I.2. DISTRIBUTION AND CHARACTER OF PERMAFROST IN THE DISCONTINUOUS PERMAFROST ZONE OF ALASKA

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(Summary)*

In Alaska, the discontinuous permafrost zone includes that part of the permafrost region south of the Brooks Range. Variations in climate, geology, topography, and vegetation cause differences in the character and distribution of permafrost within this zone. On the basis of these differences, seven different types of permafrost areas are distinguished. These different types are grouped under two major categories: mountainous areas in which summits generally exceed 3,000 feet in altitude, and which are predominantly underlain by bedrock at or near the surface; and lowland and upland areas, in which summits generally are less than 3,000 feet in altitude, and which are predominantly underlain by thick unconsolidated deposits. The thickness and the temperature of permafrost are extremely variable in the mountainous areas, whereas these characteristics are more uniform in the lowland and upland areas.

The mountainous areas are subdivided into 1) areas generally underlain by discontinuous permafrost, in the central part of the permafrost region; and 2) areas generally underlain by isolated masses of permafrost, in the southern part of the permafrost region.

The lowland and upland areas are subdivided into five types, which cover two broad zones. In the central zone (between the Brooks Range and the Alaska Range, but including the Copper River Basin), areas of fine-grained deposits are generally underlain by moderately thick to thin permafrost; and areas of thick coarse-grained deposits are underlain by discontinuous permafrost in the northern part of the zone, and by numerous isolated masses of permafrost in the southern part. In the southern zone (including the Bristol Bay area and the eastern and western margins of the Susitna Lowland), areas of fine-grained deposits are

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generally underlain by isolated masses of permafrost, and areas of thick coarse-grained deposits are generally free of permafrost. The temperature of permafrost just below the zone of seasonal variation generally ranges from -5° to -1°C (23° to 30°F) in the central zone, and is generally above -1°C (30°F) in the southern zone. The known thickness of permafrost ranges from more than 600 feet near Bethel in the central zone to lenses less than a foot thick in the southern zone.

Permafrost is either absent or at considerable depth beneath large rivers and large, deep lakes. The latent heat in these bodies of water, and also in the oceans, tends to decrease the thickness and to increase the temperature of permafrost in adjacent areas. In addition, permafrost is absent in proximity to thermal springs and active volcanoes. These features are surface manifestations of relatively high, near-surface, earth temperatures, which also tend to decrease the thickness and to increase the temperature of permafrost.

Discussion (Papers by R.J.E. Brown and O.J. Ferrians, Jr.)

R.E. Crowley asked why Ferrians' criteria for delineating the southern limit of permafrost in Alaska differed from Brown's for the southern limit in western Canada. Ferrians replied that the areas in Alaska which he designated as "non-permafrost" may in fact include some isolated masses of permafrost. These were not noted because they were of no practical significance. Brown replied that his southern limit included all known permafrost occurrences. His southern limit would probably coincide with Ferrians' if the same criteria were used. He added that engineering problems were most crucial in the northern portion of the discontinuous where permafrost is widespread and thicker but still close to 32°F and unpredictable in its distribution.

J.R. Rettie asked Ferrians to explain the significance of the cross-hatched areas on the map of permafrost distribution in Alaska. He was informed that detailed field studies were undertaken in these areas and the results were used to estimate the distribution of permafrost in adjacent areas.

G.S.H. Lock asked Ferrians whether the thawing of permafrost under bodies of water is caused by the latent heat of water or the thermal capacity of the water body.

Ferrians replied that both factors probably cause thawing. Permafrost will be thawed only under bodies of water that do not freeze to the bottom in winter.

S.R.L. Harding asked what equipment Brown used to obtain the thickness of permafrost in the southern fringe. Brown replied that the equipment was manually operated consisting of a Hoffer probe with which 6-inch long cores of 3/4-inch diameter could be obtained in frozen peat and fine-grained soils by ramming. Holes were also advanced in these frozen soils with an ice chisel adapted to 3/4 inch diameter pipe, the cuttings and chips being removed with a 2-inch posthole auger. Frozen gravelly soils could not be penetrated. J.G. Fyles commented that the Geological Survey of Canada has used the SIPRE Ice-Corer (Arctic, Vol. 16, No. 4, December 1963, pp. 270-272) to core perennially frozen peat bogs in the arctic using a McCulloch engine.

J.B. Mawdsley wondered whether differences in soil type would influence the distribution of permafrost. Ferrians replied that coarse-grained soils differ from fine-grained soils in their capacities to hold moisture and transfer heat which would certainly influence the distribution of permafrost.

It was suggested by O.F. Simonsen that N.W. Radforth's muskeg classification system could be usefully applied to the muskeg areas or peat bogs described in Brown's paper to designate the permafrost conditions. Brown replied that Radforth's system was developed primarily for engineering purposes and was not applicable to classifying peatlands on the basis of permafrost distribution. Radforth has attempted to correlate the distribution of permafrost with the H factor (lichen) in his classification. There are, however, extensive areas in northern Quebec, for example, where lichen comprises more than 25% of the surface vegetation cover but no permafrost exists. On the other hand permafrost exists in numerous locations where no lichen exists.

T.A. Harwood added that Radforth's classification does not consider the albedo of the surface and thus is not applicable. O.F. Simonsen then suggested that some correlation should be attempted. Brown replied that this would be difficult because it is possible, for example, to have two adjacent peat bogs, one wet and the other dry, with the same surface cover but differing permafrost conditions because of the difference in moisture conditions. Radforth's system does not consider varying degrees of wetness.

P. Yurkiw asked how much land area is underlain by permafrost in the discontinuous zone. Ferrians replied that there is little information on the distribution of permafrost in mountainous areas and it is possible only to speculate. Lowland areas are divided into map units but detailed information is difficult to obtain. Generally, the extent of permafrost decreases from north to south. Brown added that permafrost varied in extent from patches a few feet in diameter and one or two feet thick around individual trees at the southern limit to being virtually continuous at the northern limit of the discontinuous zone.

R.S. Taylor enquired whether any investigations had been carried out in mountainous areas on possible correlation between the snowline and the occurrence of permafrost. Ferrians replied that this problem had been examined on a general basis but not in detail. R.S. Taylor asked both authors what particular surface features are indicators of underlying permafrost. Ferrians replied that there is a large amount of literature available on patterned ground, solifluction, beaded drainage, and other such phenomena. It is necessary to exercise care in using these surface features because they do not necessarily indicate subsurface conditions. Brown described a situation north of Whitehorse, Y.T. where permafrost exists at a depth of about 10 feet beneath jackpine and poplar areas. In the discontinuous zone, these tree species are most commonly found where there is no permafrost. J.G. Fyles closed the discussion by remarking that an assessment of surface features alone is not sufficient to predict the existence of permafrost.

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