years of collaboration and over \$4 million in investment was shared and celebrated in October with a one-day TREK workshop. Many of the researchers who have been working on Geoscience BC projects in the area gathered to share and discuss their work.

Helicopters finished flying over the Search Phase III area in November, and in early 2018 we will release new geophysical data for a 9,600 km² area between the Kemess mine in the north and the Lorraine project to the south. Community leaders, Indigenous groups and explorers will benefit from this new data, shedding light on what new opportunities lie beneath the ground in the area.

In addition to completing baseline surveys, we are also funding projects to answer specific questions about the mineral and coal potential of our province. In April, work began on a pioneering project that explores a water-based method for cleaning metallurgical coal prior to coal quality testing. The project aims to reduce the size of samples required for analysis while also removing the need for organic-based chemicals in the assessment process. This will lead to a more efficient and safer technique to determine the economic value of BC’s steel-making coal resources.

The data we collect continues to give communities, First Nations, mineral explorers, governments and others access to reliable earth science information – a valuable tool to attract investment and encourage responsible development in BC.

- **30%** of project funding put into the local economy during the Search Phase III project
- **116** Geoscience BC minerals and mining projects since 2005
- **\$35.4 million** committed to minerals and mining projects since 2005
- **45,000** samples from almost every stream in BC re-analysed using modern and consistent methods





Mayor of Mackenzie, Pat Crook meets with Geoscience BC's Bruce Madu to discuss how Search Phase III will encourage investment and responsible development in the area

Modern technology for finding old gold

By unravelling the complex processes that shaped the earth over hundreds of millions of years, earth science helps to understand when, where, and how concentrations of valuable and important minerals come to be. We are working to unearth BC's hidden mineral potential and to share this knowledge to encourage investment and enable responsible development.

Gold panning with lasers and electron beams

Gold panning was one of the first techniques used to find gold in BC. Prospectors used pans and clues from the landscape to find the source of the gold nuggets they found. Now, Geoscience BC-supported researchers are using lasers and microprobes to find the 'genetic origin' of tiny gold grains by measuring ratios of other metals that provide clues about the host deposit they came from. This innovative technique also helps find new deposits of copper, a metal essential for clean energy development and clean technologies such as electric cars.

Step back: The bigger picture

Stepping back from the microscope, explorers also look at broad-scale features of the landscape to search for new deposits by mapping the faults and folds that shape the rocks. At three historic BC gold camps, Geoscience BC-funded scientists used traditional

rock hammers and modern iPads to map and analyze the structure and ages of rocks in the Cariboo, Cassiar, and Sheep Creek gold districts. This project may help locate new deposits of gold at sites such as Barkerville, the iconic town of BC's Cariboo Gold Rush in the 1860s.

How old is that gold?

The Bridge River district west of Lillooet is the most productive of BC's historic gold mining camps. Here, researchers have been using radiometric dating techniques to determine when host rocks and gold deposits formed. They found that gold deposits at Bridge River formed between 68 and 64 million years ago – ten to 30 million years later than previously thought. These results present a different understanding of the geological controls for gold deposit formation to help guide future mineral exploration in the area, and in other areas of BC.

Search Phase III

Phase III of our Search project, a multi-year initiative collecting high-resolution airborne geophysical data over northeastern and north central BC, was launched in May 2017. New airborne magnetic and radiometric data – used to better understand the characteristics of buried bedrock – was collected during the summer and fall. Flying finished in November, with data processing taking place over the winter. The data was collected by contour surveying, where skilled helicopter pilots flew just 80 metres above the ground, resulting in more accurate data and helping to identify overlooked geological and structural features.

Where to look? What to sample?

The world's oldest surviving geological map was created in 1150 BC in Egypt. Today, maps are mostly digital and commonly made using data collected by helicopters, planes, and satellites. However, boots-on-the-ground fieldwork is still necessary to create the most useful products.

Fresh approaches to seeing through cover

In BC's Northern Interior Plateau, south of Vanderhoof and west of Quesnel, bedrock is covered by a thick layer of glacial sediments and lava flows making it a tough place to explore. Our Targeting Resources for Exploration and Knowledge (TREK) project series began with aerial surveys, and follow-up fieldwork on the ground added value to the data collected.

