STABILITY ANALYSIS OF DRILLING WASTE SUMPS, WESTERN ARCTIC CANADA

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BACKGROUND

- Petroleum development projects in the western Arctic excavated large pits to dispose of industrial waste assumed to be contained by permafrost
- Primary additives of salts act as freezing point depressants allowing drilling in frozen ground
- There are approx. 270 sumps in the Mackenzie Delta Region
- Climate change threatens the stability of sumps
- Summer 2022 fieldwork investigated eleven sumps, 5 in the Mackenzie Delta and 6 in the adjacent uplands, to compare sump performance in varying terrain (Figure 1)

RESEARCH OBJECTIVES

- Investigate the stability of sumps in different permafrost conditions
  - (Mackenzie Delta vs. adjacent uplands)
- Investigate contaminant migration away from sumps and compare 2022 field data with past data sets (from the early 2000s)
- Determine a priority order for continued monitoring by regional agencies and aid in sump risk assessment
- Address community concerns of the Inuvialuit

METHODOLOGY

- conductivity surveys with EM 31 to trace KCl additives
  - KCl = conductive
  - permafrost = resistive
- Soil samples to calibrate EM 31 readings using IPC-MS
- Pond water samples to determine mobile KCl concentrations (IPC-MS)
- Soil particle size analysis comparing sump cap and undisturbed terrain
- Site aerial surveys to determine ponding and general vegetation characteristics

Figure 1. Map of eleven sumps analyzed during summer 2022

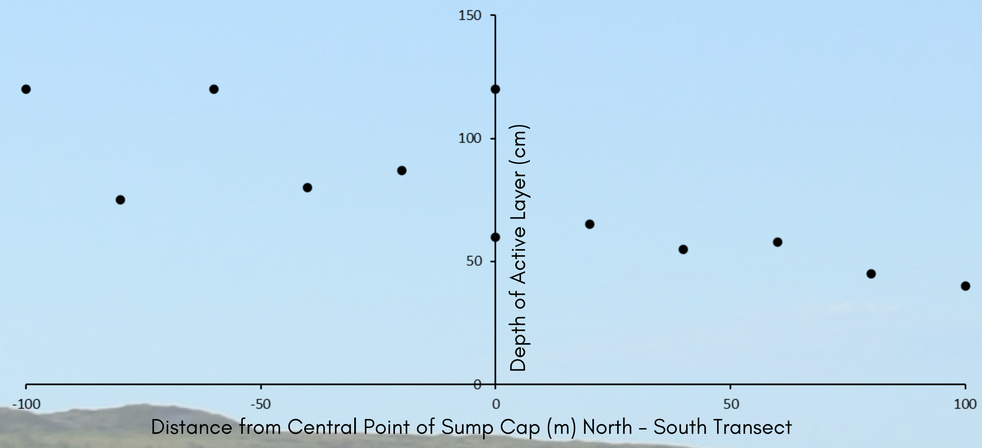

Figure 3. Measured active layer depths at F-29 North South transect

SUMMER 2022 RESULTS

- Figure 2D indicates drainage from sump towards the northwest where readings are elevated compared to background undisturbed terrain
- EM31 Readings from August 2022 (Figure 2D) indicate a higher concentration of KCl in northwest transect than 2005 EM31 map (Figure 2C) which is indication of leaching of materials
- Summer 2022 data indicates active layer depths are typically greater near the sump cap, reaching a maximum of 120 cm (Figure 3), the limit of the thaw probe used.

ITIGINKPAK F-29 SUMP

- Series of Geotechnical Reports (Inuvialuit Environmental & Geotechnical Inc., 2001. Project Description for the Proposed Petro-Canada Kurk/Napartok Winter 2001/2002 Drilling Program. Kiggiak-EBA Consulting Ltd., 2006. Itiginpak F-29 Sump Remediation Plan.) found that F-29 was at risk for failure, cap subsidence, and leaching of potentially unfrozen drilling muds into adjacent terrain.
- Thermistors were installed to assist in sump monitoring (Figure 2A). Periodic downloads have been taken and are accessible in various reports.
- Reports concluded that the sump cap has considerably subsided and recommended that areas needed to be filled to prevent further subsidence and destabilization.
- Surface of sump cap must be graded to drain properly. A top slope of 2.5% is recommended to promote runoff. Current subsidence has promoted the formation of a pond on the cap (Figure 2B)

