

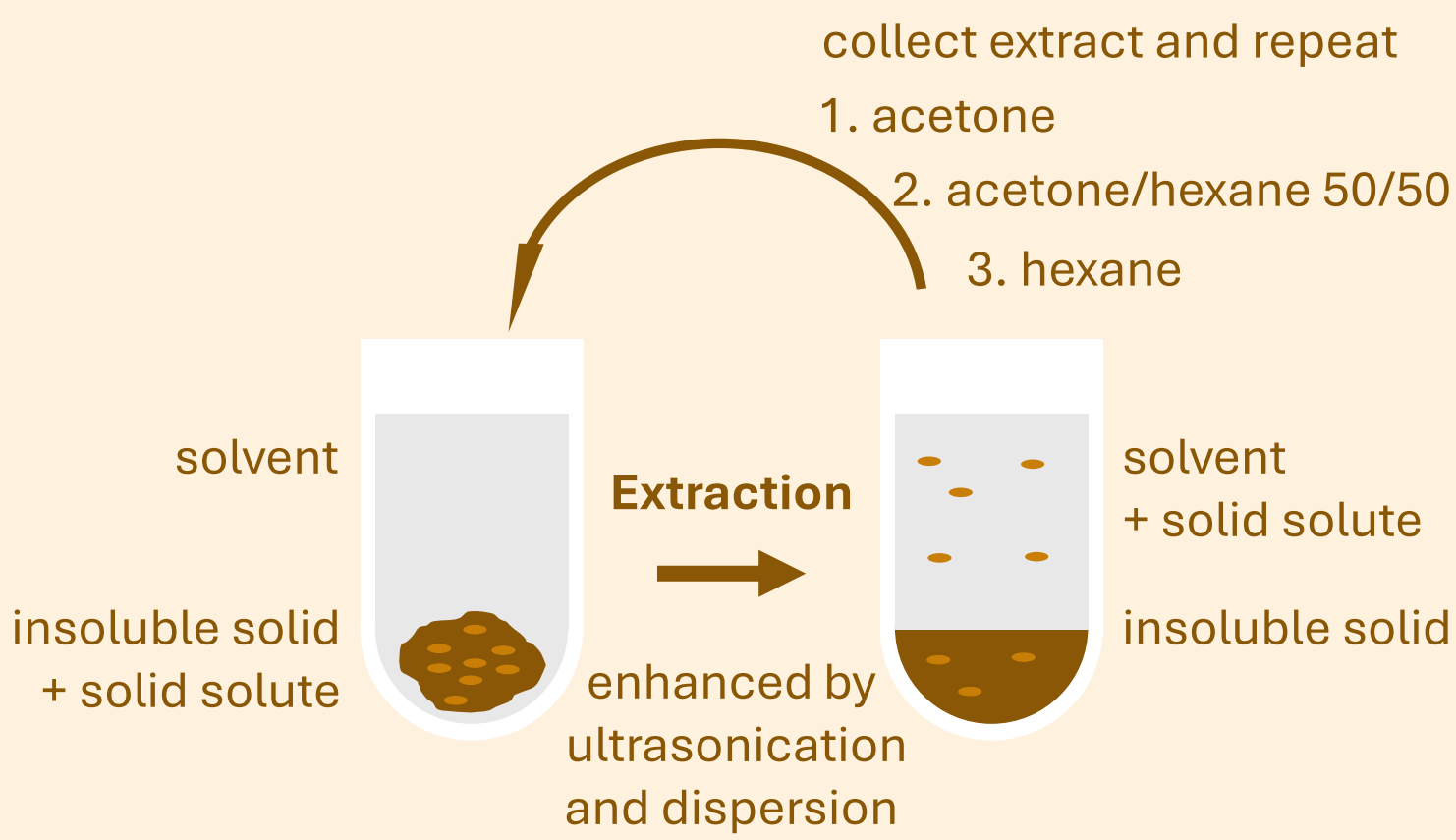
Permafrost soils as a Pollutant Barrier – are Organic Contaminants released from failing Drilling Mud Sumps in the Mackenzie Delta?

