January 2023 – NRCan: Projects Update #1

During this session with Natural Resources Canada (NRCan) / Geological Survey of Canada (GSC) personnel, the objective was to investigate and discuss energy transition related work that is currently ongoing. Omid Haeri Ardakani (PhD, P.Geo.), Research Scientist at GSC Calgary, elaborated on his project "Underground Hydrogen Storage & The Role of Geoscience in Energy Transition". In addition, Dr. Steve Grasby, Senior Research Scientist with GSC Calgary, presented his work on the "Geothermal Energy Potential of the Garibaldi Volcanic Belt". The session was moderated by John Hirschmiller, Senior Geologist & Geothermal Lead at GLJ Ltd.

To begin, Omid acknowledged the extensive network of organizations who continue to collaborate on the work being presented. He also noted the historical global energy transition journey from wood & hay in the 1850's to a much more complex energy mix that we currently employ, including hydrocarbons, nuclear, hydro, and hydrogen. Energy transition is not a new phenomenon, but rather an ongoing & evolving drive towards more efficient and greener solutions. Within many scenarios and projections (including the International Energy Agency), hydrogen is projected to play an increasing role in future energy systems as the world progresses to its Net Zero ambitions. Although hydrogen is the most abundant element in the universe with a high energy density, it is also the smallest & lightest atom. As such, the safety implications and its potential greenhouse gas effects deserve serious considerations.

Currently, hydrogen is used in the manufacturing of fertilizers, plastics, glass & steel, in fuel refining, for heating industrial, commercial & residential buildings, and more recently, as a fuel within the transportation sector. As the world and industries forecast a growing hydrogen economy, Canada, accordingly, adopted a National Hydrogen Strategy in 2021 to ensure appropriate regulatory & industrial protocols are in place. Regardless of the colour or production source (blue – produced from natural gas with no atmospheric emission, green – produced using no hydrocarbons or emissions, or grey – produced from natural gas with atmospheric CO_2 emission), there is currently significant ongoing research on hydrogen, its merits & use, and its transportation & storage. Based on available information, salt caverns, aquifers & depleted reservoirs, and hard rock caverns & abandoned mines are used commonly for storage purposes. Hydrogen storage projects being developed globally are at different stages utilizing different options within each jurisdiction. Salt caverns are the most common storage choice due to the lower associated costs, but cushion gas is required to avoid leakage. Although there is typically more information available for storage in depleted reservoirs and aquifers, progress is slow as more research is needed. In addition to technical and safety limitations, other major hindrances to storing hydrogen underground include geological & reservoir constraints, legal barriers & conflicts of interest, and social acceptance of underground storage. Currently, Canada has only one proposed hydrogen storage project (conceptual stage), which is a salt cavern in Windsor, Ontario.

NRCan's ongoing research and project objectives, in collaboration with various universities and research organizations, include the following:

1. Determining hydrogen flow within reservoirs
2. Geo-mechanical properties of reservoirs
3. Hydrogen / rock matrix interaction and potential hydrogen loss
4. Identification of the best Canadian underground hydrogen storage sites and options

5. Hydrogen loss through microbial & geochemical activities
6. Establishing / updating current standards of underground hydrogen storage

Switching gears to the Geothermal presentation, Dr. Grasby indicated that with Canada's energy production currently at 89% non-renewables (hydrocarbons, coal & nuclear), a diverse and sustained energy supply growth for renewables is needed to eventually offset hydrocarbon production to support Canada's transition to a low-carbon economy. With five volcanic belts in Western Canada, the Garibaldi Belt is the closest to the population base in BC's lower mainland and was the focus of his presentation. It is an active hydrothermal system that has not erupted in about one hundred years. In addition to the early research and drilling done by NRCan and BC Hydro, current research work is focused on Mount Meager (Phase 1) within the Garibaldi Belt as it is exhibiting excellent characteristics, with readily available data and information. Both high thermal gradients and flow rates (permeability) are necessary for commercial success in geothermal projects. Mount Cayley, which is also part of the Garibaldi Volcanic Belt, is exhibiting similar hydrothermal properties and is the 2nd Phase of his research work.

The extensive scope of the multi-dimensional research includes:

1. Geologic Mapping – studies of faults and fractures that can control fluid flow, classification of rock type & characteristics, and refine eruption history.
2. Deep Magnetotelluric Work – measures resistivity of rocks 2 to 10 km in depth to identify potential magma chambers (magma chambers less sensitive) and flow paths to surface.
3. Shallow Magnetotelluric Work – reservoir definition of the upper 2 km via surface mounted or aerial data collection system (more efficient data collection but lower quality / resolution)
4. Gravity Surveys – ascertain potential signatures of melt and geothermal system.
5. Passive Seismic – crustal imaging and baseline seismic data.
6. Fracture Studies – understanding fracture systems and stress fields for fluid flow controls.
7. Ground Temperature Studies – mostly for high latitude regions to determine ground temperature anomalies.
8. Remote Sensing – satellite imagery to define thermal anomalies and lineament detection.
9. AI / Machine Learning resource evaluation – to aid in assessing geothermal anomalies.
10. Resource Assessment & Modeling – for long-term production forecasting.
11. On-going research – closed loop geothermal systems in horizontal & inclined settings.