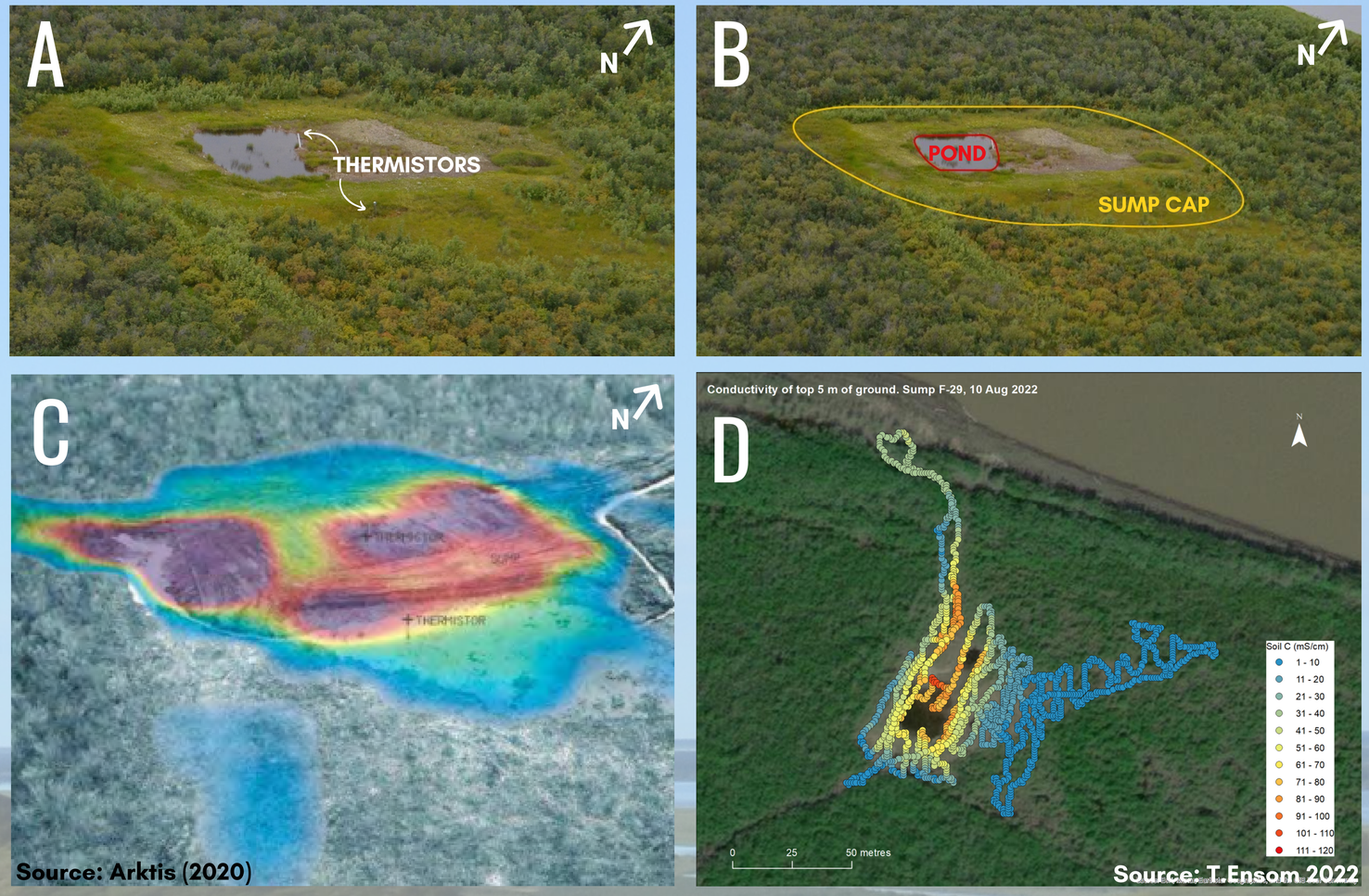

Figure 2. A) Location of thermistors on F-29. B) F-29 sump annotated to show extent of sump cap and ponding on cap. C) Electromagnetic (EM) survey showing contaminant migration beyond sump boundaries, Itiginkpak F-29 sump completed in September 2005. Where dark red is indicative of high concentrations of KCl. D) Electromagnetic (EM) survey showing contaminant migration beyond sump boundaries, Itiginkpak F-29 sump completed August 2022.

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