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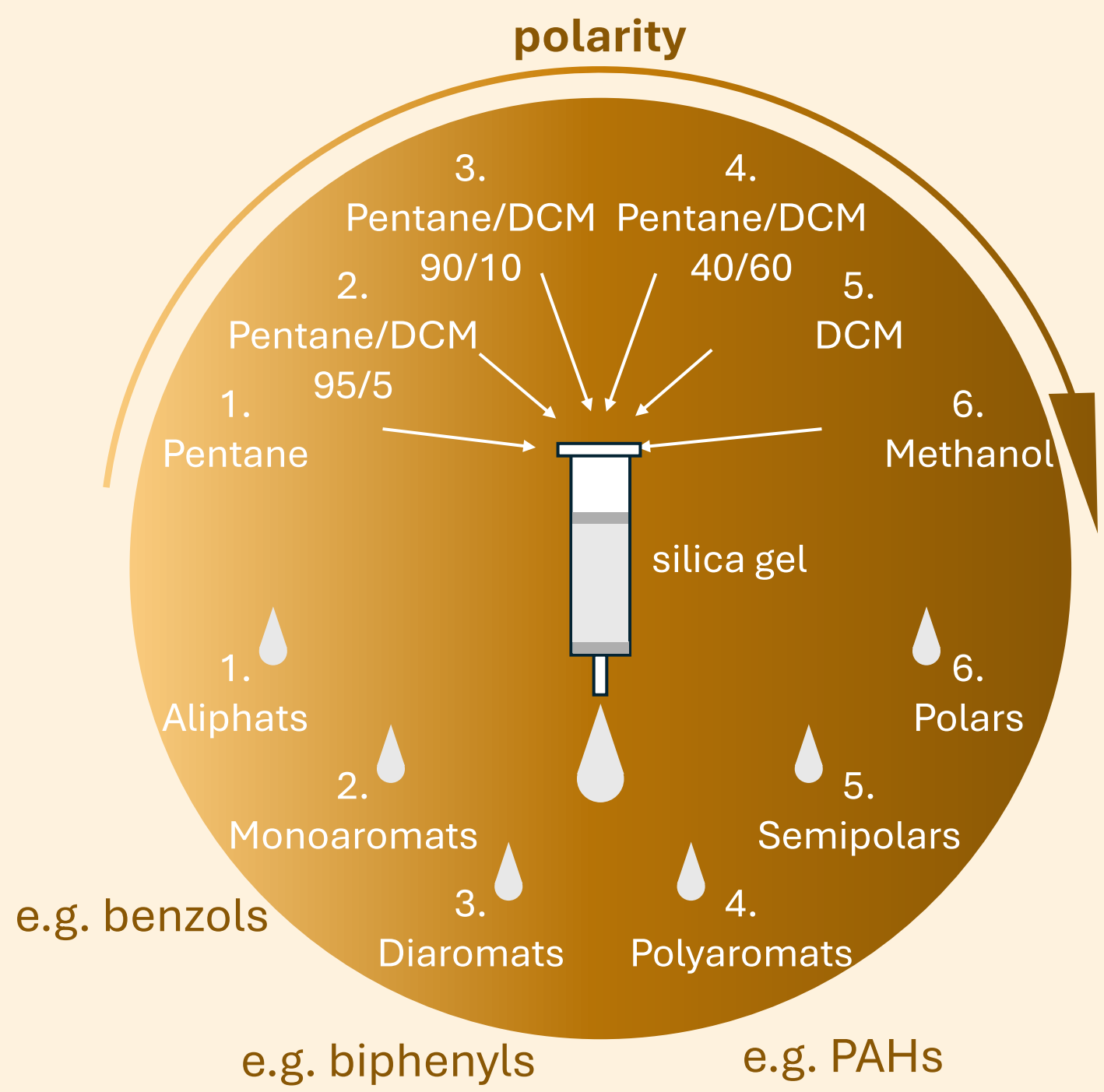
Suspect and non-target screening of organic pollutants

