LONG-TERM ACTIVE LAYER EFFECTS OF CRUDE OIL SPILLED IN INTERIOR ALASKA

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Two experimental oil spills of 7570 liters each were conducted at a black-spruce-forested site in February and July of 1976. The long-term effects of the spills on the active layer were directly related to the method of oil movement. The winter spill moved beneath the snow, within the surface moss layer, and the summer spill moved primarily below the moss, in the organic soil. The summer spill affected an area nearly one and one-half times that of the winter spill. Only 10% of the 303-m^2 summer spill area had oil visible on the surface, while 40% of the 188-m^2 winter spill had visible oil. Thaw depths in the summer spill area increased from 1977 to 1980--average thaw depth was 72 cm vs. 48 cm in the control--and remained essentially the same in 1981 and 1982. Thaw depths in the winter spill area continued to increase until 1982 to an average of 92 cm. Summer temperatures 5 cm under the blackened moss are consistently higher than under the undisturbed surface. Presumably the change in albedo due to the surface oil accounts for the increased thaw in the winter spill area.

Over the past decade a number of studies have been conducted on the effects of oil spilled in the arctic and subarctic environment. This is a direct result of the development of the Prudhoe Bay oil field and the construction of the Trans-Alaska Pipeline.

Much of the work on the impact of oil spills has considered the effects of refined petroleum products and crude oil spilled on arctic and subarctic vegetation (Hunt et al. 1973, Deneke et al. 1975, Hutchinson and Freedman 1975, Walker et al. 1978), and several theoretical and laboratory studies have investigated crude oil spills on snow and ice (Raisbeck and Mohtadi 1974, McMinn and Golden 1973). A number of studies examined the biological and chemical effects of small experimental spills on tundra soils and vegetation, especially in the Barrow and Prudhoe Bay areas (Everett 1978, Sextone et al. 1978, Linkins et al. 1978).

In contrast to these mostly small-scale studies, a series of studies conducted near Norman Wells, Canada, attempted to determine experimentally the effects of larger oil spills (Mackay et al. 1974, Hutchinson et al. 1974, Hutchinson and Freedman 1975). A study of similar scope was conducted to determine the physical, chemical, and biological effects of crude oil spilled on a forested permafrost terrain near Fairbanks, simulating as nearly as possible an actual oil spill (Jenkins et al. 1978, Johnson et al. 1980). This paper is based on a continuation of that study and examines the long-term thermal effects of oil spills on the active layer.

Studies other than those on oil spills have investigated the thermal impact of natural and man-made disturbances on the active layer (Brown and Grave 1979). Most deal with the disturbances caused by vehicular traffic, oil development, and related construction activity (Mackay 1970, Lawson et al. 1978). Fire also plays a major role in the natural disturbances of permafrost (Heginbottom 1971; Viereck 1973, 1982; Hall et al. 1978; Racine 1981), where increased thaw of the active layer follows the destruction of the insulating organic layer by fire or the construction of fire lanes. Makihara (1982) studied the modification of surface albedo by coal dust and its effect on the active layer at Prudhoe Bay.