August 2022 – CSUR Virtual Field Trip

Investigating Key Elements for CCS Applications in Alberta

Once again this year, CSUR planned a virtual field trip to various locations in order to highlight important geological aspects of undertaking projects related to Carbon Capture & Sequestration (CCS).

The Western Canadian Sedimentary Basin (WCSB) possesses significant potential for these types of projects. To explore the various elements and requirements for CCS projects, CSUR enlisted the services of Jon Noad, a senior geologist and experienced teacher & field trip guide. With CCS as the main focus, Jon designed a trip that transported the audience to 7 locations around the province to view outcrops and investigate features considered crucial for possible CCS ventures.

Jon first provided basic information on common CO_2 sequestration methods, requirements for CCS applications, and highlighted local & global CCS projects and opportunities, including Shell Canada's Quest pilot project in Alberta (injection into the Basal Cambrian sandstone). The key elements he noted for successful development were:

1. A thick, laterally extensive reservoir
2. Ideally, a burial depth of 1 to 4 kms such that CO2 can be in a supercritical (semi fluid) state
3. Sufficient reservoir properties to allow for proper transport in-situ
4. A top sealing formation or cap rock
5. A tectonically stable area

As there are only a handful of projects globally, Jon reminded the audience that CCS projects are presently not economically viable on their own but can be used to obtain carbon credits to be used towards other conventional projects. Currently, they are being touted as the most accessible and technically ready solutions for global decarbonisation options. Keeping the above-mentioned fundamentals in mind, he traveled to the various stops and delved into the characteristics of several clastic formation outcrops such as the Grinnell in Waterton Park and the Gog Quartzite in Okotoks & Kicking Horse Pass. This was followed by an examination of a core and the potential depositional model of the Deadwood formation in Alberta. It was noted that the Deadwood is considered a multi-purpose reservoir as it has been a target for various different deposits and projects besides oil & gas, including gold, geothermal, helium, and now CCS. The field trip made another stop in Waterton to examine a Carbonate outcrop (Siyeh formation) for CCS applications. Other Carbonate formations around Alberta that could also be targeted for CCS include the Keg River, Banff Limestone, and the Moose Mountain Limestone.

The final portions of the tour investigated the structural aspects and the potential implications of not having an impervious seal to surface. The consequences of CO_2 leakage could be devastating and as such, this aspect becomes a vital component for any project. As indicated by our speaker, the best seals are thick evaporites (i.e., Winnipegosis,

Gypsum, Salt), which are totally impermeable and have the capacity to heal developing faults & fractures. Generally, igneous formations appear to have better sealing qualities compared to sandstones, he noted. However, mudstones (common in Alberta), basalt layers and sills can also form great seals, but may have limitations (thin, localized, etc.).

SUMMARY

Carbon capture and storage (CCS) or carbon capture and sequestration is the process of capturing carbon dioxide (CO2) before it enters the atmosphere, transporting it, and storing it (carbon sequestration) for centuries or millennia. The injection of CO2 into geological formations has been undertaken for several decades for various purposes, including enhanced oil recovery, but the long-term storage of CO2 is a relatively new concept. Beyond the alleviation of climate change, CCS is a relatively expensive process yielding a product with an intrinsic low value i.e. CO2.

Storage of the CO2 is envisaged either in deep geological formations, or in the form of mineral carbonates. Generally speaking, the target geological formations are Palaeozoic or older, with several successful projects focused on potential Cambrian reservoirs. The depth of such reservoirs helps to keep the injected gas in a dense phase. We will examine Shell's Quest project which uses the Basal Cambrian Sandstone as a reservoir in core, before focusing on its lateral equivalent the Gog Quartzite. Outcrops in the Kicking Horse Pass will be used to highlight some of the requirements for a successful CCS system. We will also look at Precambrian limestone beds of Waterton National Park as potential carbonate reservoirs.

Other aspects of CCS systems are that the reservoir must be regionally extensive. This will allow the injected gas to percolate laterally over a time period measured in decades without the risk of breaching. Such clastic reservoirs are usually limited to lowstand fluvial deposits and shoreface deposits. Deltaics and turbidites are unlikely to be extensive enough for this purpose. We will examine sand sheets from both fluvial and shallow marine settings, while flagging up why Cretaceous reservoirs are unlikely to work as CCS targets. Ancient carbonate platforms are also areally extensive targets at depth.

Cambrian and older reservoirs are likely to be fractured as they will very likely have been subjected to tectonic stresses at some point in their geological history. Hence another critical requirement is an impervious cap rock. This may consist of shales or ideally evaporites; it is hoped field examples of both will be available for study and filming for this field trip. Thick intervals of fine grained sediments are ideal as caprocks particularly when less fractured and faulted. Th impact of structural deformation and faulting on the efficacy of fractured reservoirs as CCS targets will also be addressed through faults seen in outcrop.

In addition to the outcrops indicated above, this online field trip will also involve discussions of storage in saline aquifers and coal seams and examples of working CCS projects from around the globe. We will also examine the implications of leasing pore space. By the end of the field trip, you should have a clear idea of what is needed to build a successful carbon capture and sequestration project as well as seeing some unique geology from across the province.

PRESENTER: *Jon Noad - Jon Noad, SediMental Services - Stantec*

Jon Noad graduated in 1985 and started working as a mining geologist in South Africa. He returned to the UK to work in marine cable laying and completed a Masters in Sedimentology at evening classes. This led to a full time PhD, working in

eastern Borneo, after which he joined Shell International working Middle East exploration and in several production roles. He moved to Shell Canada in Calgary in 2006, followed by senior geoscience roles at Murphy, Husky and Gran Tierra (Colombia). Jon started a consultancy in 2017 and has run more than 50 field trips and courses for industry as well as teaching at several universities. He joined Stantec as a qualified Palaeontologist in 2022 and now undertakes site monitoring for new pipelines and construction projects.

MODERATOR: *Colleen Sherry MSC, MBA, MSL - VP, Sustainability from GLJ.*

Colleen Sherry is the current and first Vice President, Sustainability, at GLJ. Colleen supports GLJ's expanding, strategic advisory capacity in decarbonization, energy transition, ESG reporting, responsible production certification, and emerging technologies. Colleen is a sustainability, geotechnical and business strategy specialist with more than 25 years of operational and leadership experience, largely in the energy and natural resource extraction sectors. Her expertise has supported client sustainability strategy assessment and development in numerous jurisdictions world wide.

Colleen has a BSc in Geology with a minor in Geophysics from the University of Calgary, an MSc in Earth Sciences from the University of Ottawa, an MBA jointly from Queen's University and Cornell University, and an MSL (Master of Sustainability Leadership) from Arizona State University. In addition to her work at GLJ, Colleen also serves as a global Academic Associate with the School of Sustainability at Arizona State University and is a board member with CSUR (Canadian Society of Unconventional Resources) which is undergoing a transition to CSEE (Canadian Society of Evolving Energy).