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Lithium Data and Observations in Alberta

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Summary

There is interest in diversifying Alberta's resource economy towards commodities including lithium. Lithium has many uses in modern technology, notably in manufacturing rechargeable batteries, and this is leading to an increase in demand. Lithium can be found in brines in a number of formations in Alberta, in particular Devonian-aged units (Hitchon et al, 1993). The Alberta Geological Survey (AGS) is undertaking a study of lithium in Alberta. This includes compiling existing data on lithium and other geochemistry from oilfield brines; collecting new samples; using airborne geophysical reinterpretation; and incorporating all of the information into the geological framework of Alberta.

Data Compilation

The AGS has previously released data sets focused on lithium (Eccles and Jean, 2010; Lopez et al, 2019) and data sets that include lithium among other geochemical analytes (Huff et al, 2011, 2012, 2019). These data sets provide a useful look at lithium and lithium-related minerals within groundwater and oilfield brines in Alberta, but contain relatively small amounts of data that can be used for determination of fluid regimes in the Western Canada Sedimentary Basin (WCSB), or prediction of lithium concentrations from larger datasets.

There are other sources of data available in the public domain, but few that are in easily useable formats. These sources include published literature (Connolly et al, 1990); mineral assessment reports submitted to Alberta Energy (Dufresne, 2011; Eccles, 2018a,b,c; Eccles and Dufresne, 2017; Lappin, 2018); and NI 43-101 resource assessment submissions (Eccles et al, 2012a,b). These data sources have been compiled and the relevant data extracted for use in assessing lithium prospectivity.

Some of the data are missing geolocation, well information, or stratigraphic units, which has been remedied where possible based on what information could be extracted from the studies. In some instances, the data values obtained from poor-quality PDFs needed correction. These available data sources were amalgamated and checked for errors. A single database has been created from the compiled and corrected data. Additional data gathered in this year's sampling program was added to this database.

Figure 1 shows a map of the locations of the detailed geochemistry data by source publication.

Sampling Program

The AGS undertook a sampling program to collect additional samples from areas and geological units not represented in the compiled data sets. This sampling program involved collecting brine

from seven producing oil wells. Six samples were sent to labs for analyses (one of the samples collected had insufficient water volumes—entirely hydrocarbons). The samples were analyzed for trace metals, stable isotopes, and strontium isotopes. Among the previous data sets, the isotopic data in particular is sparse, but is useful in determining the source of fluids. The data locations in Figure 1 labelled “Brine Sampling 2021” are the samples collected for this work.

Figure 2 shows two plots from the data: Sr vs 87Sr/86Sr and Br vs Cl. The Sr isotope values shown in Figure 2 demonstrate that there are samples with elevated 87Sr/86Sr ratios not consistent with Devonian seawater (Eccles and Berhane, 2011; Huff, 2019). This radiogenic strontium suggests an influx of water from deeper sources. The plot of Br-Cl in Figure 2 labels the radiogenic strontium and there appears to be a relationship between the Br-Cl-Na system and the influx of basement-derived water. This should allow for the use of Br-Cl-Na data to identify different fluid regimes, as in previous work, and relate it to the deeper-sourced radiogenic Sr. The radiogenic strontium appears to correspond to the “western pre-Cretaceous regime” brine from Huff (2019).

Airborne Reinterpretation

Some of the fluid in the WCSB originates in the Precambrian basement, and it is thought that there may be a relationship between this source and some of the lithium-rich brines (Eccles and Berhane, 2011; Huff, 2019). To investigate whether there is any spatial relationship between basement structures and fluid regimes, a reinterpretation of publicly-available airborne geophysical data was contracted (Government of Canada, 2016). Figure 1 shows partial results of this interpretation, with interpreted lines and magnetic observations in the Peace River Arch area.

A direct relationship between the geophysical interpretations and the different fluid regimes has yet to be observed. The geospatial distribution of the radiogenic strontium / western pre-Cretaceous regime waters is more complex than suggested by a few plots, and hence further work is needed to determine if basement lineaments correspond to flow paths relevant to enriched lithium in brines.

Further Work

All of the compiled data, analyses of the sampled wells, shapefiles, and report from the airborne geophysical will be released as AGS publications and made available for download. Any further interpretations or observations made will be published on the AGS website and shared at Geoconvention.

