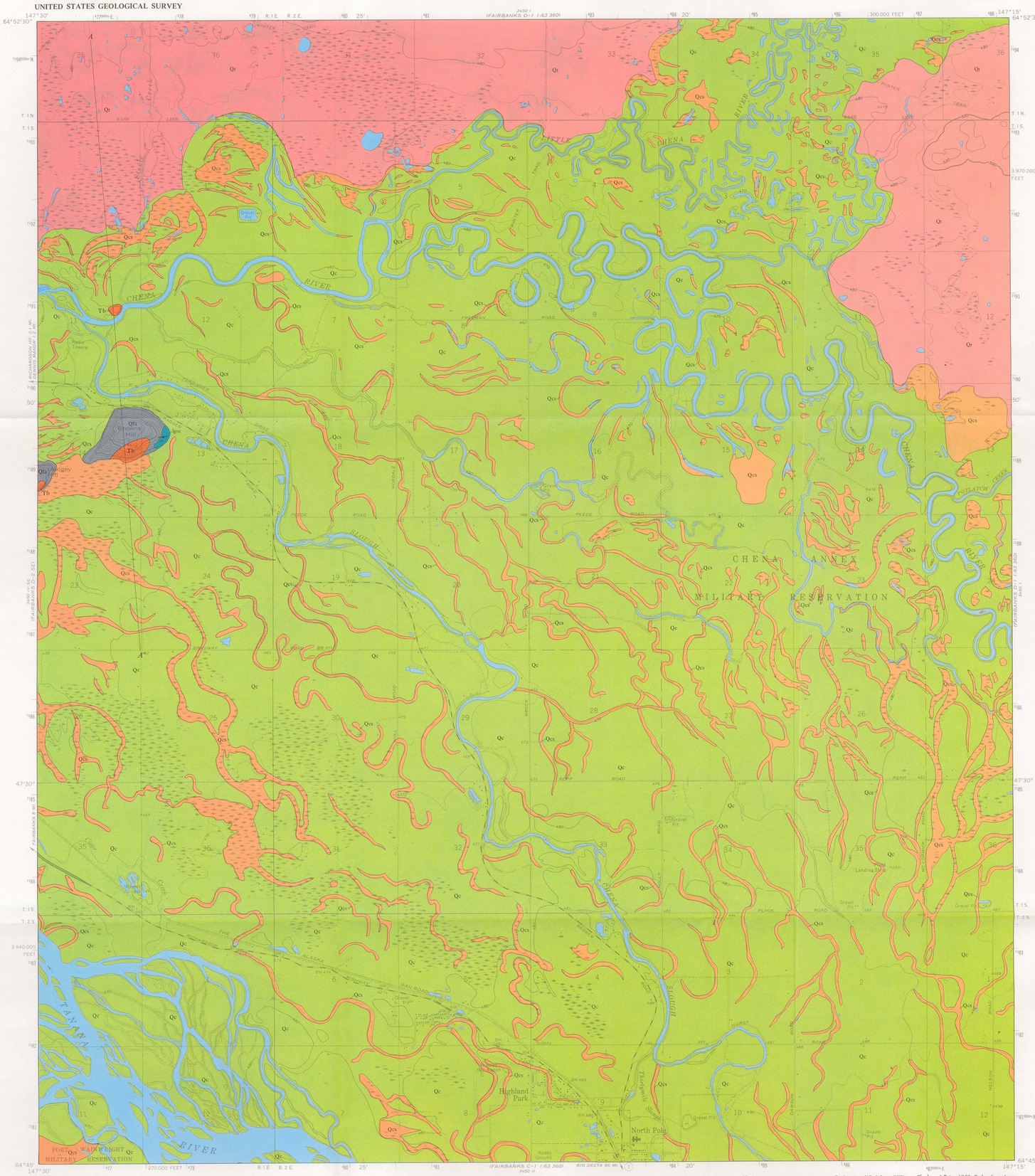
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-949



Base from U.S. Geological Survey, 1966
Universal Transverse Mercator Projection. 1927 North American datum
10,000-foot grid based on Alaska coordinate system, zone 3
1000-metre Universal Transverse Mercator grid ticks, zone 6

SCALE 1:24 000

1 0 1 MILE
1 .5 0 1 KILOMETRE

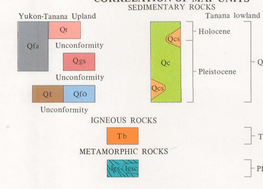
CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

