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Drilling Waste Buried in Permafrost Environments – Tracing Organic Contaminants in Surrounding Soils and Water Bodies

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From the 1960s to the early 2000s, subarctic Canada was subject to extensive onshore and offshore gas exploration activities. For onshore drilling, it was common practice to bury the generated drilling waste in open pits at the drill site. Once the drilling waste was frozen, these constructed drilling mud sumps were covered with a dense cap of fine-grained substrate, leaving the waste encapsulated solely in the perennially frozen permafrost soil. Although the drilling fluids used were primarily freshwater-based, the sump cap material often contains elevated levels of organic contaminants. These likely originate from petroleum hydrocarbons present in recovered formation water, oil and grease, as well as technical additives in spent drilling fluids. The inherent salinity of both formation water and drilling fluids buried in drilling mud sumps may cause the surrounding permafrost to thaw, leading to the risk of contaminant mobilization and their discharge into surface soils and waters.

In this study, we analyzed soils and water bodies surrounding six drilling mud sumps for organic contaminants in a non-targeted screening. Soil samples were extracted using acetone and n-hexane, enhanced by ultrasonication and dispersion. The extract was separated into six fractions by column chromatography through subsequent elution with solvents of increasing polarity. Water samples were extracted sequentially with pentane, pH-neutral and pH-modified dichloromethane, generating three extract fractions. All soil and water extract fractions were analyzed using a TRACE 1610 gas chromatograph coupled with an ISQ 7610 single-quadrupole mass spectrometer (Thermo Scientific). Comprehensive non-target screening was performed using the XcaliburTM Software linked to the NIST library.

This investigation is part of a multidisciplinary study with the overarching goal of understanding the impact of drilling mud sumps on permafrost ecosystems. Tracing organic contaminants in surrounding soils and water bodies will support the evaluation of individual sump stability and potential risks posed by sump failure. The results will further contribute to assessments of the effects on soil microbial communities, vegetation and hydrology.