



MEMORANDUM

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(NWMO)

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INTERIM RESULTS OF GEOSCIENTIFIC PRELIMINARY ASSESSMENT, TOWNSHIP OF NIPIGON, ONTARIO

1.0 INTRODUCTION

As requested, this memorandum provides a summary of interim findings of the Phase 1 geoscientific preliminary assessment of the Township of Nipigon. The geoscientific assessment is being conducted to assess whether the Nipigon area contains general areas that have the potential to satisfy NWMO's site evaluation factors (NWMO, 2010).

Results to date suggest that the Nipigon area contains at least two areas that may warrant further consideration. However, the assessment also indicates that there are substantial geological uncertainties that reduce the likelihood of identifying sites that will satisfy NWMO's geoscientific site evaluation factors.

This memorandum provides a brief summary of these findings; we would be pleased to discuss the findings further with NWMO.

2.0 SUMMARY OF GEOLOGY

The geology of the Nipigon area consists of Mesoproterozoic sedimentary and intrusive rocks, and unconsolidated Quaternary deposits overlying the 2.7 billion year old bedrock of the Canadian Shield. Proterozoic strata are widespread throughout the Nipigon area, but since they invariably overlie rocks of the Quetico Subprovince, the entire Nipigon area may be considered structurally part of the Superior Province of the Canadian Shield.

In the southern and western portions of the Nipigon region, the Proterozoic sedimentary rocks of the Sibley and Animikie Groups unconformably overlie the Archean metasedimentary rocks of the Quetico Subprovince. The metasedimentary rocks of the Quetico Subprovince and the sedimentary rocks of the Sibley Group in the Nipigon area were intruded by Nipigon diabase sills and dykes related to the failed intracontinental rifting event that occurred approximately 1.115 billion years ago, and by localized ultramafic intrusions, such as the Hele intrusion, that occurred approximately 1.115 to 1.105 billion years ago. Tholeiitic flood basalts of the Osler Group were deposited slightly later than the Nipigon sills and underlie most of the St. Ignace Island chain to the south and east of the Nipigon area.

A potentially important geological characteristic for the Nipigon area is the presence of diabase sills. The sills are relatively thin (<200 m), generally flat-lying mafic rocks that intrude and overlie other rock types in the Nipigon area. The presence and extent of sills beneath overburden and at depth within the Quetico metasedimentary rocks is largely unknown. In the western part of the Nipigon area where high resolution geophysical data is available, we have interpreted probable locations of sills in the shallow subsurface based on their magnetic response. Geophysical data resolution over the eastern part of the Nipigon area is insufficient to



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make a similarly confident interpretation at this time. In general, sills may exist at depth throughout the Nipigon area, even in areas where they do not have a surface outcrop. Geomechanically, intrusion of the sills may have induced damage to the host rock within an envelope around their contact. The potential presence of diabase sills at depth, their geometry and geomechanical influence would require further assessment should the Nipigon area proceed in the assessment process. This specific uncertainty was not present to the same extent for any of the other crystalline communities for which Phase 1 assessments were conducted.

3.0 SCOPE OF THE ASSESSMENT

The Phase 1 of the geoscientific desktop preliminary assessment included the following review and interpretation activities:

- Detailed review of available geoscientific information such as geology, structural geology, natural resources, hydrogeology and overburden deposits;
- Interpretation of available geophysical surveys (magnetic, electromagnetic, gravity, radiometric);
- Lineament studies using available satellite imagery, topography and geophysical surveys to provide information on characteristics such as location, orientation and length of interpreted structural bedrock features;
- Terrain analysis studies to help assess factors such as overburden type and distribution, bedrock exposure, accessibility constraints, watershed and subwatershed boundaries, groundwater discharge and recharge zones; and
- The identification and evaluation of general potentially suitable areas based on key geoscientific characteristics and the systematic application of NWMO's geoscientific site evaluation factors.