Using till, lake sediment and tree-top samples collected across the TREK area, Geoscience BC-supported researchers have identified new exploration opportunities. Advanced investigation, including exploratory data analysis and clay-fraction reanalysis, detected trends within the data and provided insight into the processes that formed and moved the materials. The final products clustered the data into similar groups to highlight anomalies to help indicate locations for mineralization.

Collecting valuable water quality data



Water is both a finite resource with high social, cultural and environmental value and an essential component of mining and mineral processing.¹

Water management occurs at every stage of the mineral exploration and mining lifecycles. For decades, resource managers across BC have been collecting water samples to ensure water is used and protected appropriately. The benefits of comprehensive water quality data are immeasurable, but where is it ultimately stored and how should it be shared?

In partnership with the Canada Mining Innovation Council, Geoscience BC is proposing an online water knowledge hub. The project will bring water data collected by governments, the mining sector and others together in one convenient place. This will help to improve access to data needed for regulation and decision-making, increase transparency of sector activity and broaden participation in monitoring.

In 2017, the partnership completed a fully-functional mock-up of the hub using open-source software. The pilot site currently hosts publicly-available data from the BC government's Environmental Monitoring System and one company mine site.



Researchers discuss findings from the TREK project at a 2017 workshop

“The most efficient use of resources in mineral exploration is to add value to existing data.” *Geochemist, Britt Bluemel.* Britt crunched data from almost 3,000 till sample to add new value to existing archived till samples from within the TREK project area

¹ Mining Association of Canada (2015), *Toward Sustainable Mining*



A new technique can measure halogen elements in snow to find potential mineral deposits

Made-in-BC exploration tools

We fund research to develop innovative geochemical techniques to detect buried mineralization. Halogen elements – fluorine, chlorine, bromine and iodine – are potential ‘pathfinder’ elements for locating minerals but have previously been overlooked in Canadian mineral exploration, in part due to a lack of commercial analytical techniques. Geoscience BC-funded work has promoted new made-in-BC laboratory techniques to measure halogen elements in snow, soil, and trees.

Results released in September demonstrate how using portable devices for testing stream waters can provide fast and accurate analyses cheaply and efficiently to define the mineral potential of an area. Based in the Nazko Valley area, researchers tested 159 water samples for elevated levels of elements and compounds (e.g. copper, lead and silica) using a photometer (optical) and voltammeter (electrical) instrument. The ability to generate results in the field means workers can make quicker decisions about potential exploration targets, or other related field activities, without the need to send samples away to a laboratory.

Minerals and mining in 2018

In 2018, Geoscience BC will continue illuminating the mineral and coal potential of the province and providing the information First Nations, explorers, government, and communities need to make informed decisions about minerals and mining.

For example, we will provide more information on precious and base mineral potential in southeast BC’s Kootenay-Boundary region, by mapping the last section of the Boundary regional map series. New geological maps from the Search Phase I area in west-central BC are also expected in 2018, along with the release of an exploration framework for the north-central Toodoggone mineral camp.

Several innovative ‘boutique’ sampling and processing projects will advance in 2018, including a second phase of the Roben Jig coal washing project and an integrated assessment of the regional stream sediment geochemistry for metallic deposits in the northern Stikine terrane.

Exciting new partnerships will explore the role of microorganisms in the movement of metals through the natural environment, develop new genomic-based tools for mineral exploration and advance the understanding of genomics in mine site rehabilitation.

These and other projects will be guided by the addition of members with new areas of expertise to our Minerals and Mining Technical Advisory Committee in December 2017.

Oil & Gas



*Carlos Salas, Executive Vice
President and Chief Scientific Officer*

The oil and gas sector plays a vital role in BC's economy, and has the potential to continue its growth in coming years. Collecting, interpreting and sharing new scientific data relating to this sector helps to guide responsible development and attract appropriate investment.

Questions about the hydraulic fracturing (fracking) process used to access natural gas concern three main areas: water, ground motion and greenhouse gas (GHG) emissions. These have continued to be a focus of Geoscience BC's work in 2017.

Targeted research projects funded by Geoscience BC are exploring the impacts of fracking and generating knowledge to address questions raised by communities, First Nations, the resource sector and governments. This helps to inform decisions and industry practices, regulation and policy can be improved to reduce risk and impact.

