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DESCRIPTIVE GEOLOGY OF ANCHORAGE AND VICINITY, ALASKA

By E. Dobrovolny and Robert D. Miller

assisted by Maurice Cooley

PRELIMINARY REPORT

FOR OPEN FILE

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INTRODUCTION

Location

This report deals only with Anchorage and vicinity at the head of Cook Inlet, Alaska. It includes the Anchorage quadrangle and that part of the Knik quadrangle east of Knik Arm. The area studied includes the major portion of the Anchorage District (Professional Paper 192, plate 3) north of latitude 61° and west of longitude 149°. It is bounded on the south and southwest by Turnagain Arm and on the northwest by Knik Arm which are extensions of Cook Inlet.

Topography

In the eastern third the Chugach Mountains rise to altitudes of about 5,500 feet. The trend of the 1000-foot contour is approximately N. 20° E., roughly parallel to the steep west-facing slope of the Chugach Mountains. The western two-thirds is an irregular plain which rises as much as 600 feet above sea level.

Owing to recent glacial activity, the valleys of the mountain mass are U-shaped and their steep slopes are almost barren of talus. The upper tributaries of the major streams generally contain rock basin lakes and are separated by sharp, serrated ridges. Along the mountain front are many terraces, the most prominent of which are at an approximate elevation of 1700 feet. The streams descend to the lowlands over cascades and water falls.

As the deposits of the plain are recent glacial materials, the area as a whole is poorly drained. Kettles, broad undrained depressions, low hillocks or mounds, dunes and outwash fans are common. Near the mountain front elongate north-south trending mounds from 1 to 3 miles long control the orientation of smaller streams except at low places where the streams flow westward. A well-developed outwash plain spreads fan-like southwest from the point where the Eagle River emerges from the mountains. This plain is dissected by Ship Creek and Chester Creek and has a southwestward sloping gradient of about 50 feet per mile. South of the outwash plain and west of the mountains is a poorly drained area of lakes, kettles, low irregular mounds, and along the coast east of Pt. Campbell is a sinuous cliff head dune ridge. Paralleling the outwash plain to the north is a prominent ridge ranging in width from three-quarters to one-and-one-half miles and rising abruptly 100 feet above the land on either side. This hill, in its southern part, contains many small undrained lakes and in its northern part broad abandoned channels as well as the present channel of Eagle River. North of this hill is a pitted outwash containing partly abandoned channels, a few lakes, and at the base of the mountains, several small alluvial fans.

Climate

Anchorage and vicinity, located at the head of Cook Inlet some 200 miles from the open ocean, is more influenced by the comparatively mild and humid climate prevailing in the Gulf of Alaska than by the colder climate of the Arctic region because the Alaska Range to the north is usually a barrier to southward migration of cold air.

Temperature and precipitation charts are included in another part of this report. The data were secured from the Weather Bureau files and compiled for the period 1938 - 1948 inclusive. On the temperature chart are shown the average number of days per month having a range in degrees of (1) less than the freezing temperature, (2) between 32 and 40 degrees Fahrenheit, (3) 41 and 60 degrees, and (4) more than 61 degrees. The precipitation chart shows the average number of days per month during which (1) there was no rainfall, (2) the rainfall was a trace, and (3) the rainfall was one inch or more.

These data were included in the report because temperature and precipitaion are factors which control certain construction activities such as excavation, laying bituminous mats or setting concrete.

Population and Industry

Anchorage is the only incorporated city in the area. Other towns shown on the maps are either railroad stations housing maintenance employees, or are trading posts. In 1940 Anchorage had approximately 3000 people.

Primarily because of increased activity in the Fort Richardson Military Reservation adjacent to Anchorage to the north, the civilian population has greatly increased. The civilian population within the city limits and suburban areas has been variously estimated as 10,000 to 30,000. These estimates are perhaps somewhat colored by the desires of those making the estimates as well as the difficulty of separating temporary employees working on construction during the summer months from the permanent residents.

The principle industries or activities which give employment to the people of Anchorage and vicinity are the Army at Fort Richardson, the Alaska Railroad which has its headquarters and main shops in Anchorage, salmon canneries, Federal Government, transportation such as air lines and bus lines, and service trades and professions.

Previous Work

The first geological investigations in this area were made by S. R. Capps in 1915 (1). Anchorage and vicinity comprises somewhat less than one-third of the area covered by Capps in his map titled "Geologic sketch map of the Turnagain-Knik Region." This map is on a scale of 1:500,000.

In 1940 a more comprehensive work by Capps (2) contains a compilation of the geologic information available at that time for the Alaska Railroad region. Included with the report is a geologic map on a scale of 1:250,000. Capps was able to define more accurately than previously the age of some of the rock units and to bring together factual data from many sources.