1. Extract compounds from soil matrix



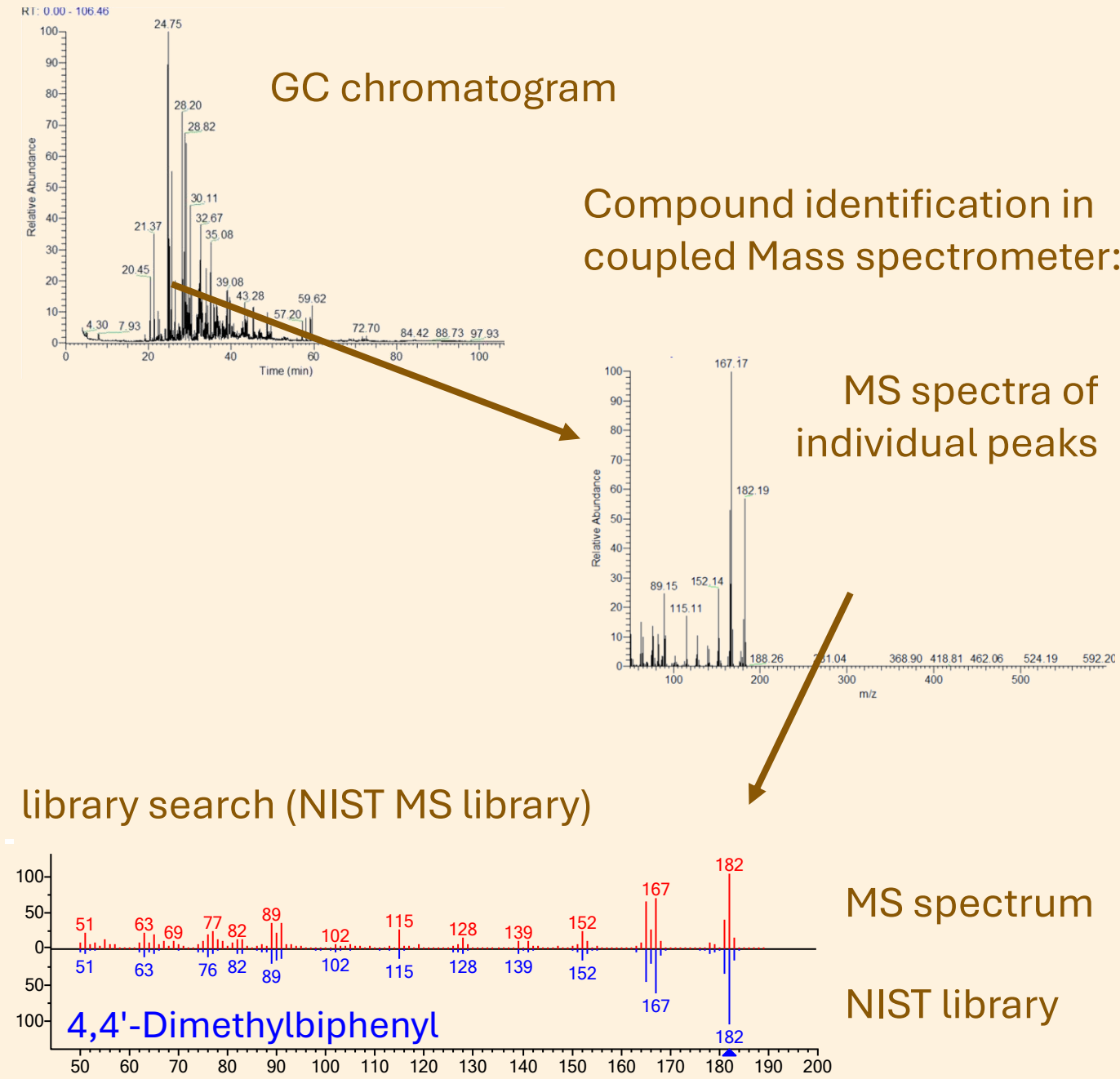
2. Fractionation of extract

The extract is trapped in a stationary phase (silica gel column) and subsequently eluted with solvents with increasing polarity. This procedure generates 6 individual fractions per sample, each including different groups of compounds, effectively reducing peak overlap in chromatograms.