In September we launched GHGMap, a pioneering greenhouse gas measurement project, at the Union of BC Municipalities Convention in Vancouver. This innovative project uses a miniature optical instrument developed by NASA's Jet Propulsion Laboratory mounted on a drone to detect and analyze GHG emissions. It is being used to generate the first Canadian GHG inventory based on real-time, remote data collection, dramatically improving the speed, accuracy, safety and cost of measuring GHG emissions.



*A GHGMap drone flies over Burrard
Inlet during a demonstration at the
2017 UBCM Convention*

In November 2017, we signed an agreement with Fort Nelson First Nation (FNFN) in northeastern BC to transfer management of four hydrometric water monitoring stations. This expands Fort Nelson First Nation's water monitoring capacity and builds its ability to act as a land steward, while continuing to provide vital water information to the public.

To better understand the effects of escaping 'fugitive' gas on shallow, fresh-water aquifers, we also began a field-based investigation into the impacts of shale gas development on water quality. The study explores how gas moves into aquifers and the impact this has on water. The results are important for developing monitoring protocols for fugitive gas emissions.

- 42 oil and gas projects since 2005
- \$20 million committed to oil and gas projects since 2005
- 4 Hydrometric stations being managed by Fort Nelson First Nation under a new agreement
- 17 Stations in the Canadian National Seismograph Network to monitor the effects of ground motion caused by fracking activity
- 9,600 km² of shallow water aquifers mapped by the Peace Project



“ Releases of greenhouse gases such as methane, carbon dioxide and nitrous oxide to the atmosphere present real concerns for climate change and air quality. Assessing and reducing these emissions requires reliable, uncomplicated measurements.” *Dr. Michael Whiticar, GHGMap Project Lead*



Drilling work in 2017 confirmed findings about groundwater in northeastern BC

Greenhouse gas emissions

GHGMap

The GHGMap project plays an important role in understanding the location and volume of GHG emissions while developing innovative and low-cost technologies. The project uses a miniature optical instrument developed by NASA's Jet Propulsion Laboratory mounted on a drone. Test flights were completed on Vancouver Island in the spring and the project received a warm welcome from the resource sector, government and community leaders when it was formally launched in September. This was followed immediately by drone test flights at oil and gas development sites in northeastern BC.

Additional flights will take place in 2018 to develop GHGMap, and the project will develop a business model for this highly accurate yet and low-cost tool. The same technology will have the ability to measure GHG emissions from other sources such as wetlands, landfills, sewage treatment plants and agricultural feedlots. In combination with our BC Natural Gas Atlas project, it will also be possible to pinpoint the source natural gas emissions.

Studying the effects of fugitive gas in groundwater

Natural gas can leak into the ground during drilling and gas extraction. At a site near Hudson's Hope in the Peace Region of northeastern BC, we are funding a project to use existing infrastructure to study the effects of these natural gas leaks on groundwater to improve understanding of how to optimize remediation. The project brings together many skills from geochemistry, biochemistry, genomics, hydrogeology and geophysics. Improving our understanding of these 'leaky' boreholes will assist decision makers and guide monitoring and remediation protocols.

Mapping and monitoring ground motion in northeastern BC

Research shows that fracking can cause seismic activity, and that this movement is rarely felt at the surface. Providing new science to better understand this relationship helps to mitigate risks and to further improve regulation and industry practices.

Seismic consortium

Geoscience BC is part of the BC Seismic Research Consortium alongside experts from the resource sector, provincial and federal governments and regulatory bodies. The group works to build knowledge about the relationship between ground motion and fracking or wastewater disposal, and to identify where knowledge gaps lie. First set up in 2012, the consortium has resulted in 11 new stations being added to the Canadian National Seismic Network in northeastern BC to collect high resolution data about the location and strength of ground motion.

‘Shake maps’

Not all areas experience ground motion equally. Seismic waves travel through different rocks and sediments at different speeds, so the intensity of an earthquake can vary from one area to another.

Buildings and public infrastructure, including pipelines, are built to specific engineering codes to withstand ground motion, but the presence of certain sediments and geological conditions beneath them may amplify otherwise non-threatening seismic waves.

We are creating ground motion amplification maps (‘shake maps’) for the Montney play in northeastern BC to help identify areas of risk to people and infrastructure.

Seismic ‘traffic lights’

Geoscience BC-funded researchers have also installed custom, low-cost, mobile seismic sensors to monitor ground motion related to hydraulic fracturing in the Montney using the same sensors

developed for BC’s earthquake early-warning system. By installing sensors on well pads and modelling ground motion resulting from fracking and wastewater disposal, this project improves the understanding of risks involved. The results will provide the information needed to improve protocols, regulation and policy.