Even though Capps' work was reconnaissance, no important additional contributions have been made to his map or that part of the text dealing with the pre-Pleistocene geology. His observations and conclusions regarding the regional Pleistocene geology were sound and, except for details, will not be greatly modified by future work.

Purpose and Scope of Report

Because several centers of industrial activity are firmly established in Alaska and are assured of continued growth, there is an immediate need for geologic maps that will furnish basic data for planning future expansion.

Anchorage and vicinity was selected as an area to be mapped geologically because it is the Alaskan community undergoing most rapid expansion. The Anchorage and Knik quadrangles include all of the usable area into which expansion of Anchorage can take place.

The text of this report is an expanded, though incomplete, legend of the rock units mapped. Not all rock samples taken have yet been tested, and some additional information still needs to be gathered, but the information shown on the map will not be greatly modified. As a geologic map is most useful in the planning and development stages of communities, this limited preliminary version is made available to other Federal agencies and the general public.

On this map are delineated all deposits as they are exposed on the surface. So that better concepts of depth relations can be formulated, the measurements of some outcrops and some well sections are shown on the map. Deposits less than 3 feet thick are included with the underlying materials. It should be emphasized that this is an ideal which in all places could not be achieved. Materials test data and pebble counts of lithologies are presented in tabular form at the end of the report.

Acknowledgments

Personnel representing many Federal and Territorial agencies were considerate and helpful in providing data for use in the report or providing facilities to prepare data.

Mr. Harold Jorgenson of the Bureau of Land Management permitted the use of their set of aerial photographs and added land lines on the compilation base map. Mr. N. E. Nelson, construction engineer, Civil Aeronautics Administration, provided use of a materials laboratory and test data taken in connection with tests made for the new Anchorage International Airport. Mr. Shaw, Territorial Bureau of Mines, made several insoluble-residue tests on limestone. Mr. W. A. Niemo, Alaska Road Commission, supplied materials test data. Colonel Lyle E. Seaman and Mr. A. U. Theuer of the Army Engineers made available data on tests they have on file and provided records of water wells. Mr. Ludlow G. Anderson of the U. S. Bureau of Mines gave use of office space and many publications.

DESCRIPTIVE GEOLOGY

Principle features

The oldest rocks are in the eastern third of the quadrangles. These include hydrothermally metamorphosed coarse sediments, lava flows and intrusives which were not differentiated in the field and are mapped as greenstone.

In the extreme southeastern part of the Anchorage quadrangle is a sequence of argillites and graywacke that occupies approximately five square miles and unconformably overlies the greenstone.

Beneath the glacial deposits in the lowland near the mountains in Knik quadrangle are slightly indurated Tertiary sands, conglomerates, and shales. One exposure extends along the Eagle River from the railroad bridge to the highway bridge. Another exposure is along the Palmer-Anchorage highway about one-half mile south of Lower Fire Lake. The contact between the slightly indurated materials and the greenstone is concealed by glacial deposits, but is probably unconformable.

The youngest deposits are unconsolidated glacial, glacio-fluvial, lacustrine and marine sediments which cover the surface of the western two-thirds of the two quadrangles. Sediments carried by rivers to Knik and Turnagain Arms are filling them rapidly. Glaciers are active today in the quadrangles adjacent to the area mapped. Recent deposits have not been separated from Pleistocene deposits because no criteria was observed which could be used to distinguish them.

Cretaceous system and older (?) rocks

Greenstone and metamorphosed volcanic rocks. Similar descriptions of these rocks have been made by many geologists. However, observations made along the west-facing slope of the Chugach Mountains indicate that perhaps more graywacke is present in the sequence than is suggested by Capps and Park.

Limestone occurs in three places north of Potter. About one-quarter mile south of the mouth of Little Rabbit Creek is a cliff containing a limestone exposure approximately 40 feet wide and 25 feet high. On the north side this block of limestone is separated from the greenstone by a fault dipping 62° N. W. On the south side the contact with the greenstone is concealed by till. At the base of the cliff is marshy ground and the top of the cliff is mantled with till. Results on the one sample tested show the rock to contain 4.2 percent residue insoluble in hydrochloric acid, and 95.8 percent calcium carbonate. Limestone of this approximate proportion of insoluble residue to calcium carbonate probably does not exceed 10,000 cubic yards and excavating even that quantity would require removal of overburden which will be 50 to 70 feet thick 100 feet back of the exposed face. Limestones from the adjacent localities contain insoluble residues which range from 51 percent to 64 percent.