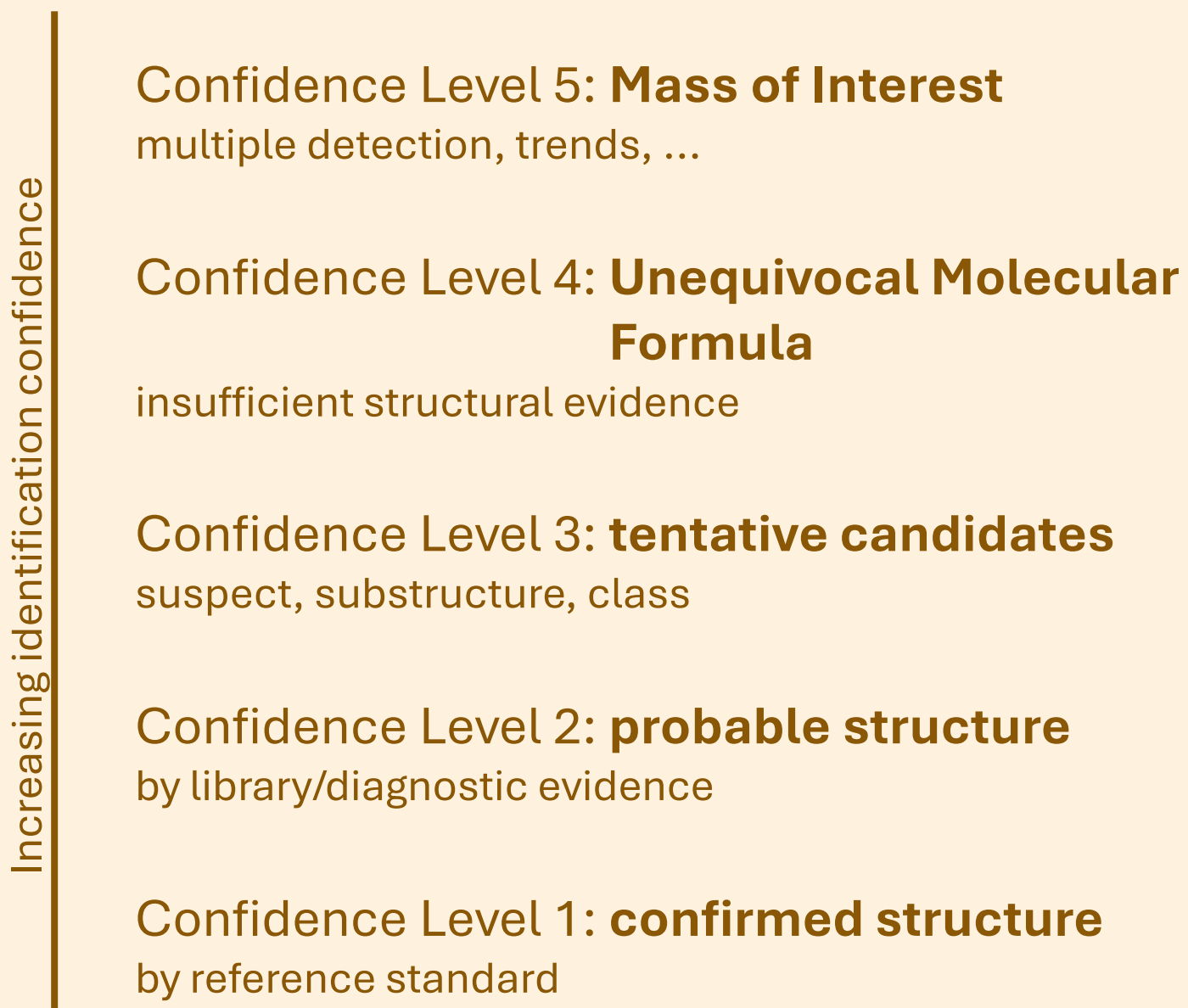


3. Identification of compounds

The 6 fractions are injected separately into coupled GC-MS. In non-target analysis, every single peak in the generated GC chromatogram is evaluated.