Water

In 2014 the Council of Canadian Academies, a highly-respected scientific panel, released a report that identified knowledge gaps associated with natural gas development ². It called for the collection of more baseline groundwater data and more research into the effects of natural gas development on groundwater.

The findings of the report guide much of Geoscience BC’s work relating to the impacts of natural gas development on surface, shallow and deep water, with a focus on northeastern BC. We are funding water studies and monitoring networks in key areas to augment the baseline data required for water resource protection and regulation.

In November 2017, Fort Nelson First Nation (FNFN) and Geoscience BC signed a two-year agreement which will see FNFN manage hydrometric water monitoring stations at D’Easum Creek, Dilly Creek, Kiwigana River and Sahtaneh Creek. The stations will monitor water flow as part of FNFN’s Liard River Basin Monitoring Initiative. Previously, the stations were part of Geoscience BC’s Horn River Basin Aquifer Project. Data from the monitoring network will be independently verified by a qualified professional, and FNFN will share data publicly through the Mackenzie DataStream water data website.

Mapping groundwater

Peace Project

Our Peace Project is the first large-scale effort to map northeastern BC’s groundwater using helicopters carrying geophysical equipment. It is providing reliable technical data to understand the region’s shallow aquifers and inform decisions about their use and protection. The Peace Project has surveyed an area one-quarter the size of Vancouver Island (9,600 km²).

² Council of Canadian Academies (2014), *Environmental Impacts of Shale Gas Extraction in Canada*

In 2017, eight shallow wells were drilled and logged to see how well the predictions made using the aerial survey data match the reality of underground conditions.

The Peace Project is supported by a wide range of partners, including the Ministry of Forests, Lands and Natural Resource Operations and Rural Development, the Ministry of Environment, the BC Oil & Gas Commission, the Ministry of Energy, Mines & Petroleum Resources, Progress Energy Canada Ltd., ConocoPhillips Canada, Northern Development Initiative Trust, and the BC Oil & Gas Research and Innovation Society. It has additional support from the Peace River Regional District and the Canadian Association of Petroleum Producers.

Oil and Gas in 2018

2018 is set to be an exciting year for Geoscience BC-funded oil and gas sector research.

- We will continue the GHGMap project, including refining the reporting protocols needed and conducting drone survey

flights in northeastern BC in spring 2018. Work to develop the sensor technology so it can one day be produced commercially will follow.

- The BC Seismic Research Consortium is set to be extended under a new agreement in 2018 so that it can continue to improve knowledge about the relationship between natural gas development and ground motion.
- The Peace Regional Groundwater Monitoring project will begin, with the installation of 30 custom groundwater monitoring wells to generate a comprehensive dataset of methane levels and other potential pollutants in the Peace region's groundwater. The results will be used to develop groundwater monitoring plans for oil and gas development for the region. This project's legacy will include a regional groundwater monitoring network for future research and monitoring.

“ This (agreement) gives us the ability to make decisions with sound data to ensure our water is being utilized in a safe and sustainable manner.” *Chief Harrison Dickie, Fort Nelson First Nation*



A drone measures greenhouse gas emissions in northeastern British Columbia as part of the GHGMap project

Geothermal



Carlos Salas, Executive Vice President and Chief Scientific Officer

The concept of adding geothermal to BC's energy mix has been discussed for many years but to date there is no geothermal power generation in Canada. With high potential in some areas of BC, there is a need for unbiased information on the viability of generating geothermal heat and power.

Identifying appropriate geothermal resources in BC requires time, reliable earth science, and considerable research and development to answer important questions: How hot are the rocks? Can the resource be accessed economically?

Getting to know BC's geothermal potential

Geothermal may play a significant role in the long-term energy strategy for BC as we transition to alternative sources of energy for electricity and heat.

Geoscience BC's geothermal research is focussing on projects and sites with high potential to provide communities and decision-makers with the unbiased data, information and knowledge.