Samples of greenstone were collected for testing physical properties and, until the results become available, no additional contribution can be made to the following description written by Park (3):

"The hydrothermally metamorphosed rocks comprise a wide variety of materials. They include altered igneous rocks of acidic composition, altered andesite, and especially water-laid tuff and agglomerate. They also include altered argillite, graywacke, and chert of sedimentary origin. This whole series has been cut by both basic and acidic dikes. ----"

"Owing to the deformed and metamorphosed character of this series of rocks only a vague idea of their structure has been obtained. They were difficult to study in the field because they are generally so greatly altered and weathered that determinable specimens are not easily obtained.

"Along the shore of Turnagain Arm west of Indian Creek, the contact between this group of rocks and the argillite and graywacke to the east has been the site of intense deformation, with shearing and brecciation. Bunches of argillite and graywacke are apparently squeezed and infolded into the metamorphic rocks, and the linear arrangement of these included materials is roughly parallel to the line of contact. The axis of the main folds aline themselves approximately with the axial trend of the mountains and also roughly parallel to the line of contact with the argillite-graywacke series. This direction is N. 10°-20°E. The folds plunge north at relatively flat angles. Numerous faults of both normal and reverse types and with great differences in amount of offset are present. Most of these faults are parallel to the axes of folding, although a transverse east-west fault system is developed.

"No information concerning the thickness of these rocks was obtained. Capps considers them to be at least several thousand feet thick, and this estimate appears to be as close as can at present be made.

"The age of this group of rocks is probably pre-Cretaceous, although where the contact with the argillite-graywacke series has been seen deformation, infolding, and alteration have been so severe that definite relations are difficult to establish. It is impossible from the information obtained to state that either rock series definitely overlies the other, but the metamorphic rocks are much more intensely deformed and intruded than the argillite-graywacke group and are therefore considered older. This is in accord with Capp's conclusions."

Argillite and Graywacke. A part of one day was spent observing the argillite and graywacke rocks. The contact separating them from the greenstone was verified. Samples for testing physical properties were not taken. The description by Park (3) serves better than could be made as the result of so short an investigation.

"Nearly the whole of the area is underlain by argillite and graywacke. The argillite and graywacke are locally covered by Pleistocene or Recent deposits, or, in places, intruded by igneous masses of small areal extent. Minor quantities of conglomerate, limestone, and partly indurated sandstone are interbedded with the argillite and graywacke, forming many small but distinct lenticular beds.

"Thin-banded argillite and graywacke are by far the most common rock types. The bands range in thickness from a fraction of an inch to more than 100 feet, although the average is between 2 and 3 inches. Gradational bedding, cross-bedding, and in few places ripple marks testify to the shallow-water origin of the deposits. It has not been feasible to attempt to differentiate between argillite and graywacke on the map.

"Graywacke. The graywacke grades on the one side into argillite and on the other into sandstone and conglomerate. It consists mainly of sharply angular bits of rock and fragments of quartz, feldspar, and other minerals. Coarse muscovite and some biotite are common constituents, and some hornblende is present. Fragments of coarse epidote, clinozoisite, and a few broken tourmaline grains have been seen. Small crystals of apatite are common. Most of the feldspar present is either basic oligoclass oracidic andesine, although orthoclase and other members of the plagioclase series may be present.

"The groundmass is a fine-grained aggregate of chlorite, sericite, graphite, and, in places, much calcium carbonate, both in grains and in stringers. A little epidote and limonite are widespread, a mineral of the kaolinite group is common, and leucoxene may be present. Many specimens of the somewhat schistose rock are partly recrystallized and have a groundmass composed chiefly of very fine grained feldspar needles, probably near oligoclase in composition. The rock fragments are usually bits of fine-grained graywacke or argillite. In some areas the fragments measure more than an inch across, although usually much less. Macroscopic argillite fragments may be evenly and closely distributed through beds as much as 100 feet thick or even more. Some phases of the rock strongly suggest a tuff, and such rock is with difficulty distinguished from the later greenstone tuff series.

"The graywacke in many places is mineralized, and the oxidized rock has a dull reddish-brown color.

"Argillite. The argillite locally grades into schist and slate, but usually the rock cleavage is undulating and irregular. The color of the fresh rock is dark gray, and under the microscope much graphitic material is seen.

"The rock consists of very fine particles of quartz, with some feldspar. The particles are subangular, probably somewhat water worn. The groundmass is exceedingly fine and consists of chlorite, sericite, a member of the kaolinite group, and graphite. The argillite shows almost no recrystallization, but in the more schistose phases of the rock recrystallized minerals are slightly developed.

"Many specimens of the argillite resemble fine water-laid tuff, and it is entirely possible that considerable volcanic material is included in the series.

"Conglomerate, sandstone, and limestone. Conglomerate, sandstone, and limestone form scattered lenticular beds in the much more abundant argillite and graywacke.

