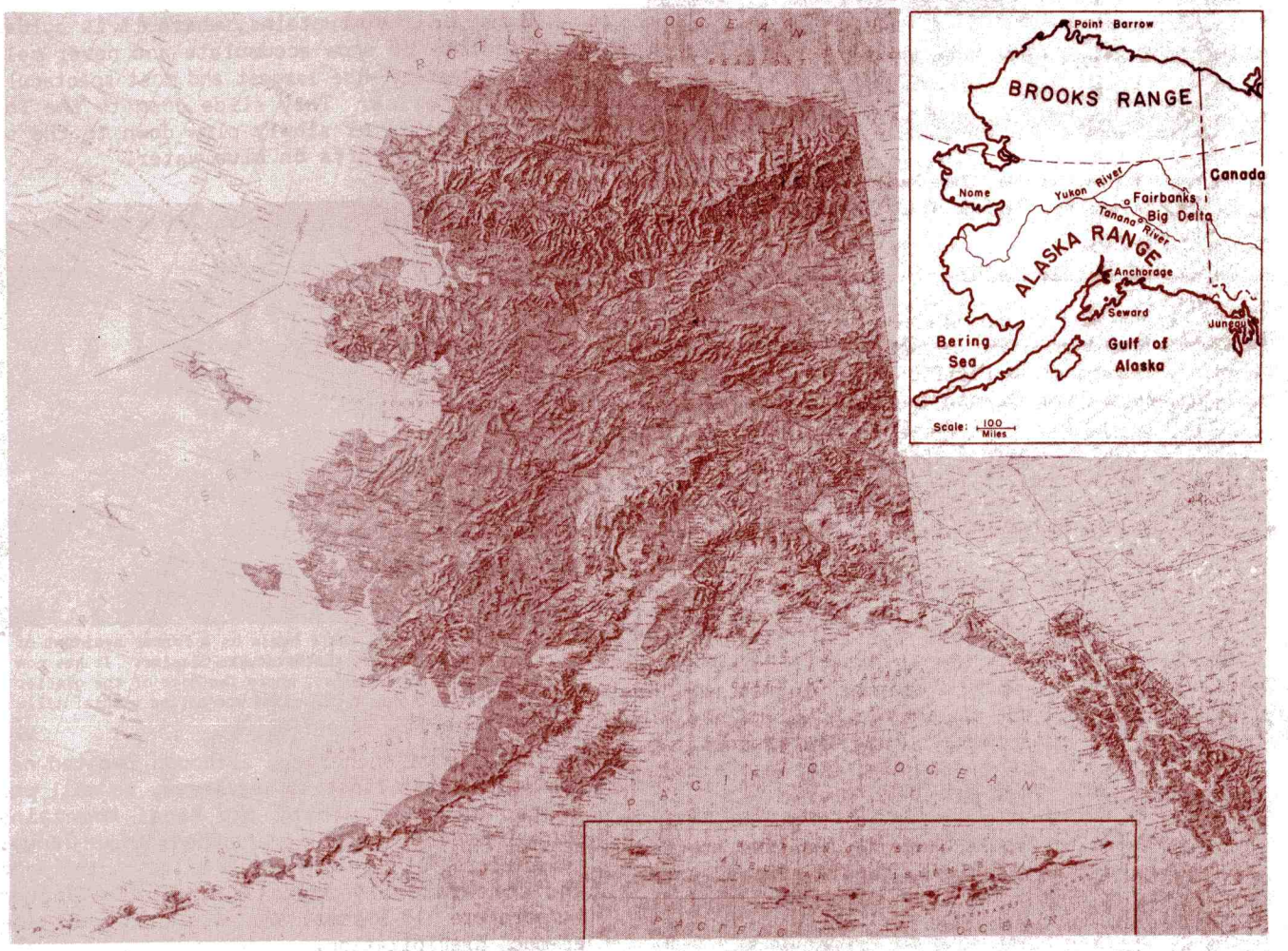
Screenings from the Soil Research Lab

IOWA ENGINEERING EXPERIMENT STATION
IOWA STATE COLLEGE, AMES, IOWA

Jan. - Feb., 1959
Vol. 3, No. 1



TALES OF ALASKAN GREATHOOD...