To date, our work has included mapping BC's geothermal 'hotspots' and producing a guide for communities who are considering using geothermal for power or heat. Future projects currently being considered include:

- A scoping project in northeastern BC to assess dual-purpose power generation and direct-use heat. In this case, a small binary cycle plant could produce electricity while the remaining heat on the water could heat greenhouses so that fresh produce can be grown in BC's north; or be used by the forestry sector to dry wood.
- We are generating knowledge to de-risk geothermal decisions in the Garibaldi-Cayley-Meager Volcanic Belt. This region, which lies north of Whistler, could provide much-needed electricity to the lower mainland in the future.

“To date, BC is nowhere near realizing its potential for geothermal power, even though we know that potential is significant. Providing key science to help lower exploration risk to those highest ranked prospects is vital so that we can all make appropriate and balanced decisions about future development.” *Carlos Salas, Executive Vice President and Chief Scientific Officer*

“Geoscience BC's... geothermal study was a significant stimulus for the Terrace economy.” *Carol Leclerc, Mayor of Terrace*

- **8** geothermal projects since Geoscience BC began geothermal work in 2012
- **\$545,000** committed to geothermal projects since 2012
- **20%** annual growth rate of 'non-hydro' renewables such as geothermal in Canada 2010-2014³



³ National Energy Board (2016), *Canada's Energy Future 2016: Energy Supply and Demand Projections to 2040*

Historic Mount Meager data available

Easy access to earth science data is needed for exploration companies and researchers to assess the viability of geothermal power generation in the Mount Meager area north of Whistler.

The geothermal potential of Mount Meager has been studied since the early 1970s, with several proposals for a commercial geothermal power plant in the area suggested. However, data, maps, and reports from companies, government agencies, researchers and students who have worked in the area have been difficult to access.

In 2017, Geoscience BC compiled and shared these resources – including some that were previously not accessible to the public – on our website and Earth Science Viewer web mapping application. Information generated from over 40 years of exploration into geothermal power potential at Mount Meager is now available in one location. Easy access to this information will facilitate exploration companies' and academics' efforts to better understand the geothermal potential of the area. It has also been shared with communities and First Nations in the area.

Is geothermal energy an option for communities in northeastern BC?

Although northeastern BC has lower potential for geothermal power generation than Mount Meager, oil and gas drilling in the area provides geological data which can be used to better define its geothermal potential. Using this wealth of data and previous studies, Geoscience BC-supported researchers are investigating the potential for economically viable geothermal development sites east of the Rocky Mountains in northeastern BC.

Our researchers are also studying if binary cycle power plants are an option for these lower temperature resources. The ability to have co-existing power generation and commercial activities that use heat may make some of these lower temperature areas of the province economically viable.

What is a binary cycle power plant?



To generate electrical power in areas with cooler geothermal reservoirs, groundwater is used to heat a fluid which boils at a lower temperature than water. This fluid is often a type of oil, and the steam generated runs a turbine to generate electricity. Any remaining heat in the groundwater can be used for heat-intrusive uses such as kiln drying or greenhouses.

Answering community questions

Online tutorials explain Direct-Use Geothermal Roadmap

A 2016 Geoscience BC-funded report identified that many communities did not have the tools they need to make informed choices about geothermal. This includes the language, geological information, and limitations of geothermal energy and where it can be used.

We supported researchers to produce a series of online tutorials to explain geothermal energy and provide a free, online reference tool for communities interested in developing geothermal energy for direct use heat applications. The webinars answer questions from “What is geothermal?” to explaining a roadmap of how to develop a project in your community, including permitting, environmental and economic considerations.

Scholarships

Geoscience BC awards up to ten scholarships annually to graduate students working on BC-based projects – a program that helps to encourage and inspire the next generation of earth scientists. For 2017 seven student projects are being funded, with subjects ranging from contaminated mine sites to gold deposit origins to estimating hydrocarbon deposits.

Understanding how selenium behaves at contaminated sites

Masters candidate **Laura Volden (Desaunoy)** is investigating the behaviour of selenium, an industrial contaminant during biological water treatment. When selenium is removed from wastewater leaving mine sites, little is known about the behaviour of the selenium in the solid residual left behind. Supervisor: Dr. Dirk Kirste, Simon Fraser University.



Laura Volden (Desaunoy)

BC coal deposits as a source for Rare Earth Elements

PhD candidate **Vinoth Kumar Kuppusamy** is developing a preliminary database of rare earth concentrations across three coal fields in southeastern British Columbia. Rare Earth Elements (REE) are considered ‘critical elements’ due to the importance in clean energy and defense applications. They can be extracted from secondary sources, but there is currently no proper quantification, characterization and extraction analysis available for coal deposits in BC. Supervisor: Dr. Maria Holuszko, The University of British Columbia.