"The conglomerate grades from indurated grit to rock containing boulders as much as 10 feet in diameter, although the average diameter is probably less than 1 inch. The pebbles vary greatly in composition; fragments of argillite and graywacke are the most common, but igneous and other sedimentary rocks are present. The pebbles of igneous rock are usually granitoid in texture and have the composition of a diorite. The matrix of the conglomerates is usually argillite or, more commonly, fine-grained graywacke. This matrix is in places slightly mineralized, and one spot of free gold was seen in a conglomerate lens found in the most recent gorge of lower Crow Creek. As mentioned by Capps and also by Martin, Johnson, and Grant (U. S., op. cit. p. 117), the conglomerate does not form sharp, distinct beds but grades in all direction into the finer sedimentary rocks. Most of the conglomerates are intraformational and do not mark any significant break in deposition. Many are sheared and deformed; the pebbles tend to flatten parallel to the cleavage.

"Sandstone is nowhere very common, and it grades locally into quartzite, although the mineral grains are rarely well cemented. The fresh sandstone is usually feldspathic and grayish. It merges gradually into graywacke.

"Several small lenses of impure limestone have been observed. These are especially common near the summit of the pass between Crow and Raven Creeks. The limestone has a fine granular texture and a dark bluish-gray color.

"From the paleontologic evidence these beds are considered to be of Upper Cretaceous age. There must, however, have been a considerable time interval between the deposition of this Upper Cretaceous series and theEocene coal-bearing beds of the Chickaloon region. Northwest of the area mapped the argillite-graywacke series is covered by several thousand feet of greenstone tuff. These two formations are separated by a distinct angular unconformity. In the Chickaloon region the lower Tertiary (Eocene) coal beds are described as unconformably overlying the argillite-graywacke series. No direct evidence has been obtained concerning the relationship between the postargillite greenstone and the Eocene coal beds. From the lithologic dissimilarity of these rocks, especially the indurated condition of the greenstone tuff, it may be logically reasoned that the tuff is pre-Tertiary and was consolidated and partly eroded before the deposition of the lowest Tertiary beds.

"If the above reasoning is correct, the conclusion may be drawn that the argillite-graywacke series cannot be the youngest Upper Cretaceous formation, because it is separated from the basal Tertiary beds by several thousand feet of clastic rocks and by two definite, widespread unconformities.

"As the area described in this report is so small, it is entirely possible that other parts of the argillite-graywacke series are older than Upper Cretaceous."

Tertiary system

Rocks in the Knik quadrangle assigned to the Tertiary system are interbedded sandstone, conglomerate and shale.

The sandstone ranges in grain size from fine to coarse and locally grades into conglomerate. Component grains are quartz, graywacke, granite, argillite, feldspar, greenstone and tuff reflecting the kinds of rocks in the adjoining mountains. On clean fractures the prevailing gray colors of the source rocks are evident. Weathered surfaces are tan to brown.

The conglomerate contains the same rock types and minerals as the sandstone, and has a sandstone matrix. Some iron oxide cement is present.

The shale occurs in beds 0.2' to 0.8' thick and appears to be somewhat more resistant to abrasion than the sandstone. In the exposure along Eagle River the shale is carbonaceous and contains thin lenses of coal. One coal bed 2.0 feet thick has been mined. South of Fire Lake the shale is blue-gray and contains stringers of sandstone. This shale is deeply weathered and might easily be confused with glacial deposits were it not for the sandstone and stratigraphic position.

Quaternary system

General discussion. Pleistocene and Recent deposits include: (1) till, (2) outwash sands and gravels, (3) terrace gravel, sand, silt, and clay, (4) alluvial fan gravel and sand, (5) peat, (6) estuarine clay, silt and sand, and (7) eolian sand and silt.

The principle criterion used in mapping these deposits was grain size. Locally, where the grain size distribution is highly variable, the geologic and topographic terms such as outwash or alluvial fan was used to represent the deposits. In other places where the areal extent of one kind of grain size deposit is too small to show on the map, it is included with adjacent deposits. In the legend an attempt has been made to represent these deposits in the sequence in which they were formed. As many deposits of different texture were formed entirely or partly contemporaneously, the stratigraphic relationship was not always evident. Pebble counts were made of gravels representing different deposition cycles, but appreciable lithologic distinctions were not found.

Till. Till includes deposits of unsorted materials ranging in size from clay to large isolated boulders. The largest isolated erratics observed are approximately 10 feet on an edge. Locally the till includes sorted beds of clay, silt, sand or gravel that at least in part have been distorted.

Component rock particles are representative of all older rocks of which graywacke is the most abundant type. The range of physical properties is wide because the materials range from predominantly silt-size in one locality to predominantly boulder-size in another.

