GSC Scientific Presentation 104 – Presenter's notes

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I will talk about the assessment of…

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This is an important one because this project is multidisciplinary and without everybody's contribution, this project could not be carried out. I unfortunately don't have the time to name everyone, but there are people from three Divisions (Québec, Ottawa and Calgary), two universities (INRS and O of Ottawa), people from the province (from the Departments of Environment and Energy and Mines) and from the industry

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The Elgin area is a prospected field for condensates, which are composed of hydrocarbons such as ethane, propane and butane. It would probably be more interesting for the industry than just methane because the price of gas is still very low. However, there is presently a moratorium on HF in the province until more science-based knowledge is gained on health and environmental issues. This project will provide some of this knowledge. This project started 2 years ago and will last 4 years. A total of 39 gas wells have been drilled so far, mostly in the McCully gas field.

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Since little data is available on the caprock or intermediate zone, our approach for thise project involved the use of, of course, geological data, but also multi-source indirect data from different fields, such as…

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For this project, we drilled 10 wells, both conventional and diamond-drilled wells, to have core samples for further analyses. In our wells, we carried out borehole geophysics, among other things to identify the depth at which flowing fractures were located and, thus, where we could sample groundwater. We carried out slug tests to obtain K values. We also installed different types of sensors downhole. Outcrops were also visited to obtain more information on the fracture network.

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… more specifically in the Moncton sub-basin. The two units of interest to the industry are the Hiram Brook tight sandstone and the Frederick Brook shales, that that are two members of the Albert Formation of the Horton Group. These units can be found at a depth of more than 2 km. The overlying units, which correspond to the IZ, are composed, among other things, of the Windsor Group, which contains evaporite deposits. This unit is of high interest for this project because it represents a good protection for shallow aquifers since it can be considered nearly

impermable and it has a very low brittleness index (I'll come back to that in a minute). At the top, there is the Mabou group, mainly composed of conglomerates, sandstone, siltstone and shale. The regional bedrock aquifer is also located in the Mabou Group, but only in the upper 100 m or so.

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A paper on the geological re-interpretation of this region was recently published. This figure, which was used for the graphical abstract, illustrates schematically the evolution of the Moncton Basin with areas of sedimentary deposition in light yellow and positive reliefs in brown. The two first stages of basin evolution took place in a strike-slip setting, but resulted in a net extension along fault nearly perpendicular to the basin axis during the first stage and in net shortening during the second stage. During the late stage, the influence of the main faults is more subtle and deformation is mainly associated with salt motion, the salt being indicated by a black interval on the top of figure. This new model enhances the close relationship between tectonics and sedimentation in this kind of basin.

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Borehole geophysical logging was carried out in all the shallow observation wells. Site-wise differences… for instance, in recharge and discharge zones, helping defining the GW flow conceptual model. This figure shows GW electrical conductivity logs. Blue logs represent down-flowing (recharging) groundwater which is relatively fresher (lower conductivity). Red logs on the right represent up flowing conductive (briny) groundwater rising from depth. We'll explain why in a few slides. Note the upward reducing electrical conductivity in log PO-02 as fresher groundwater enters the borehole (and dilutes the conductive waters entering at the base of the borehole).

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Rock-Eval analyses, that are commonly used to identify the type and maturity of organic matter, showed that the McCully gas field contains dry gas, while the Stoney Creek field located less than 100 km to the east (south of Monton) contains oil for the same stratigraphic level, confirming that the area of the McCully gas field was buried at greater depths compared to the NE (Moncton) and E (Elgin) margins of the basin. In our shallow observation wells, one of the core samples from a well located in the Elgin area also belonging to the Horton Gr. showed values in the condensates zone.

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The thermal maturation map based on organic matter reflectance confirms the decrease of maturation for the Albert Fm towards the east.

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This map shows the different water types that we have in the monitoring wells. Most of them are of the Ca-HCO3 type (shown in pink here), thus young water. However, in red, we have two special water types that are unusual in shallow aquifers. These water types, corresponding to old, evolved water can only be explained by the presence of regional flow and the rock salt structure exploited by Potash Corp. I'll talk about more in the next slide. Hydrocarbon concentrations were found to be low across the study area. This dotted line shows the location of the cross-section that I will discuss on the next slide: it crosses the Kennebecasis River valley.

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The location of this cross-section is similar to that of the numerical model, although it extends further south. This 2D conceptual model shows the surface topography, the water table elevation, local and regional GW flow direction and the salt structure located under the Kennebecasis River valley that we mentioned earlier. Although most of the flow is indeed local and shallow (as indicated by the numerical model), the presence of regional and deeper flow paths (that are deeper than 100 m) are indicated by the unusual geochemistry observed in some of the wells located at the bottom of the Kennebecasis River valley (such as this one: PO-2). The unusual water type observed in 2 wells located just north of the Kenn River (showing evolved and old groundwaters) indicates a contribution from evaporites whose chemical components are presumed to have been transferred to the more active flow zone by diffusion. The regional groundwater flow discharge occurs to the NW of the river itself, likely because there is more flow coming from the SE than the NW due to the higher topography and larger volume.

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Based on regular monitoring, only 2 wells would contain thermogenic gas, despite the fact that conventional graphs used to define the origin of methane could have indicated a wider occurrence. A comparison of the isotopic signature between GW samples and gas extracted from core samples from our shallow observation wells indicate that both microbial and thermogenic gas found in this region appears to come from the shallow bedrock itself. Therefore, although evidence of some upward migration over a few hundreds meters have been found, large-scale migration from a deep gas reservoir to the surface is considered very unlikely.

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The Aquistore CO2 Storage site is located in SE Sask in the northern Williston. It is ~80 km from the Weyburn EOR field.

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The CO2 Capture Plant is shown here after completion in 2013. 2.6 million tonnes captured to date = 1 million cars for 1 year or 250,000 cars during the 4 years of the project.

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What is our role? We are focusing on two specific areas of research: monitoring methods and induced seismicity. The expected outcomes are as listed.

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At the Aquistore site, a permanent array of 630 geophones (green dots) was deployed to 1) monitor the migration of CO2 in the subsurface and 2) listen for any induced seismicity at the site.

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Based on this assessment, the deepest well in SK was drilled to a total depth of 3400 m. This is the CO2 injection well.

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110 ktonnes

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Canada Centre for Mapping and Earth Observation (*CCMEO*)

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threshold speed attained or exceeded I percent of the time.