Conclusions

Studies of the microstructure of samples from the experimental oil spill sites have shown the characteristic effects of contamination. Samples investigated were taken from various parts of the soil profile in the active layer, and include peats, mixed organic and mineral soils, with samples having various grain size compositions. The microstructures apparently reflect the effect of bi-directional freezing (upwards from the permafrost, downward from the ground surface) with multiple freeze-thaw cycles (extending over thousands of years or longer). Superimposed on these effects are those due to the addition, in the last twenty five years, of oil and its breakdown products, which are adsorbed and retained along the surfaces of mineral particles and organic material. The contaminant is responsible for a characteristic aggregation. The findings are interpreted on the background of earlier experimental and field investigations of microstructure in uncontaminated and contaminated soils.

Measurements of hydraulic conductivity of the samples from the Caribou-Poker Creeks site give values which are, at least in part, due to interaggregate porosity developed as a result of contamination. These hydraulic conductivities facilitate the subsurface transport of immiscible hydrocarbon contaminants through the O1, A1, and C1 horizons.

This subsurface transport has apparently been responsible in more recent years for the contamination of the selected 'control' site situated between the winter and summer spill zones. Additional field sampling should now be undertaken to collect soil samples from an uncontaminated control site situated up slope from the two large scale spill zones and to evaluate the spatial extent of the subsurface migration of hydrocarbon contaminants between the original summer and winter spill zones.

Observations in the field at the Caribou-Poker Creeks site show the effects of contamination after more than two decades on the vegetation cover and its species composition and also on the form and nature of the surface layers more generally. Remote sensing is, at present, still barely capable of revealing these changes when the area affected is as small as that at the Caribou-Poker Creeks site. The effects there, however, are an analogue for the large spills that have occurred in Russia and the neighbouring republics, and which are indeed recognisable in current remote-sensing images. With the improvement in remote sensing imagery, and a better understanding of the processes, such as may be gained from intense monitoring and further investigations at the Caribou-Poker Creeks site, it will be possible to apply remote sensing to observing and then to predicting the course of changes due to contamination. Remote sensing should then be an important part of an integral strategy for the devising of appropriate and cost-effective bioremedial or other responses. The work reported in this paper indicates the potential of the experimental spill sites for establishing in detail, the relation between soil microstructure, terrain modification, and the prediction of the future course of events at spill sites in otherwise natural conditions.

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