The most continuous and widespread distribution of till is along the lower flanks of the mountains and in their stream valleys. In the lowlands near the mountains are many isolated hills of till surrounded by younger well-sorted granular materials. The till on the lower slopes of the mountains is coarse. Most of its larger rock components are rounded pebbles and boulders. About 10 percent of the mass is silt. The till of the lowlands is composed mainly of sand, silt and clay. Perhaps less than 20 percent could be classed as coarse as gravel.

The till varies widely in physical properties within short distances, both vertically and horizontally. In places these changes occur in less than a foot. Where clay, silt, sand, and gravel are intimately mixed, the till is tough and will stand in near vertical slopes. Where the till is dominantly clay and silt, vertical or near vertical slopes and faces can be excavated, but will "fail" in one or two years because of soil creep. Where the till is coarse and has clay and silt well distributed throughout the mass, slopes of 1 to 1 will "stand".

Blue clay. A blue to gray marine clay is exposed along the coast of Knik Arm from Pt. Woronzof to the mouth of Eagle River, north of Eagle River, and along the coast one-half mile south of the mouth of Rabbit Creek. It is compact when dry and extremely adhesive when wet. Some unsaturated blocks of clay from 3 to 8 inches in diameter occur in landslides along the shore. The blocks extending below high tide are moved by shore currents and, in the process, incorporate pebbles in their outer parts. Blocks of this kind have been picked up by ship anchors from the channel of Knik Arm. Laminations one-fourth to 2 inches thick are visible on undisturbed cleaned samples. These laminations represent differences in ratio of silt-size particles to clay-size particles in individual laminae. As the clay is impervious, it makes aquifers of all overlying granular materials. The surfacing of the many springs along its outcrop is controlled, therefore, by the position of the impervious clay.

At Pt. Woronzof and between the mouth of Eagle River and Pal triangulation station, the clay lenses with silt and sand. Similar lensing probably takes place in the subsurface ~~west~~ east and south of the outcrop belt.

Fossils were found at one small locality near Pt. Woronzof. The seven species identified by F. Stearns Mac Neil are marine, have a range from Pleistocene to Recent and still live in the area. Presumably these fossils lived in environments similar to those of the present estuaries of Knik and Turnagain Arms.

Lower silt. A small area of silt is exposed on the tip of Pt. Woronzof. Were it not for the marked contrast with the sand on one side and gravel on the other, the silt would have been included with the sand. This silt is brown. The beds are angular and truncated. As the silt lenses with sand which, in turn, lenses with the blue clay, it belongs to the same deposition cycle.

Lower sand. Sand, which interfingers in its lower part with the blue clay, is widely exposed south of Chester Creek and west of the 200 foot contour. The sand is evenly fine-grained, though thin lenses of silt are interbedded with it in many places. Northwest of Sand Lake the sand includes a fairly high percentage of coarse sand and some gravel.

Gravel. Two extensive areas are predominantly gravels. One is along the eastern part of the lowland and the other is south of Eagle River. About one-half mile south of Sand Lake is a comparatively small deposit of gravel that currently is being used commercially. In part this gravel interfingers with the lower sand described above.

Coarse-grained materials predominate in the gravel of the western part of the lowland. Some lenses 3 to 6 feet thick are almost entirely composed of boulders 3 to 8 inches in diameter. Other lenses, although containing boulders of the same size, have a ground mass of silt, the intermediate fraction being absent. The gravel and sand contact in the southern part of the lowland is represented in a saw-tooth manner in order to convey the idea that the sand and gravel interfinger or tongue with one another. Although some light-gray granite pebbles and boulders are conspicuous, graywacke and greenstone constitute the bulk of the rock types.

South of Eagle River the gravel is as coarse as in the eastern part of the lowland. Some lenses of fine gravel are included, but no material as fine as sand was observed. Contact with the till is abrupt. In addition to graywacke, greenstone and granite, this gravel contains boulders of Tertiary sandstone and some coal.

Pitted outwash sand and gravel. Between Cairn Pt. and Birchwood is a pitted outwash. The gravel sand and silt of this outwash are sorted and, though there is a crude northeast-southwest alignment of similar grain sizes, their distribution is erratic.

Outwash sand and gravel. The materials of the outwash plain on which Anchorage is situated are exceptionally well-graded from coarse gravel and boulders at the apex of this fan-like deposit to fine sand and silt at the outer margins. Near Eagle River the gravel contains some boulders a foot or more in diameter and practically no sand and silt.

Southwestward the boulders decrease in number and size, and coarse sand becomes plentiful. In the immediate vicinity of Anchorage gravel lenses from 2 to 6 inches thick alternate with coarse sand lenses of about the same thickness and range from 20 to 50 feet in length. South of Anchorage the deposit contains almost no gravel and the sand size dominates the silt fraction. Alternation of lenses of slightly different texture are present where boulders are found, though the lensing is not so strikingly apparent.