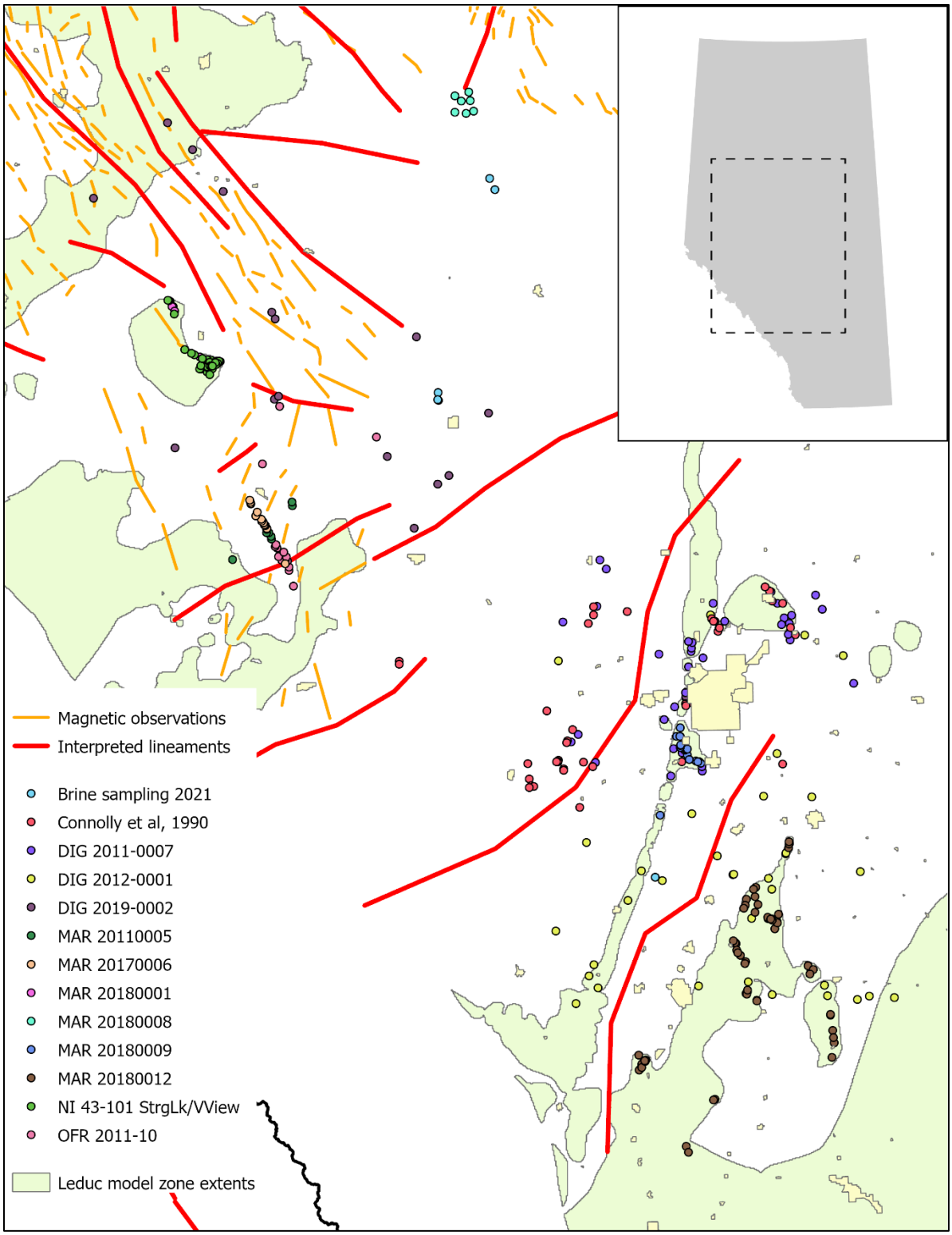

Figure 1: Map of the compiled data, brine samples collected, and airborne geophysical reinterpretation.