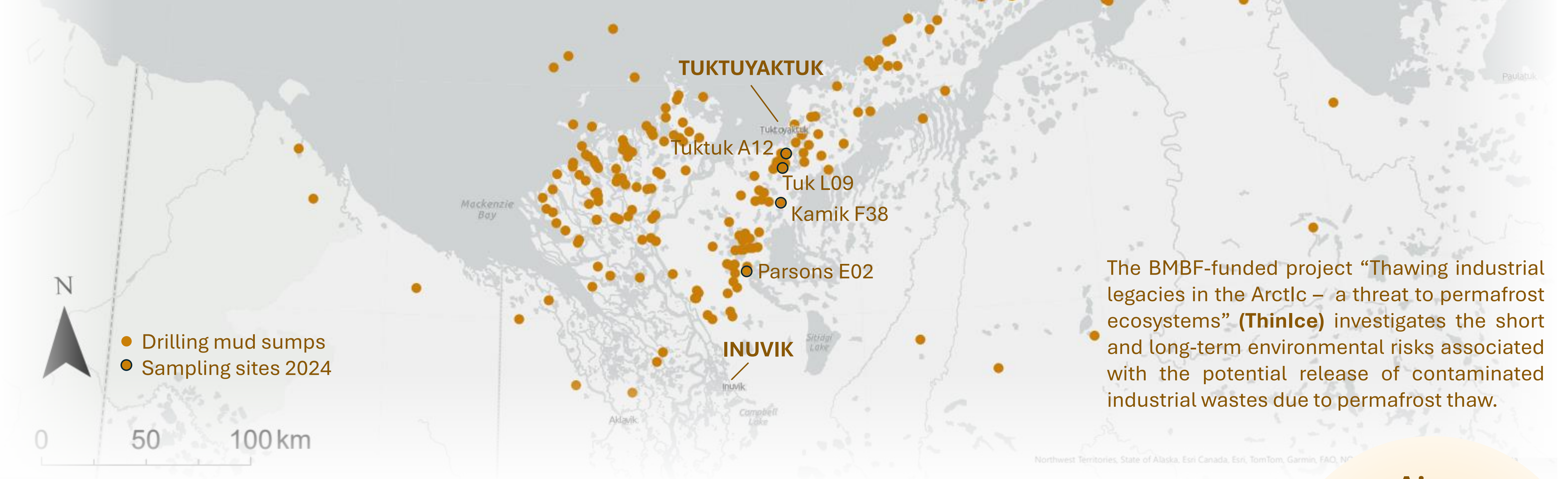
Levels of identification confidence (Schymanski et al. 2015):



4. Quantification of identified compounds

Reference standards are required to determine device-specific Retention Factors (Rf) for each individual compound of interest. Once available, the ratio of surrogate standard and compound peak area in the GC chromatogram can be used to calculate concentration of compound in the sample.