Based on available information for the Nipigon area, the key geoscientific characteristics and constraints that were used to identify general potentially suitable areas were as follows:

- **Geological Setting:** Areas of unfavourable geology identified during the initial screening (Golder, 2012) were not considered. These include areas underlain by the Mesoproterozoic Sibley Group sedimentary rocks and areas covered by surface outcroppings of the Nipigon sills.
- **Structural Geology:** Areas within or immediately adjacent to regional faults and fault zones were avoided. The main structural features in the Nipigon area include major fault zones such as the Black Sturgeon fault zone and the Jackpine River fault, as well as the Gravel River fault that borders the southeast corner of the Nipigon area. There are also several mapped but unnamed brittle faults of lesser extent within the Nipigon area.
- **Lineament Analysis:** In the search for general potentially suitable areas, there is a preference to select areas that have a relatively low density of lineaments, particularly a low density of longer lineaments, as they are considered more likely to extend to greater depth than shorter lineaments.
- **Overburden:** The distribution and thickness of overburden cover is an important site characteristic to consider when assessing amenability of an area to site characterization. At this stage of the assessment, preference was given to areas with greater mapped bedrock exposures.



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- **Protected Areas:** All provincial parks and conservation reserves within the Nipigon area were excluded from consideration in the selection of potentially suitable areas. Areas closer to two First Nation reserves were also not assessed.
- **Natural Resources:** Areas with known deposits of economically exploitable natural resources were excluded from further consideration.
- **Surface Constraints:** For the identification of potentially suitable areas, the principal factors considered were topography and the size and location of water bodies and wetlands. At this stage of the assessment, preference was given to areas without significant surface constraints.

4.0 INTERIM ASSESSMENT FINDINGS

The geoscientific desktop preliminary assessment showed that the Nipigon area contains at least two general areas that may warrant further consideration. One small area includes a granitic pluton located in the Mound Lake area and the metasedimentary rocks adjacent to it. The other, larger, area is underlain by metasedimentary rocks of the Quetico Subprovince within the eastern portion of the Nipigon area.

The two identified general siting areas appear to have a number of geoscientific characteristics that are favourable for hosting a deep geological repository. The areas appear to have sufficient depth and sufficient lateral extent to host a deep geological repository, low potential for natural resources, good bedrock exposure, limited surface constraints (topography and water bodies) and are generally accessible. However, there are several significant uncertainties that, when combined, reduce the likelihood of the two identified areas to satisfy NWMO's geoscientific site evaluation factors. These include:

- The potential for lithological heterogeneity within both the metasedimentary rocks and the granitic pluton in the Nipigon area. The area identified near Mound Lake covers two different rock types (metasedimentary rocks and granitic). The contact between these two rock types would need to be evaluated. In addition, the lithological heterogeneity associated with the metasedimentary rocks in the area would need to be assessed. In general, lithological heterogeneity makes site characterization more difficult and can lead to spatially variable geomechanical, thermal and hydrogeological properties.
- The existence and extent of Nipigon diabase sills in the Nipigon area. As discussed above, because of their horizontal nature, the presence of sills at depth cannot be ruled out, even in areas where they do not have a surface outcrop. The intrusion of these sills in the geological past sills may have caused damage to the pre-existing rock. The presence of sills at depth, and associated rock damage, has the potential to create pathways for groundwater movement, which could affect the containment and isolation characteristics of the rock.
- The presence of mafic dykes and the potential presence of smaller dykes not identifiable on available mapping and geophysical data. The intrusion of dykes may have caused damage to the host rock that would need to be assessed. In addition, the thermal and hydraulic conductivity of the dykes (and sills) would need to be investigated.
- The proximity of these two areas to the Black Sturgeon fault zone and Jackpine River fault. It is uncertain to what extent the two areas are structurally impacted (degree of fracturing) as a result of their proximity to these major features.

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Detailed investigations would be required to resolve these inherent uncertainties and assess with a sufficient level of confidence whether the Nipigon area contains areas that can satisfy the geoscientific site evaluation factors.

5.0 SUMMARY OF INTERIM FINDINGS

The interim results indicate that there are substantial geological uncertainties in the Nipigon area that reduce the likelihood of identifying sites that will satisfy NWMO's geoscientific site evaluation factors. These uncertainties relate to the potential for lithological heterogeneity, the existence of both sills and dykes in the Nipigon area, and the proximity of the area to major fault zones.

6.0 REFERENCES

Golder Associates Ltd. (Golder), 2012. Initial screening for siting a deep geological repository for Canada's used nuclear fuel - Township of Nipigon, Ontario. Nuclear Waste Management Organization.

NWMO, 2010. Moving Forward Together: Process for Selecting a Site for Canada's Deep Geological Repository for Used Nuclear Fuel, Nuclear Waste Management Organization, (available at www.nwmo.ca).

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