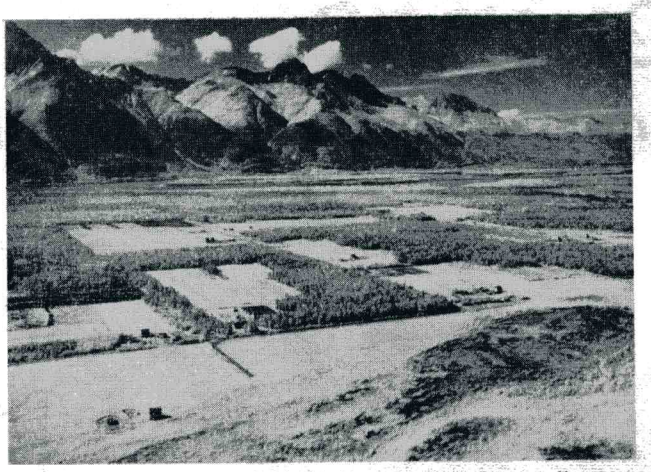
Plus Some Stray Lowdown on Soils

Alaska, the Great Land, home of sourdoughs and sockeye salmon, northern lights and southern comfort, soon will be wearing its union suit on the outside, looking taxworn and tired like the rest of us. Suddenly the United States will become 20% larger in area, almost 100% wider and 100% longer.

The new state is about 200 miles north of the rest of the congregation, but mostly it is west--straight north of Hawaii, as a matter of fact. Central Alaska is two time zones removed from our Pacific Coast states, four away from Iowa, and five away from the centrally located? capitol in D. C. Actually four time zones are used in Alaska--from east to west they are Pacific Time, Yukon, Alaska Standard and Bering. The U. S. will have seven standard time zones in all. And you say you're confused by daylight saving?

Physically, Alaska is about one-third above the clouds and one-third under water, and with a climate varying from the cool wet of Philadelphia to the cold dry of Montana to the prolonged cold and dryness of the Arctic. In general, the colder areas are the drier areas; the glaciers are all in the wet and snowy south, where they form in the well refrigerated mountains and shiver their way down to where it's warm.

Return to Table of Contents



The Matanuska Valley. Cleared patches are farms. Mountains are part of the Alaska Range. Indians are behind the mountains. (We can tell by the smoke signals.)

Face and Physiography

Whereas most of our states have to be satisfied with a frowsy mountain or two, Alaska has two major mountain ranges! A Pacific Mountain system bolts northward from Oregon and Washington through British Columbia into the Alaskan panhandle, and bends across southern Alaska and down into Kodiak and the Aleutians. It is called the Alaska Range, and includes modest Mt. McKinley, 20,300 ft., and a few hundred littler ones.

In northern Alaska an extension of the Rocky Mountain system (the fact is they're all rocky) cuts east-west across the northern third of the state. This is the Brooks Range. Between the two mountain ranges is a central plateau region, flat by contrast but otherwise not very flat. In walking over this terrain much exercise will be instinctively spent stooping over and picking blueberries. They are delicious.

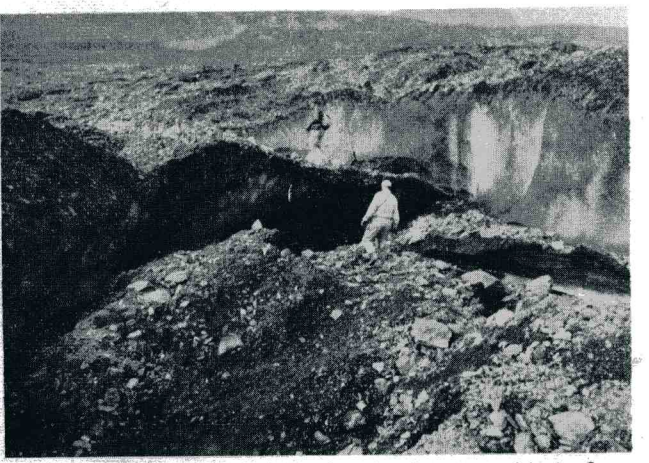
North of the Brooks Range is the true Arctic, a region of happy Eskimos, gentle slopes, angry dogs, and no trees. We might suggest a reasonable correlation between the two latter.