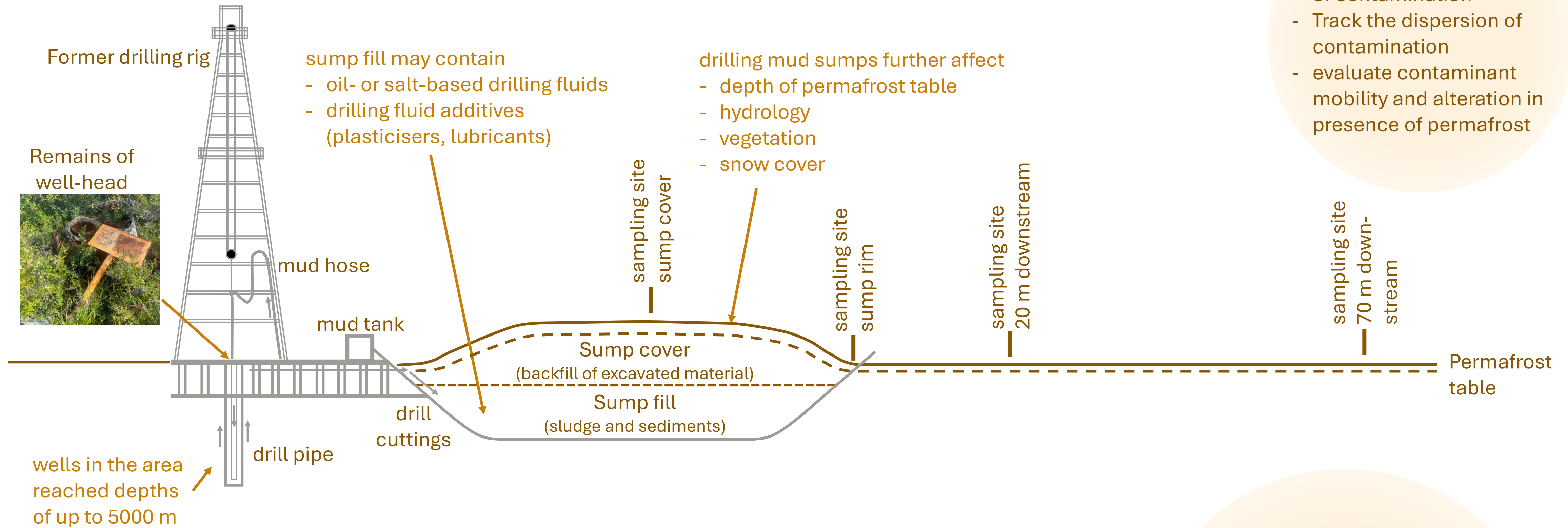
From the 1950s to the early 2000s, the Mackenzie Delta (NWT, Canada) was subject to extensive oil and gas exploration activities. It was common practice to dispose of drill cuttings and fluids in open pits, which were then backfilled with excavated material. The expectation was that the drilling waste would remain safely encapsulated as permafrost aggraded into the backfill materials. To date, the majority of the 233 documented drilling mud sumps in the area show signs of failure, including cracking, subsidence or collapse of the sump cover, raising doubts about the containment of the drilling wastes.



Drilling mud sumps are one of many industrial sites in the Arctic where potentially hazardous substances have been handled or stored. Warming temperatures are now threatening ground stability and the natural hydrological barrier function of permafrost, which was relied upon. As such, permafrost degradation is expected to increase the release and mobility of organic pollutants, with the potential to amplify their impacts on the environment.

The BMBF-funded project “Thawing industrial legacies in the Arctic – a threat to permafrost ecosystems” (**ThinIce**) investigates the short and long-term environmental risks associated with the potential release of contaminated industrial wastes due to permafrost thaw.