Vinoth Kumar Kuppusamy

Finding ‘sweet spots’ in the Doig Formation, Western Canada Sedimentary Basin

PhD candidate **Pablo Lacerda Silva** is building a detailed geological model of the Doig Formation in northeastern British Columbia, to constrain the timing of generation and migration of hydrocarbons within in the basin, and to estimate the volume and distribution of hydrocarbons remaining. Supervisor: Professor Marc Bustin, The University of British Columbia.



Pablo Lacerda Silva

Origins of the Brucejack gold deposit

PhD candidate **Duncan McLeish** is looking at the origin of the high-grade gold mineralization at Pretium Resource's Brucejack mine in northwestern British Columbia, one of the highest grade intermediate sulphidation epithermal gold deposits in the world. Duncan is producing a step-by-step reconstruction of the magmatic-hydrothermal history of the deposit. Supervisor: Professor Anthony. E. (Willy) Williams-Jones, McGill University.



Duncan McLeish

Unravelling one of BC's most prolific mineralization areas

Masters candidate **Nicole Rioseco** is studying the Purcell Anticlinorium, a massive geological structure that contains some of the oldest rock exposures in the Canadian Cordillera as well as some of BC's most prolific mineral deposits. Nicole's studies will reveal the nature of this poorly-understood tectonic interface in southeastern BC to help target mineral exploration. Supervisor: Dr. David Pattison, University of Calgary.



Nicole Rioseco

Monitoring wastewater disposal in northeast BC

Masters candidate **Matthew Simons** is modelling the movement of wastewater plumes through the subsurface in northeastern BC where large volumes of highly saline wastewater are disposed of by oil and gas operators by pumping it into deep, permeable geologic formations. The models generated will help understand how the migration of wastewater is influenced by changes to the groundwater flow regime after disposal and pumping operations. Supervisor: Dr. Diana Allen, Simon Fraser University.



Matthew Simons

Sequestering carbon dioxide in mine tailings

PhD candidate **Sterling Vanderzee** is examining how to safely sequester carbon dioxide, a greenhouse gas, in mineral form within mine tailings. By examining the minerals and chemical processes occurring within tailings materials, he will identify the factors required to produce a secondary magnesium carbonate 'cement' within the tailings. The findings will potentially impact carbon accounting for mines and stabilize tailings at a lower cost. Supervisor: Dr. Gregory Dipple, The University of British Columbia.



Sterling Vanderzee

Financials

Management's Responsibility For Ongoing Financial Reporting And The Accompanying Summary Financial Statements

The summary financial statements and the information contained in the annual report are the responsibility of the management of Geoscience BC Society (the "Society").

The summary financial statements have been prepared in accordance with Canadian accounting standards applicable to summary financial statements for not-for-profit organizations. As part of its responsibilities, the Society maintains systems of internal accounting and administrative controls of high quality, consistent with reasonable cost. Such systems are designed to provide reasonable assurance that the financial information is relevant, reliable and accurate, and that the Society's assets are appropriately accounted for and adequately safeguarded.

The Society carries out its responsibilities with regard to these summary financial statements and the audited financial statements upon which they are based mainly through its Finance Committee (the "Committee"). The Committee reviews the summary and annual financial statements and other information contained in the annual report and recommends these to the members of the Society for approval. The Committee meets periodically with management and the external auditors. Following these meetings, the Committee may meet privately with the auditors to ensure free and open discussion of any subject the Committee or the auditors wish to pursue. The Committee also recommends the engagement or re-appointment of the external auditors, reviews the scope of the audit and approves the fees of the external auditors for audit and non-audit services.

The accompanying summary financial statements, and the audited financial statements on which they are based, have been audited by Beauchamp & Company LLP Chartered Professional Accountants in accordance with Canadian Auditing Standards, and have been approved by the Society on the recommendation of the Finance Committee.

