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Fine-scale distribution of soil organic carbon associated with diapirs in the frost boils of a High Arctic polar desert.

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Polar deserts make up approximately a quarter of the ice-free Arctic region in Canada. Previous work on polar deserts suggests that carbon redistributed to depth via cryoturbation, leaching and root inputs may enrich subsurface soils with soil organic carbon (SOC). Given, arctic soils are sensitive to climate warming and contain nearly fifty percent of global terrestrial carbon stocks, understanding the SOC distribution in these landscapes is important. Diapirs are areas of uplifted parent material above the permafrost table that are associated with patterned ground such as frost boils. These diapirs might be an important feature in polar deserts as they are overlain with a Bhy soil horizon enriched in soil organic carbon (SOC) that may provide important resources for plants growing on the surface.

We used a field-portable visible and near-infrared (vis-NIR) range spectrometer to detect SOC, indicative of the diapir Bhy horizon, in the subsurface soil profile of frost boils (n= 559). To better understand the fine-scale variability of SOC distribution, we collected spectra of the soil profile using a fine scale 3 x 3 sample grid on a subset of frost boils with (n= 12) and without (n= 12) diapirs detected. Profile spectra were analyzed for SOC using a calibration model developed in Unscrambler® X v.10.2 that was based on partial least squares regression and a calibration dataset for polar deserts. We found that SOC varied with depth between frost boils and enhanced SOC at depth indicative of diapirs occurred on approximately 17% of frost boils. The distribution of SOC within the fine scale grids was extremely variable and also differed between frost boils. These results provide a promising sign that better prediction of carbon distribution in frost boils can made using vis-NIR spectroscopy.