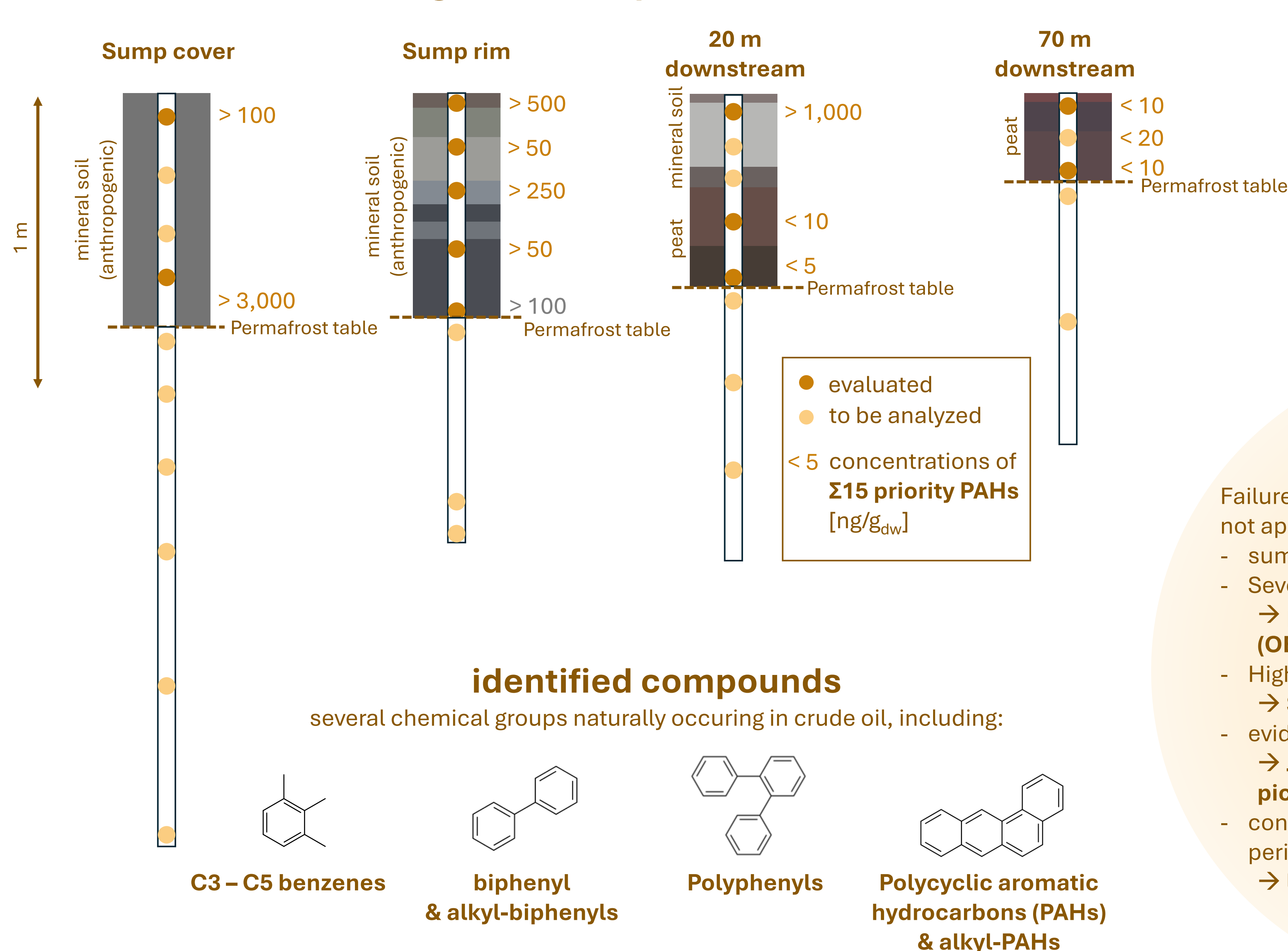
sampling strategy on schematic drilling mud sump



Aims

- Assess type and degree of contamination
- Track the dispersion of contamination
- evaluate contaminant mobility and alteration in presence of permafrost

Insights on sump Parsons E02



Next steps

- continue free extractable compound analysis for samples below PF table
- high resolution MS for PCBs
- pyrolysis for drill fluid polymers
- purchase more reference standards to accurately calculate the retention factors for each compound in the GC-MS analysis.

Preliminary results

- Failure of drilling mud sump Parsons E02 is not apparent in aerial pictures, still:
- sump cover highly contaminated with PAHs
 - Several crude oil components were identified → possibility that oil-based drilling fluids (OBF) were used
 - Higher concentrations in greater depth → Surficial soil analysis not sufficient
 - evidence for PAHs outside sump area → Judging sump performance from aerial pictures not sufficient
 - contamination levels decrease strongly in periphery → low mobility or wrong flow direction?



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