Where the materials are coarse, weak Tertiary sandstone forms some of the smaller fraction. In the finer materials the Tertiary sandstone was not recognized. South of Anchorage lenses of clastic coal 2 to 6 inches thick and 3 to 15 feet long are present in the sand and gravel deposits. Some pieces of coal are 4 inches in diameter. These coal lenses, when encountered in well or homesite excavations, have been erroneously interpreted as exploitable deposits.

Throughout Anchorage and vicinity, this outwash plain is by far the most desirable location for industrial and municipal sites. The materials composing the plain are so uniform that prediction as to the nature of the exploitable deposits can be made with confidence. The excellent drainage of the gravel and sand contributes not only to good foundation conditions, but also provides a dependable, though small, water reservoir for homesites.

Higher silt. Northwest of Sand Lake, underlying the site of the new International Airport, is a silt which overlies the blue clay and sand sediments exposed along the coast of Knik Arm. The silt is light tan to gray, evenly grained and has faintly recognizable horizontal laminations. Difference in relief on this poorly drained material is approximately 80 feet. Irregular hills and kettles extend beyond the mapped boundary. In one kettle, from which the peat was removed in construction of the International Airport, the peat was 25 feet deep and the horizontal distance across its top was 75 feet.

Alluvial fans of sand and gravel. Alluvial fans occur along some of the creeks where they enter the lowland. The fans developed by the North Fork and the South Fork of Campbell Creek contain more sand than gravel. In contrast, the smaller fans north of Ship Creek contain more gravel than sand. Lenses are irregular, truncated, and may be horizontal or steeply dipping. Where streams have entrenched the fans, the lower lenses are locally exposed in the steep valley walls. The lenses on the fan surface are more regular than the lenses lower in the fan. This irregularity reflects the changing base level of the fans which at its highest level was controlled by ice occupying the lowlands. Rock particles composing the fan material are principally greenstone.

Stream terraces of sand and gravel. Terraces along the major streams were mapped as one unit, although they occur at several levels. They vary greatly in grain size from silt to gravel and, with some lag, reflect the composition of the materials through which they flow. The terraces of Campbell Creek are composed of fine sand and silt. Chester and Ship Creek terraces contain coarse gravel and sand. The terrace of gravel near the mouth of Ship Creek is much coarser than the gravel of the outwash on which Anchorage is built, but is about as coarse as the gravel found in the outwash two miles up stream.

Where the blue clay extends up the stream valleys elongate clay blocks paralleling the valley wall have slumped from 10 to 50 feet. As these slide blocks are from 10 to 100 feet wide and 100 to 1000 feet long and are covered by gravel, they resemble stream terraces.

Abandoned channel gravel. Northwest of Anchorage, roughly paralleling the mountain front, are broad channels. These channels are topographically high compared to the present level of Eagle River. Some of them are occupied by diminutive streams which could not have developed the well defined wide flood plains or cut the steep valley walls. Some of the channels contain stagnant lakes or lakes which are drained by small streams.

The valley fill of these abandoned channels is composed of coarse gravel and boulders. Some thin, widespread lenses of silt and sand are present, but though the silt provides agricultural lands, it makes up only a small part of the fill.

Peat. Peat deposits are scattered throughout the lowland, but are most common south of Anchorage. They border lakes or occupy parts of poorly drained valley bottoms. For mapping purposes the marshy areas and local tidal flats containing organic materials about three or more feet thick were classed as peat.

Exposures revealing the entire section of any given peat deposit are rare. However, near Pt. Woronzof, the peat is 14 feet thick, is dark brown in its lower part and contains well-preserved woody tissues. In other places silt and clay is mixed with the organic matter in such proportions as to give it the appearance of slime.