January 11, 2018



Director



Director

Report Of The Independent Auditor On The Summary Financial Statements

To the Members of Geoscience BC Society

The accompanying Summary Financial Statements, which comprise the Summary Statements of Financial Position as at March 31, 2017 and the Summary Statements of Revenues and Expenditures and Changes in Net Assets for the year then ended, and related notes, are derived from the audited Financial Statements of Geoscience BC Society as at and for the year ended March 31, 2017. We expressed an unmodified audit opinion on those Financial Statements in our report dated September 21, 2017. Those Financial Statements, and the Summary Financial Statements, do not reflect the effects of events that occurred subsequent to the date of our report on those Financial Statements.

The Summary Financial Statements do not contain all the disclosures required by Canadian accounting standards for not-for-profit organizations as included in Parts II and III of the CPA Handbook. Reading the Summary Financial Statements, therefore, is not a substitute for reading the audited Financial Statements of Geoscience BC Society.

Management's Responsibility for the Summary Financial Statements

Management is responsible for the preparation of a summary of the audited Financial Statements in accordance with the Basis of Preparation disclosed in footnote 2 to the Summary Financial Statements.

Auditor's Responsibility

Our responsibility is to express an opinion on the Summary Financial Statements based on our procedures, which were conducted in accordance with Canadian Auditing Standards 810, 'Engagements to Report on Summary Financial Statements'.

Opinion

In our opinion, the Summary Financial Statements derived from the audited Financial Statements of Geoscience BC Society as at and for the year ended March 31, 2017 are a fair summary of those Financial Statements, in accordance with the criteria described in the Basis of Preparation.



CHARTERED PROFESSIONAL ACCOUNTANTS

Vancouver, British Columbia
January 11, 2018

Summary Statements Of Financial Position As At March 31, 2017 and 2016

| | 2017 | 2016 |
|---|---------------|---------------|
| ASSETS | | |
| Current Assets | | |
| Cash and cash equivalents | \$ 475,453 | \$ 108,454 |
| Investments | 12,043,977 | 12,074,113 |
| Accrued interest receivable | 27,661 | 30,552 |
| Amounts receivable | 10,155,396 | 5,742,035 |
| Prepaid expenses and deposits | 138,967 | 124,856 |
| | 22,841,454 | 18,080,010 |
| Capital Assets | 56,075 | 74,858 |
| | \$ 22,897,529 | \$ 18,154,868 |
| LIABILITIES AND DEFERRED CONTRIBUTIONS | | |
| Current Liabilities | | |
| Accounts payable and accrued liabilities | \$ 756,661 | \$ 381,778 |
| Deferred Revenue Contributions | 10,000,000 | 5,000,000 |
| | 10,756,661 | 5,381,778 |
| NET ASSETS | | |
| Net Assets Restricted For Approved Programs | 4,727,248 | 6,001,481 |
| Unrestricted Net Assets | 7,413,620 | 6,771,609 |
| | 12,140,868 | 12,773,090 |
| | \$ 22,897,529 | \$ 18,154,868 |

Nature Of Operations And Going Concern (Note 1)

Basis Of Preparation (Note 2)

Approved By The Board:



Director



Director

See accompanying notes to the summary financial statements

Summary Statements Of Revenues And Expenditures For The Years Ended March 31, 2017 and 2016

| | 2017 | 2016 |
|---|---------------------|-----------------------|
| Revenues | | |
| Grants – BC Ministry of Energy and Mines | \$ 5,000,000 | \$ 100,000 |
| Grants – other, and program reimbursements | 265,244 | 712,191 |
| Investments | 629,372 | 166,482 |
| Other | 2 | 23,262 |
| | 5,894,618 | 1,001,935 |
| Expenditures – Programs | | |
| Program costs incurred | 3,836,152 | 3,950,313 |
| Program management | 465,576 | 447,358 |
| Publishing costs | 49,416 | 74,002 |
| Scholarship awards | 50,000 | 50,000 |
| GST/HST, non-refundable portion | 41,114 | 67,697 |
| GIS Server – implementation & maintenance | 21,938 | 15,729 |
| | 4,464,196 | 4,605,099 |
| Expenditures – Administration | | |
| Amortization of capital assets | 35,613 | 26,733 |
| Communications and marketing | 103,600 | 62,340 |
| Consulting | 90,039 | 64,964 |
| Dues and memberships | 6,370 | 12,628 |
| Equipment lease | 7,305 | 7,022 |
| Gifts and promotion | 16,702 | 15,801 |
| GST/HST, non-refundable portion | 33,860 | 23,177 |
| Insurance | 8,890 | 7,944 |
| Investment management fees | 45,776 | 44,046 |
| Office and sundry | 22,530 | 26,288 |
| Office relocation | — | 20,764 |
| Outreach – First Nations and Government Relations | 300,659 | 182,418 |
| Professional fees | 155,464 | 107,651 |
| Recruitment | 69,349 | 921 |
| Rent and utilities | 174,500 | 163,241 |
| Salaries and benefits | 788,644 | 577,871 |
| Sponsorship | 24,571 | 20,353 |
| Staff training and professional development | 2,351 | 1,287 |
| Travel, conferences and meetings | 152,915 | 134,108 |
| Website, internet and e-mail | 23,506 | 19,005 |
| Workshops | — | 13,206 |
| | 2,062,644 | 1,531,768 |
| Deficiency Of Revenues Over Expenditures | \$ (632,222) | \$ (5,134,932) |