Warm Bottom and Cold Heart

North though it is, southern Alaska and the southeastern panhandle receive a lot of canned Pacific heat via the Japan Current. The mountains exhibit human weakness and retaliate this kindness by filling the ocean with ice cubes. Then we send the water back to Japan.

Actually the southern Alaskan mountains form what is called an orographic barrier, oro being Greek for mountain and Spanish for gold, which figures if you read history. When the warm and wet Pacific Ocean air whisks into the mountains it catches its death of cold. Result, sniffles, or, more accurately, snow. Annual precipitation on the southern coast runs around 100 inches, with snow accumulation of the order of 10 to 25 feet, depending on winter temperatures. Yet in many coastal areas the mean winter month temperature is scarcely below freezing.

Higher in the mountains, where it is colder, vast amounts of snow accumulate and never melt. Result, glaciers--the largest and most spectacular in North America. They slide down to the lowlands and melt, or slowly plow down to the sea and make white puffs on blue water.

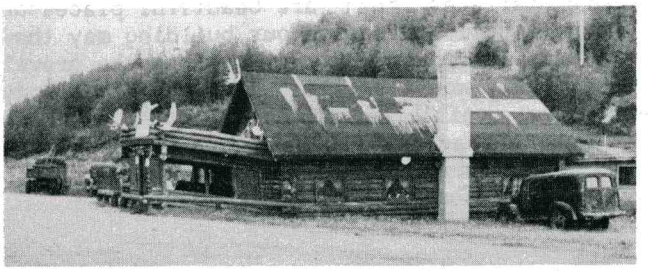


Two sourdoughs cool their heels on a former resident of the Matanuska Valley, the Matanuska Glacier. It has now melted back some 50 miles, where the nose of the glacier is busy at work depositing mixed mud called glacial till.

The city of Anchorage, although located near the south coast close to sea level, is well protected on the south by the Kenai Mountains. Annual precipitation, 14 inches; mean January temperature, 11°F. Seward, 80 miles to the south and comparatively unprotected, has a January temperature 11° warmer, and more than four times as much precipitation.

North of the Alaska Range the thermal isolation is more complete. At Fairbanks, annual precipitation is 12 inches and the mean January temperature is 18° below zero, which sounds like a pretty mean temperature all right. Leaping over the next mountain range to the north, we find that at Barrow the annual precipitation is only 4 or 5 inches. The mean annual temperature at Barrow is 10°, which is decidedly below freezing, even for an Eskimo. In Fairbanks it is 26°.

Return to Table of Contents



Bert and Mary's roadhouse gives guests a warm welcome with typical Alaska "slide-in" hospitality. The house is going down due to melting of ice in the permafrost. Note that the house is heated, the front porch is not.

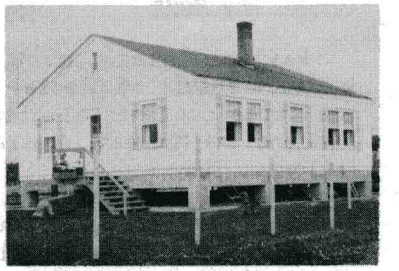
A Firm Understanding

Friendships notwithstanding, a mean annual temperature below freezing usually means that freezing will exceed thawing, and things slowly freeze up. Such a perennial frigidity is called permafrost. In soils there is more to permafrost than meets the eye, since the perennially frozen part is well below the ground surface. Above the permafrost, terra is not so firma; this is the so-called active layer, which freezes and thaws every year.

Permafrost usually has ice in its veins, in which case frigidity lends rigidity -- in other words, the frozen soil is hard. Unfortunately when it thaws the reverse is true; ice turns to water, soil turns to mud, and life is full of problems.

You would never guess it to look at the ground surface, but most of Alaska and about one-fifth of the world is in permafrost. In the Arctic around Barrow, the permafrost extends over 1000 feet deep, and the thickness of the upper, active layer is only one to three feet. In central Alaska the permafrost commonly extends a few hundred feet and is locally absent, depending mainly on the vegetative cover. In southern Alaska permafrost is present only where the ground is well protected, and may have formed in an older, colder climate.

A famous condition known as "drunken forest." Trees get tipsy when the lake thaws the permafrost and enlarges.



The best way to avoid troubles with permafrost is keep it cold. We'll assume the floor is insulated.