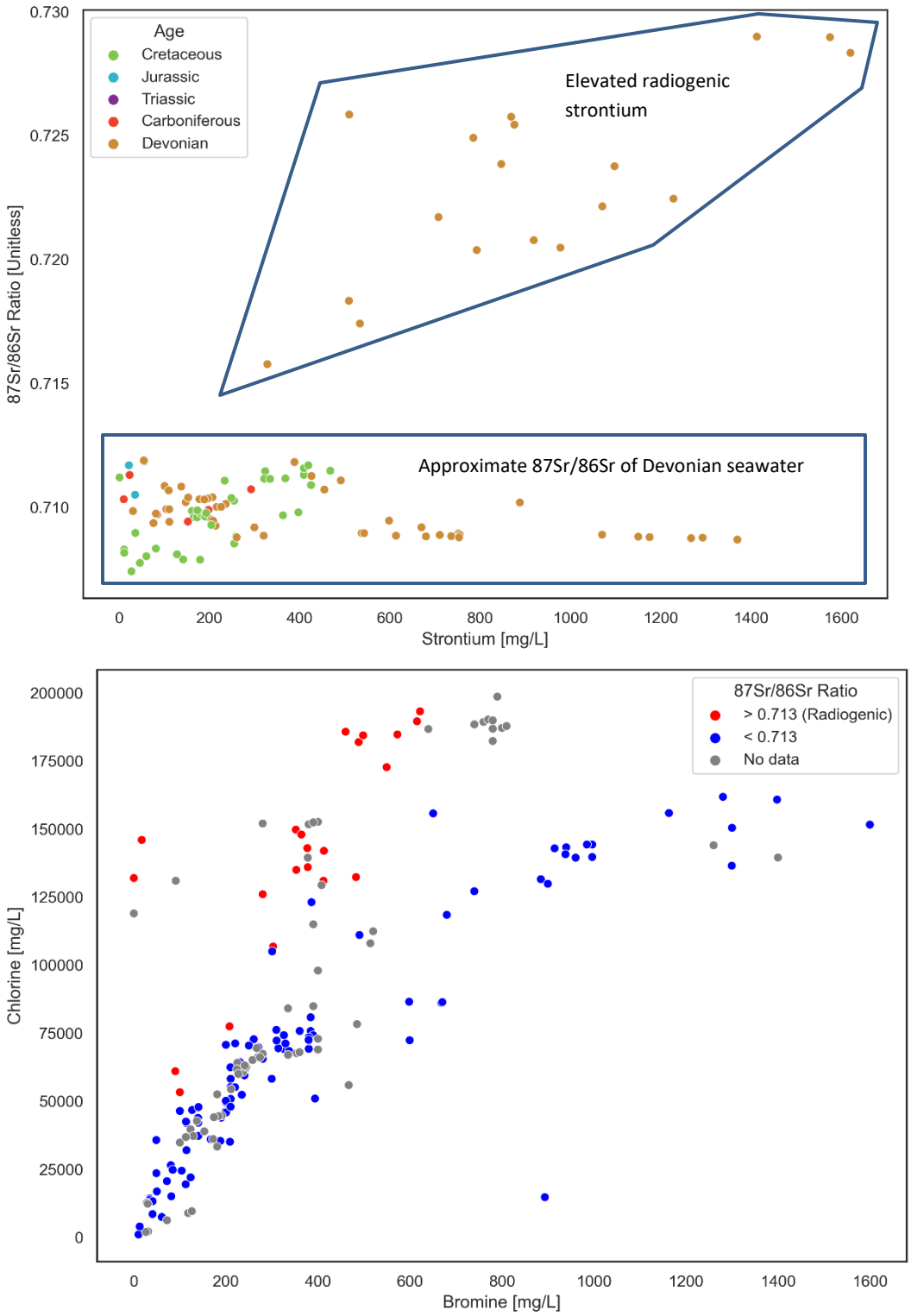

Figure 2: Strontium vs 87Sr/86Sr isotope ratio (top); bromine vs chlorine concentration (bottom).

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References

Connolly, C.A., Walter, L.M., Baadsgaard, H. and Longstaffe, F.J. (1990): Origin and evolution of formation waters, Alberta Basin, Western Canada sedimentary basin. I. Chemistry; Applied Geochemistry, v. 5, p. 375–395.

Dufresne, M. (2011): Peace South - A report on lithium exploration near Peace River, west-central Alberta; Alberta Energy, Mineral Assessment Report 20110005, 65 p., URL <http://content.energy.alberta.ca/xdata/MARS/MAR_20110005.pdf> [April, 2021]

Eccles, R. (2018a): A report on Boron, Bromine, Lithium and Potassium exploration on the Sturgeon Lake property near Sturgeon Lake; Alberta Energy, Mineral Assessment Report 20180001, 186 p., URL <https://content.energy.alberta.ca/xdata/MARS/MAR_20180001.pdf> [April, 2021]

Eccles, D.R. (2018b): A report on Lithium exploration on the Utikuma River property near Red Earth Creek; Alberta Energy, Mineral Assessment Report 20180008, 110 p., URL <https://content.energy.alberta.ca/xdata/MARS/MAR_20180008.pdf> [April, 2021]