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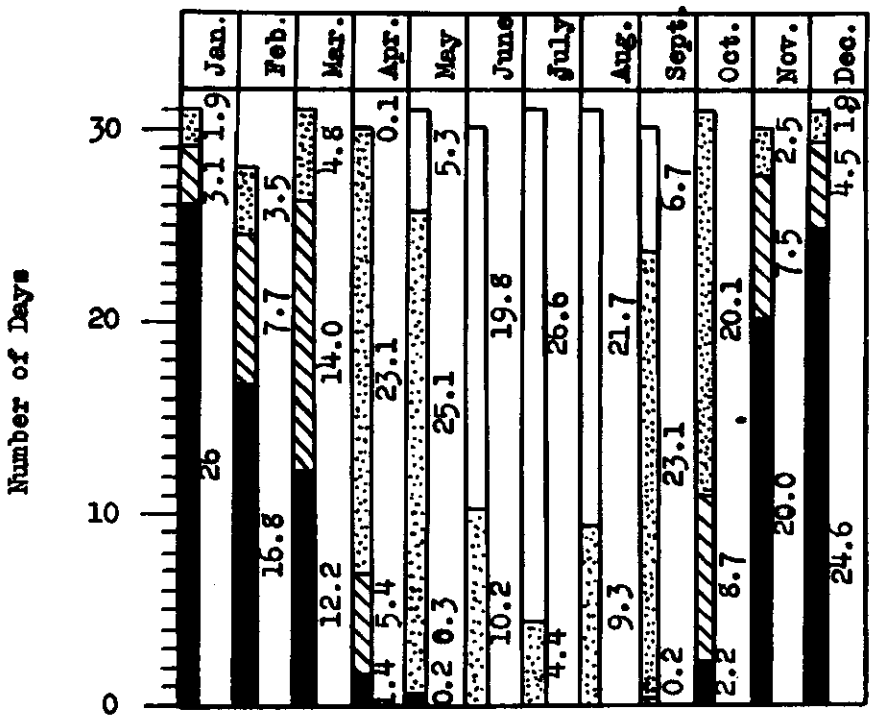
Temperature Ranges at Anchorage
Alaska
1938 - 1948 Inclusive



Days in which maximum temperature was above 61° F.

Days in which maximum temperature was between 41° - 60° F.

Days in which maximum temperature was between 32° - 40° F.

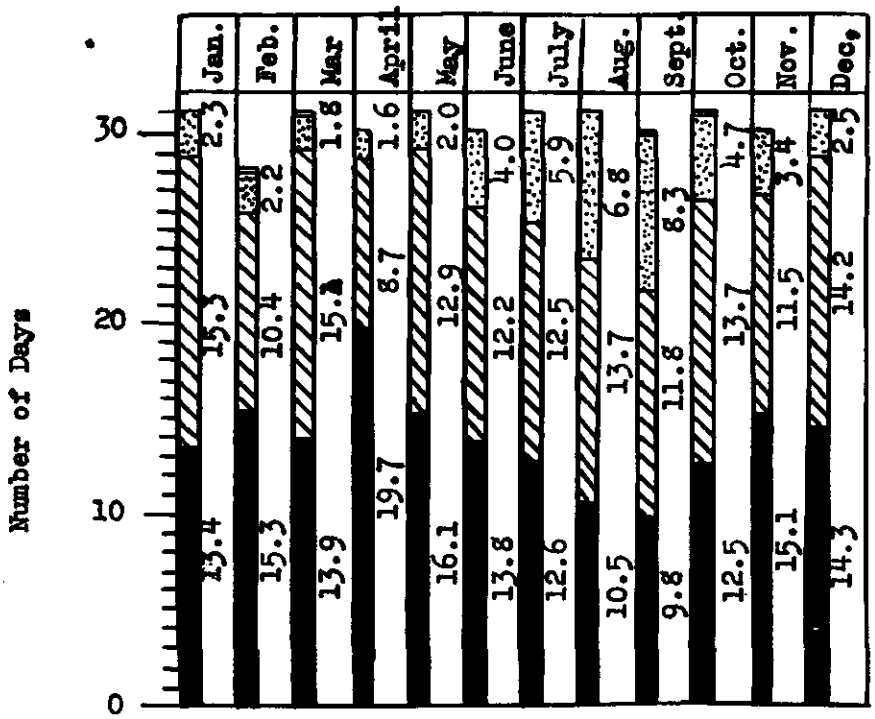
Days in which maximum temperature was less than 32° F.

Compiled from Climatological Data,
issued by the Weather Bureau,
U.S. Department of Commerce,
Anchorage Alaska, for the years
1938 - 1948 inclusive

GPO D FSO

Chart 1

Precipitation Ranges at Anchorage
Alaska
1938 - 1948 Inclusive



Days in which precipitation was more than 1.0 inch

Days in which precipitation was between 0.1 - 0.99 inches

Days in which precipitation was between Trace - 0.09 inches

Days in which there was no precipitation

Compiled from Climatological Data,
issued by the Weather Bureau,
U.S. Department of Commerce,
Anchorage, Alaska, for the years
1938 - 1948 inclusive