How to Thaw Permafrost

Permafrost is a master of romantic suspense, and a partial thaw can either warm the heart or be a terrible letdown. Permafrost is perched in such a delicate equilibrium with climate and local environment that the slightest twitch or improper nudge can really tip things up. A heated house will thaw its own little nitch in the permafrost and often sink down into it.

Clearing of timber for farm land or roads is the most important cause for permafrost thawing. Apparently removal of trees allows greater heat absorption in summer without greatly affecting heat loss in the winter. Curiously, lakes also cause thawing and may thus be self perpetuating, like Congress. Whether or not thawed ground subsides depends on the amount of ice incorporated in the permafrost. This is related to type of soil.

SOILS IN ALASKA

In the soils department Alaska unquestionably ranks as America's Number One Rock Garden. Soil materials exist mainly in the valleys, which is where everybody lives unless he's a mountain goat. Soils fit into several categories, depending on whether they originated by action of wind, water, ice, or humbug. Soil formation by routine chemical weathering of rocks is practically non-existing in most of Alaska; weather too cold. One result is a state-wide scarcity of clay except in older sedimentary rocks.

Deltas and Coastal Plain

First let's fly to the land of the Eskimo. Much of the area north of the Brooks Range is coastal plain--flat, wet, treeless and clayey, just like southeast Texas only colder. Also the "clay" is mostly silt. A similar area is the large Yukon River delta which forms the chin on Alaska's face, between Nome and the Aleutians. Such flat areas of sediment are studded with lakes, permafrost, lemmings, and Arctic owls.

Return to Table of Contents

Ice on the Move

Farther inland, most soil is a direct or indirect result of glacial action. Compared to the large continental glaciers that inhabited Iowa and the Midwest, Alaska glaciers are little fellows. They spend their time skiing down the mountains and through the valleys. When these valley glaciers reach the lowlands they may spread out into a large, flat, piedmont glacier or ice field, but these are not common.

As everybody knows or supposes, glacial ice grinds rocks into soils which are then carried along and deposited when the ice melts. In Alaska such glacial till mainly occurs as hilly, hummocky moraines downstream from what's left of the glaciers. Deep lake-filled depressions, or kettles, occur where blocks of included ice have melted. All in all, glacial till is a relatively minor soil type in Alaska.

Gravel

Far more important economically are deposits from water. In Alaska most river water anywhere near the Alaska Range is entirely fish-free and resembles thin mud soup because it comes from melting glaciers. As the water moves downstream from the ice front it swishes back and forth, removes a lot of glacial till and replaces it with water-deposited gravel, cobbles, and boulders. These are fast rivers, and finer materials are carried on out to sea to build deltas and coastal plain.

Readjustment of stream systems to a lower level, as often happens, leaves widespread gravel terraces that are beautiful places on which to build things. Your building may thaw the permafrost, but who cares, since the gravel most likely won't settle. Also there's plenty of gravel available for building material. And to make a road all you have to do is push off the trees. Indeed a beautiful arrangement, unless you plan on farming.

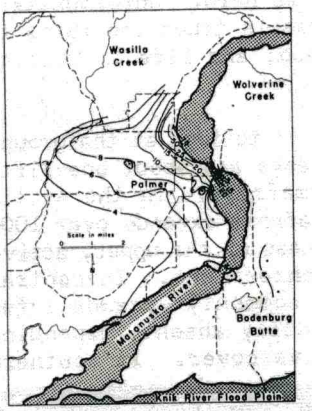
Glacial meltwater forms a fast and furious braided stream which spends its life loading and unloading sediment. Terraces are seen as dark areas in the back ground. Winds blowing across the river bars lift much silt and deposit it on nearby terraces and upland.

Silt

Fortunately for the farmer but sad news for the engineer, much of the terrace gravel is covered by a layer of silt. The silt also extends onto the uplands, a reasonable reason to assume it is wind-blown. It is sufficiently important to warrant special action by engineers. We'll have to tell you about it.

The Dusty Crew

During the summers of 1954-55 seven men from Iowa State College sniffed and savored silts in Alaska and brought back tales of wonder and woe. For example, thickness, clay content and sand content are closely related to the braided river systems. Thickest deposits with coarsest silt are usually close to a river.



Contours show the variable sand content of Matanuska Valley loess. Thickness and clay content contours show the same trends: From west to east thickness varies from one to several tens of feet, and clay content drops from 20 to less than 6 percent. Table below shows average mineral composition of some Alaska loesses.

