

THE CONCENTRATION OF CERTAIN CHEMICAL ELEMENTS IN THE SOILS OF ALASKAN ARCHAEO- LOGICAL SITES

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ABSTRACT. The content of phosphorus, nitrogen, potassium and calcium was determined in the soils of two Alaskan native village sites and in adjacent soils bearing natural forest growth. The food used by primitive man in Alaska was largely of animal origin and was relatively high in the chemical elements mentioned. During the course of time the soil of the village sites was greatly enriched with the result that there has been a 50 to 175-fold increase in phosphorus, a 3 to 7-fold increase in nitrogen, a 4 to 6-fold increase in potassium and a 2 to 12-fold increase in calcium.

IT is a common occurrence for foresters, and others whose work takes them into the field, to encounter ancient native village sites along the Alaskan coasts and rivers. As a rule a village site may be identified by its highly advantageous situation, by the depressions or other evidences of house locations, and, perhaps best of all, by the nature of the vegetation. Hrdlička (1937) and other anthropologists, (Anonymous, 1941), who have worked in Alaska have commented on the fact that the vegetation of old village sites usually differs in floristic composition and in *color* from the adjacent undisturbed vegetation. It is significant that the vegetation of the village sites is not only unusually luxuriant, but is also much darker green, presumably an effect of a relatively high level of soil fertility. Among the plants encountered on old village sites on Kodiak Island the most common is reported to be the stinging nettle, a species which is generally regarded as nitrophilous, that is, a "nitrate plant." As indicated by the vegetation, and as suggested by Hrdlička, chemical conditions in the soil of the village sites appear to have been altered by human agencies. The purpose of this note is to report the concentration of certain chemical elements in the soil of two such sites.

So far as is known to the writer, Arrhenius (1931, 1934) was the first to point out, from his extensive studies in Sweden, that the content of phosphorus was unusually high in the soil of old village sites, some of them dating back to the Stone Age. The food used by primitive man, whether of animal or

plant origin, was relatively high in phosphorus and all the organic refuse remained in, or closely adjacent to, the village. The Alaskan sites are actually village sites and kitchen middens combined. During the course of time the soil was enriched in various chemical elements but most especially in phosphorus, which in the soil tends to be "fixed" in forms that render it resistant to losses by leaching. In 1939 Castagnol reported accumulations of phosphorus in the soils of ancient village sites in Indochina which were analogous to those reported by Arrhenius in Sweden. Notably high concentrations of phosphorus in old village sites were later noted in Thailand by Pendleton (1943). Thorp (1942) remarked that farmers in the United States have noted that the soils of old Indian villages are more productive than adjacent soils. He speaks of "...man-induced fertility migration in soils." Thomas (1947) commented on the unusually high concentration of bases in the soil of old house sites in Uganda.

During the summer of 1949 three composite sets of samples of soil were obtained from an old village site near the mouth of the Russian River, where it empties into the Kenai River, on the Kenai Peninsula, Alaska. This village site is on a relatively flat bench. The area supports a very heavy growth of grasses and other herbaceous plants, unusually dark green in color. Numerous pits or depressions mark the former location of dwellings, presumably of the semi-subterranean type. The upper 6 inches of soil was sampled at each location by four or more borings within a radius of approximately 50 feet and the samples were composited in the field. Three such sets of samples were collected from as many different locations within the area of the village site. Samples of soil from undisturbed white spruce [*Picea glauca* (Moench.) Voss.] forest stands, obtained for another purpose, were available for comparison. In 1950 comparable samples were obtained in Southeastern Alaska from the Auke village site about 10 miles northwest of Juneau and from an adjacent second-growth stand of Sitka spruce [*Picea sitchensis* (Bong.) Carr.].

Analyses were performed following standard methods, as described by Peech, *et al.* (1947). The exchangeable calcium and potassium was extracted with a normal neutral solution of ammonium acetate. Readily soluble phosphorus was extracted with a 0.002 normal solution of sulfuric acid, buffered

with ammonium sulfate to pH 3.0. Nitrogen was determined by the Kjeldahl method. The results follow in table 1; all constituents are expressed in terms of the elements, not the oxides. Values for phosphorous are in parts per million; these values may be converted to percentages by multiplying by 0.0001.

TABLE 1

Chemical Analyses of Soils from Two Alaskan Village Sites
and from Comparable Forest Stands.

	Phosphorus, ppm	Nitrogen, per cent	Potassium, per cent	Calcium per cent
<i>Russian River village site</i>				
Location 1	2048	1.021	0.036	0.261
Location 2	1360	0.742	0.044	0.654
Location 3	1590	1.178	0.048	0.708
Average	1666	0.980	0.043	0.541
<i>White spruce forest</i>				
Location 1	4	0.162	0.012	0.035
Location 2	39	0.118	0.009	0.051
Location 3	60	0.109	0.009	0.051
Average	34	0.130	0.010	0.046
<i>Auke village site</i>				
Location 1	1250	1.005	0.022	0.717
Location 2	282	1.263	0.028	1.068
Location 3	1079	0.799	0.026	0.697
Average	870	1.022	0.025	0.827
<i>Second-growth Sitka spruce forest</i>				
Location 1	6	0.217	0.003	0.262
Location 2	5	0.318	0.005	0.294
Location 3	5	0.475	0.004	0.432
Average	5	0.337	0.004	0.329

It is obvious that human occupancy of the Russian River village site has resulted in a tremendous increase in the content of phosphorus in the soil—an increase amounting to nearly 50-fold. Increases in the other elements, although of lesser magnitude, are also notable. In the village-site soil nitrogen shows a 7-fold increase, potassium a 4-fold increase and calcium a 12-fold increase.

In the soil of the Auke village site there has been an increase in the phosphorus content of about 175-fold. Nitrogen shows an increase of about 3-fold, potassium 6-fold, and the calcium content has been doubled.

With such profound increases in the soil fertility of the village sites it is not surprising that the vegetation of these areas should differ from that normal for the region in species composition, luxuriance, and color.

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