See accompanying notes to the summary financial statements

Summary Statements Of Changes In Net Assets For The Years Ended March 31, 2017 and 2016

| | Restricted For Approved Programs | Unrestricted | Total |
|---|--|---------------|---------------|
| Balance, March 31, 2015 | \$ 6,684,997 | \$ 11,223,025 | \$ 17,908,022 |
| Internally-imposed restrictions | 3,421,362 | (3,421,362) | — |
| Deficiency of revenues over expenditures | (4,104,878) | (1,030,054) | (5,134,932) |
| Balance, March 31, 2016 | 6,001,481 | 6,771,609 | 12,773,090 |
| Internally-imposed restrictions | 2,658,033 | (2,658,033) | — |
| (Deficiency) Excess of revenues over expenditures | (3,932,266) | 3,300,044 | (632,222) |
| Balance, March 31, 2017 | \$ 4,727,248 | \$ 7,413,620 | \$ 12,140,868 |

See accompanying notes to the summary financial statements

Notes To Summary Financial Statements March 31, 2017 and 2016

1. Nature Of Operations And Going Concern

Geoscience BC Society (“Geoscience BC” or “the Society”) was incorporated under the Society Act (British Columbia) on April 26, 2005 as a not for profit organization. The Society is exempt from taxation under subsection 149(1) of the *Income Tax Act* (Canada). The purpose of the Society is to promote, fund and otherwise support applied geoscience research in British Columbia. The Society had its genesis in a \$25 million funding commitment announced by the government of British Columbia in January 2005, which unrestricted funding was subsequently received and the Society incorporated. The Society has had certain members and directors in common with, and its creation was promoted by, both the Association for Mineral Exploration British Columbia and the Mining Association of British Columbia. However, the Society operates independently of both organizations and is controlled by a separate board of up to 13 directors, which also comprises the Society’s membership. Although it functions to complement the efforts of pre-existing provincial and federal agencies, Geoscience BC also operates on an arms-length basis from the governments of both British Columbia and Canada.

The Society has no source of operating revenue and its future operations are therefore dependent upon the receipt of continued unrestricted and non-repayable funding, anticipated to be from government sources. In the event such funding is not received, the Society would in due course deplete its cash reserves and be required to cease operations. At March 31, 2017 the Society expects to maintain operations for a period sufficient to complete all existing commitments to fund programs from liquid asset balances currently on hand.

Management believes that these actions make the use of the going concern basis appropriate; however, it is not possible at this time to predict the outcome of these matters. If the going concern basis is not appropriate, adjustments could be necessary to the carrying amounts and/or classification of assets, liabilities, revenues and expenditures in these summary financial statements, and these adjustments could be material.

2. Basis Of Preparation

The Summary Statement of Financial Position and Summary Statements of Revenues and Expenditures and Changes in Net Assets are derived from, and are consistent with, the audited Financial Statements of Geoscience BC Society as at and for the year ended March 31, 2017. Omitted from this presentation are certain other financial statements and footnote disclosures, all of which are required in order for a complete and formal presentation pursuant to Canadian accounting standards for not-for-profit organizations. Accordingly, readers are directed to read the Summary Financial Statements in conjunction with these annual audited Financial Statements, available for viewing at <http://www.geosciencebc.com/s/FinancialStatements.asp>.

In the opinion of management, the Summary Financial Statements included herein faithfully reflect the financial information considered material to the expected users of the information, and accordingly the summarized presentation is not misleading in these circumstances.



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