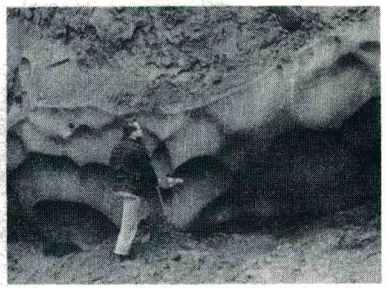
	Fairbanks (3 samples)	Big Delta (3 samples)	Matanuska (5 samples)
Quartz	42	32	30%
Feldspars	27	23	4
Micas	13	31	3
Rock fragments	7	3	45*
Amphiboles, pyroxenes	3	3	3
Clay minerals	Montmoril-lonite	Ill., Kaol., Chlorite	Chlorite

*Mainly metamorphics

Return to Table of Contents

Screenings
from the Soil Research Lab

Jan. - Feb., 1959
Vol. 3, No. 1



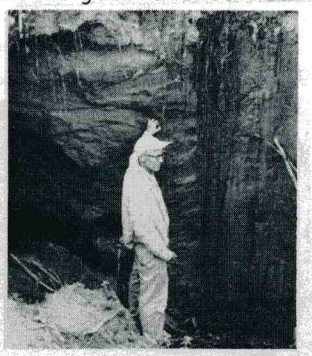
This buried ice mass was exposed in the search for cold cash, in this case gold. It is embedded in a thick deposit of silt. Curious concave structure comes from giant nozzles used to wash away the silt.

Winds from the glaciers now whip up noticable dust storms which leave noticable dust deposits of silt. However, local distribution pattern of dust is not always identical with that of the older silt.

The Alaskan loess nearly always falls in the B.P.R. category A-4(8)--no active clay mineral. As any soil engineer can tell you, A-4(8) friable silty soils are the absolute worst for frost action. These soils combine high permeability with good capillary action, both of which bring water into the freezing zone. Icy fingers push the silt grains apart and make a frost "heave." Even more important, in permafrost areas large masses of clear, subterranean ice form by mysterious means, perhaps from thermal contraction cracking, and filling of cracks with surface water. (Photos above.)

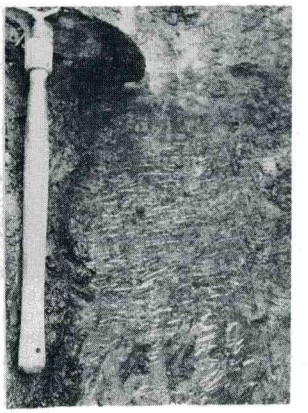
Such icy phenomena occur mainly where silt is thick. They are particularly prominent around Fairbanks, where silts are thicker in valleys and on lower slopes due to wash and downhill sliding.

Actually even here there is little trouble with permafrost until the ice melts. Then, look out. In two or three years cleared fields can thaw and become so hummocky they are more like an obstacle course than a cabbage patch. Many must be abandoned. One farmer was nonchalantly driving his tractor over a new field when the ground failed and he had to climb out. A golf course near Fairbanks has some of the most spectacular traps imaginable--15 foot holes with vertical walls and no places to grab. Approximately one-fourth of the land near Fairbanks is underlain by permafrost containing large masses of ground ice. So it pays to reconnoiter before buying, building, or clearing off trees.



Anyone for golf?

Fine ice lenses in soil make a "frost heave." Unfortunately such action is not limited to Alaska, but pushes up underneath roads whenever conditions are right. When the ice melts and the road goes to pot, it is referred to as "spring break-up" because of what it does to a car.



GREAT SOIL GROUPS

Drop the Landing Gear

In low, soggy permafrost areas, Alaska silts show a remarkable proficiency for getting things stuck. Permafrost is often the major reason for the wetness, since the underdrainage is sealed.

In this connection we might lean on the agronomist's scheme for describing the upper soil layers or soil profile by means of great soil group. One of the most common great soil groups in Alaska is aptly called the Half Bog. A Half Bog soil consists of a thin layer of peat over a layer of water-mineral soup. It is often sprinkled on top with trees.

The treachery of the Half Bog is that the peat layer is strong enough to support one pass of one vehicle, but once wheels cut through the peat the next stop on the way down is permafrost. This means you can usually drive into a place but you may not be able to drive out. Life is like that.