Eccles, D.R. (2018c): A report on Lithium exploration on the Rimbey Homeglen property near Leduc County; Alberta Energy, Mineral Assessment Report 20180009, 136 p., URL <https://content.energy.alberta.ca/xdata/MARS/MAR_20180009.pdf> [April, 2021]

Eccles, D.R. and Berhane, H. (2011): Geological introduction to lithium-rich formation water with emphasis on the Fox Creek area of west-central Alberta (NTS 83F and 83K); Alberta Energy Regulator / Alberta Geological Survey, AER/AGS Open File Report 2011-10, 22 p. URL <https://ags.aer.ca/publication/ofr-2011-10> [April, 2021]

Eccles, R. and Dufresne, M. (2017): A report on Lithium exploration on the Fox Creek property near Fox Creek; Alberta Energy, Mineral Assessment Report 20170006, 108p., URL <https://content.energy.alberta.ca/xdata/MARS/MAR_20170006.pdf> [April, 2021]

Eccles, D.R. and Jean, G.M. (2010): Lithium Groundwater and Formation-Water Geochemical Data (tabular data, tab delimited format); Alberta Energy Regulator / Alberta Geological Survey, AER/AGS Digital Data Release 2010-0001. URL <https://ags.aer.ca/publication/dig-2010-0001> [April 2021]

Eccles, D.R., Dufresne, M.B., McMillan, K., Touw, J. and Clissold,R.J. (2012a): Technical Report, Inferred Li-K-B-Br-Ca-Mg-Na resource report on lithium-enriched formation water, Valleyview Property, west-central Alberta. National Instrument 43-101 Technical Report prepared for Lithium Exploration Group Inc., 244 p.

Eccles, D.R., Dufresne, M.B., McMillan, K., Touw, J. and Clissold,R.J. (2012a): Technical Report, Maiden Li-K-B-Br-Ca-Mg-Na resource estimate report on lithium-enriched formation water, Fox Creek Property, Swan Hills area, west-central Alberta. National Instrument 43-101 Technical Report prepared for Channel Resources Ltd., 202 p.

Government of Canada (2016). Geoscience Data Repository for Geophysical Data. URL <http://gdrdap.agg.nrcan.gc.ca/gdrdap/dap/search-eng.php>

Hitchon, B., Underschultz, J.R. and Bachu, S. (1993): Industrial mineral potential of Alberta formation waters; Alberta Energy Regulator / Alberta Geological Survey, AER/AGS Open File Report 1993-15, 92 p., URL<https://ags.aer.ca/publication/ofr-1993-15> [April 2021]

Huff, G.F. (2019): Origin and Li-enrichment of selected oilfield brines in the Alberta Basin, Canada; Alberta Geological Survey / Alberta Energy Regulator, AER/AGS Open File Report 2019-01, 29 p. URL <https://ags.aer.ca/publication/ofr-2019-01> [April, 2021]

Huff, G.F., Stewart, S.A., Riddell, J.T.F and Chisholm, S. (2011): Water geochemical data, Saline Aquifer Project (tabular data, tab delimited format); Alberta Energy Regulator / Alberta Geological Survey, AER/AGS Digital Dataset 2011-0007. URL <https://ags.aer.ca/publication/dig-2011-0007> [April, 2021]

Huff, G.F., Bechtel, D.J., Stewart, S.A., Brock, E. and Heikkinen, C. (2012): Water geochemical data, Saline Aquifer Project, 2011 (tabular data, tab delimited format); Alberta Energy Regulator / Alberta Geological Survey, AER/AGS Digital Dataset 2012-0001. URL <https://ags.aer.ca/publication/dig-2012-0001> [April, 2021]

Huff, G.F., Lopez, G.P. and Weiss, J.A. (2019): Water geochemistry of selected formation brines in the Alberta Basin, Canada (tabular data, tab delimited); Alberta Energy Regulator / Alberta Geological Survey, AER/AGS Digital Data Release 2019-0002. URL <https://ags.aer.ca/publication/dig-2019-0002> [April, 2021]

Lappin, E. (2018): A report on Lithium exploration on the South-Central Alberta property near Red Deer; Alberta Energy, Mineral Assessment Report 20180012, 745 p., URL <https://content.energy.alberta.ca/xdata/MARS/MAR_20180012.pdf> [April, 2021]

Lopez, G.P.; Weiss, J.A.; Pawlowicz, J.G. (2019): Lithium Content in Groundwater and Formation Water in Alberta (tabular data, tab-delimited format); Alberta Energy Regulator / Alberta Geological Survey, AER/AGS Digital Data 2019-0029, URL <https://ags.aer.ca/publication/dig-2019-0029> [April 2021]