GPO D FSO

Chart 2

MECHANICAL ANALYSIS

Number of Sample	Location					Cubic yards	Average thickness	Overburden	Material or map unit	Liquid limit	Plasticity index	Sieve Analysis								Hydrometer						
	1/4 Fraction	1/4 Section	Section	Township (N)	Range (W)							% pass 3/4"	% pass 1/2"	% pass #4	% pass #10	% pass #50	% pass #60	% pass #80	% pass #100	% pass #200	% pass 0.0500 mm	% pass 0.0370 mm	% pass 0.0190 mm	% pass 0.0090 mm	% pass 0.0050 mm	% pass 0.0036 mm	% pass 0.0010 mm
S 1	SW	SW	27	14	3				Till					95	91	78	74		66	56							
S 2	SW	SW	14	14	2				Till			76	67	50	38	14	13		12	11							
S 3	NE	NW	32	12	3				Till			97	94	86	82	68		60	56	42							
S 4	SW	SE	11	12	4				Till	20.9	6.3					97		94	92	82	81	69	49	31	23	19	12
S 5	SW	SW	17	12	3				Till			80	77	71	68	61	61		58	52	42	40	34	24	17	12	3
S 6	NE	SW	33	13	3			4'	Till	18.2	2.3	72	66	57	52	40	38		35	30	30	28	21	13	9	6	0
S 7	NE	SE	32	12	3				Gravel			82	77	66	58	27		14	10	3							
S 8	SW	NE	7	12	4				Gravel			48	37	22	18	9		6	5	3							
S 9	NW	SE	26	13	2				Gravel			87	84	48	21	12		11	10	9							
S 10	NE	NE	14	14	2				Gravel			70		48	41	24	23		22	22							
S 11	NW	NW	28	13	3				Gravel		NP	48	40	22	13					0.9							
S 12	NW	SE	8	12	3	162,000	15'	3'	Gravel			56	50	31	20	7		4	3	2							
S 13	SE	SE	18	12	3	37,200	27'	3'	Gravel			70	66	53	44	18		15	14	13							
S 14	NE	SW	33	12	3	12,700	8'	3'	Gravel			77	73	61	48	13		7	5	3							
S 15	NW	NW	28	13	3	3,000	10'	3'	Gravel			39	34	25	18	2		1	1	1							
S 16	SW	SE	4	12	4	1,000,000	22'	3'	Gravel			55	47	33	26	6		5	4	3							
S 17	SW	SE	9	12	4				Dune sand							99		89	79	13							
S 18	SE	SW	9	12	4				Sand							100		98	96	58							
S 19	NE	NE	36	13	4	14,350	15'	3'	Sand			86	83	72	64	31		17	12	6							
S 20	NW	NE	11	12	4				Sand					100	99	75	66		43	22							
S 21	NE	NE	9	12	4				Sand						100	92	81		43	11							
S 22	NE	SW	25	13	4		0-5'		Sand	NP	NP	100	99	96	92			22		3							
S 23	SE	SE	9	12	3				Sand						100	46	33		13	4							
S 24	NW	SE	24	13	4		0-3.0'		Silty sand	NP	NP	100	98	91	83			26		19.5							
S 25	SE	NE	20	13	4				Silt							100		100	99	89	61	37	11	3	2	1	1
S 26	SW	NE	24	13	3		0-3.5'		Silty clay	46	26		98	96	94					80		78	75				
S 27	SE	SW	18	12	3				Clay					100	99	97	97		96	95	92	90	80	63	51	41	19
S 28	SW	SW	3	11	3				Clay	55	32.8						100		100	98	94	90	78	71	65	60	41
S 29	SE	SW	13	14	2				Clay	39	19.6										100	99	97	93	83	72	29
S 30	NW	SE	13	14	2				Clay	36	13										100	99	98	96	83	71	28
S 31	SE	NW	14	14	2				Clay	26	4.6										96	94	90	72	52	40	14

GPO D FSO

PEBBLE COUNT

ANCHORAGE AND KNIK QUADRANGLES

Sample number	% Quartzite and greenstone	% Vein quartz	% Coarse greenstone and argillite conglomerate	% Granite	% Porphyry	% Igneous undifferentiated	% Schist	% Volcanics undifferentiated	% Enstatite	% Sandstone at Eagle River	% Ocher	% Quartzite conglomerate	% Coal	Total no. pebbles
A 1	83	8.2	3.3	4.5	1									215
A 2	68.5	12.4	7.0	7.3	2	2.4	0.4							242
A 3	77.6	8.0	4.6	4.6	1.7	3.5		0.8						250
A 4	72.9	13.0	4.0	3.4	2.5	4.2								353
A 5	73.0	9.8	4.0	5.7	2.9	4.6								174
B 1	79.8	6.2	6.7	1.5	0.5	3.8	0.5		1.0					208
B 2	78.4	4.5	6.0	2.0	0.5	5.7	0.25		1.2	0.25	1.2			401
E 1	79.5	12.5	3.8	1.2	1.5	0.7			0.5					392
E 2	76.4	12.5	5.2	2.3		2.3				0.3		0.6		302
D 1	70.5	14.9	3.3	2.4	1.4	3.3					2.4	0.9	0.4	207
D 2	72.2	13.0	2.0	3.0	3.5	4.5				0.2		1.0	0.2	397

GPO D FSO

Chart 4