"Looks like All Bog to me."

Muskeg and Tundra

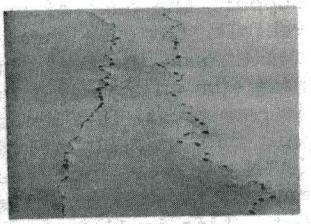
Another great soil group with a liquid sound is Bog, locally called muskeg. In Bog soils the peat layer is thicker, trees usually don't grow, and water often stands in ponds. Nobody trys to go very far on Bog soil. One interesting condition is "quaking bog" which vibrates when you stamp your feet. Soil beneath the peat is so wet it behaves as jelly.

Return to Table of Contents

Tundra, with an oblong thaw lake in the background. Streams often develop queer meander patterns because they melt into and run along the top of vertical ice wedges. The ultimate is when Eskimo boatmen can portage across meanders and drift downstream to go upstream.

A third major group is Tundra, the soil of the Eskimo. Whereas profile development in the Bog and Half Bog great soil groups is mainly halted by excess water, in Tundra it is halted by cold. Tundra is thus a zonal soil because it is the normal product of the cold arctic or subarctic climatic zone. Actually, Tundra is very similar to Half Bog. One difference is no trees.

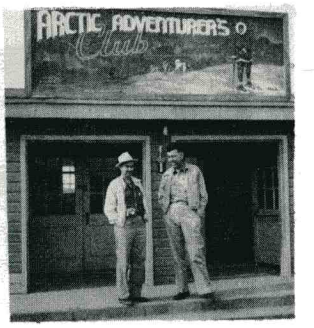
Most Tundra is in permafrost, and the associated ice masses often shape and squeeze the terrain into some thoroughly spectacular patterns. The soil itself consists of a foot or so of tough vertically fibrous peat overlain by grass and wildflowers and underlain by wet, thunky soil. The main productivity is caribou, reindeer, ducks and Eskimos. Domesticated reindeer from Siberia offer the Eskimo a chance to settle down and turn rancher, but he is reluctant so long as there is good hunting. As for trafficability, Tundra is practically impassable except in winter. Even walking is very slow unless you're a duck.



No ice wedges visible, but their message can be seen: —... .—. .—. .—. .—.
A "beaded stream" results when the stream crossing buried ice wedges melts out deep holes. Holes are 5 to 20 feet across, about as deep as they are wide.

Whither the Farmer?

Where trees have grown and drainage is good, the most common great soil group is a new one called Subarctic Brown Forest. There is very little weathering or increase in clay content, the "soil profile" being a layer somewhat darker in color and loaded with fine roots and fluffiness. The loose structure and good drainage make this Alaska's number one agricultural soil, though it does require fertilizer. Initial clearing of trees with bulldozers can be a little harsh on the topsoil unless clearing is done while the ground is frozen; otherwise the bulldozers clear away soil and all.



Two sourdoughs grimly reflect on the condition of Alaska wildlife.

Because of the long hours of summer daylight our biggest state also has some of the biggest vegetables. Potatoes, cabbages, turnips, rutabagas, carrots, and dairy cattle do well in Alaska, although cattle feeding has its problems during the long winter. Typical Alaska barns exhibit a very superior storage capacity.

The most prominent agricultural area is the Matanuska Valley, 500 miles north of Anchorage. A big boost came in 1934 when some 200 farm families were moved here from dust bowl areas in Oklahoma. The number two area for agriculture is around Fairbanks, and there aren't many more numbers. In 1950 Alaska produced about 15 percent of its own needs, but still had enough potential farm land to come out about even.

The Alaskan who does make a go of it can gain satisfaction from living in the true homesteader tradition, finding his way in the face of genuine hardship, even if the hardship is merely a wife who balks at cooling her crupper in the outdoor plumbing. Still, it may be five years or more before he can make the land begin to pay out, and one can experience a lot of privation in five years. Many of the early homesteaders were bachelors who didn't make out so well gold mining, so they were already used to going without.

Podzol--the Ashy Soil

Whereas the Subarctic Brown Forest soil group is typically of Alaska loess and is

Representative scenery includes a bit of loose loess. Bulk density runs as low as 60 lb per cu ft.

Return to Table of Contents

literally fine for farming, the loess doesn't occur everywhere. Where loess is thin and the underlying material is sandy, weathering is either prolonged or more intense because of less mineral surface area, and the result is a leached ash-gray layer directly underneath the forest mat.

Podzols offer a good contrast to the loess soils, which by comparison are as fertile as a rabbit's living room. Podzols are gardened near Anchorage and other towns mainly as a matter of convenience, but with so much land available a large-scale effort on a Podzol can be regarded as a mistake.

SUMMARY

Alaska soils accumulate in and around the mountains like lint in a navel. Common soil materials are glacial till, alluvium, and loess. Deltaic and marine soils are widespread in less settled areas. Ice accumulates in fine grained soils in permafrost and can raise some difficult problems if the warmth of humanity makes the permafrost melt.

The slight weathering of the loess is described by the Subarctic Brown Forest great soil group. On sandy soils, sour old Podzols may develop. In wet areas the typical soils are Bog (muskeg) and Half Bog, depending on the thickness of the peat. In the treeless Arctic the great soil group is Tundra, also mostly peat. None of the latter are any great shakes for agriculture, although they can surely shake the engineers.

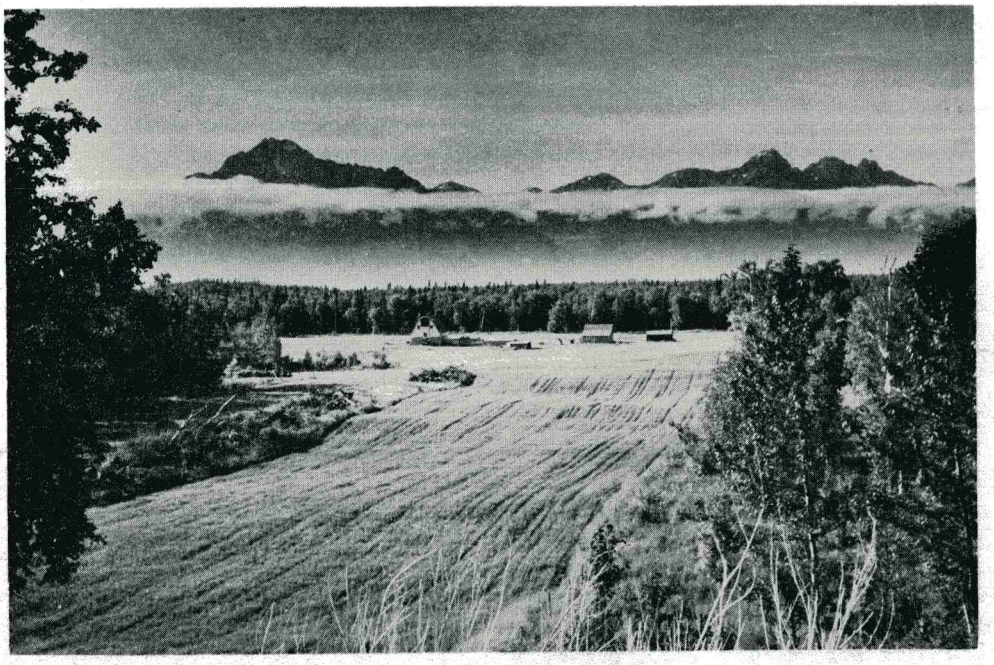
ACKNOWLEDGEMENTS AND REFERENCES SIGHTED

Engineering and geological studies of loess in the Matanuska Valley, Big Delta and Fairbanks areas and of coastal plain and beach materials near Pt. Barrow will soon be published as Iowa Engineering Experiment Station Bulletin 186. An excellent survey from the standpoint of agriculture is "Exploratory Study of the Principal Soil Groups In Alaska," by C. E. Kellogg and I. J. Nygard, U.S.D.A. Agricultural Monograph No. 7, 1951. For permafrost plus a fine bibliography see Troy L. Péwé, "Permafrost and its effect on life in the North," 18th Biology Colloquium, 1957.

Iowa Engineering Experiment Station investigations in the Far North were sponsored by the Geography Branch, Office of Naval Research, under Contract Nonr 530(04), now expired, rest in peace.

IN THE NEXT ISSUE: Fine sands in eastern Iowa.

RLH



Return to Table of Contents