APPROXIMATE MEAN DECLINATION, 1976

QUADRANGLE LOCATION

Geology modified from Williams, Péwé, and Paige, 1959., Bedrock geology by R. B. Forbes and F. R. Weber, 1972–73; surficial geology by T. L. Péwé and J. W. Bell, 1972–73

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

A blanket of loess of Quaternary age, a few inches to several hundred feet thick, covers nearly all the quadrangle. This loess is not shown on the map where less than 3 ft thick

SEDIMENTARY ROCKS

Qr READY BULLION FORMATION (Holocene) — Massive homogenous unconsolidated eolian silt; reworked and retransported to lower slopes and valley bottoms; locally referred to as "muck." Unconformably overlies Goldstream Formation; grades upslope into Engineer Loess. Well sorted, less than 10 percent clay; locally contains layers and lenses of sand and gravel. Grains angular; consists mostly of quartz, feldspar, and mica; locally cemented by iron oxide. In valley bottoms, contains abundant organic matter as plant fragments, peat lenses, sticks, logs, and rooted stumps. Silt poorly to well stratified; 3–30 ft thick, thinning upslope. Gray to black when frozen, tan when thawed; locally mottled by iron staining. Silt is perennially frozen and contains ice seams and lenses as much as ½ in. thick. No large ice masses; no vertebrate fossils of extinct animals

Qc CHENA ALLUVIUM (Pleistocene and Holocene) — Well-stratified layers and lenses of unconsolidated sand and rounded river gravel overlain by as much as 15 ft of gray silt; Illinoian(?) to Holocene in age. Gravel consists mostly of quartz and gneiss, and clasts from ¼ in. to 3 in. in diameter. The unit is 10 to more than 400 ft thick. Locally perennially frozen from 3 to 275 ft with low ice content. Formation generally lies unconformably on bedrock

Qcs Swale and slough deposits — Consists of poorly stratified lenses and layers of unconsolidated stream-laid silt and silty sand; fairly well sorted, contains 10–30 percent clay; grains angular and subrounded and consist of quartz, feldspar, and mica; contains organic material. Brown to grayish blue, mottled with carbonaceous material and iron staining. Locally perennially frozen with moderate to high ice content

Qfa FAIRBANKS LOESS (Pleistocene and Holocene) — Massive homogeneous unconsolidated eolian silt on upper slopes and hilltops. Thickness 3–200 ft. Well sorted, less than 10 percent clay; grains angular; consists mostly of quartz, feldspar, and mica; locally cemented by iron oxide; locally calcareous; tan to tan-gray when dry, brown when wet. Locally contains dark carbonaceous layers and iron-oxide-stained bands. Contains at least two white vitric volcanic ash layers ½ in. to 6 in. thick. Generally free of permafrost. Remains of Illinoian through Holocene land mammals present. On lower slopes and valley bottoms grades into Gold Hill Loess, Goldstream Formation, and Engineer Loess. Unconformably overlies Cripple and Tanana Formations and pre-Quaternary bedrock

Qfg GOLDSTREAM FORMATION (Pleistocene) (Shown in cross section only) — Massive homogeneous unconsolidated organic eolian silt; reworked and retransported from upper slopes to lower slopes and valley bottoms. Locally referred to as "muck." Unconformably overlies Fox Gravel in valley bottoms and Tanana Formation and Gold Hill Loess on lower slopes; unconformably overlain by Ready Bullion Formation and Engineer Loess; grades upslope into Fairbanks Loess. Well sorted, less than 10 percent clay. Grains angular; consists mostly of quartz, feldspar, and mica; locally cemented by iron oxide; locally calcareous. Contains abundant organic material as minute carbonized fragments and some peat lenses, sticks, twigs, and logs. Pleistocene (Wisconsinan) vertebrate fossils abundant, including frozen partial carcasses of extinct species. Silt is poorly to fairly well stratified; 10 to more than 300 ft thick, thinning upslope. Gray to black to greenish black when frozen, tan when thawed. Deposit is perennially frozen and contains ice seams and lenses as much as ½ in. thick; large (1–50 ft thick) ice wedges in upper part; top of ice masses truncated at contact with overlying Ready Bullion Formation. Ice masses form polygonal pattern 25–100 ft in diameter on surface. Large masses of pingo ice locally present. Contains one thin white vitric volcanic ash layer near middle of deposit

Qt TANANA FORMATION (Pleistocene) (Shown in cross section only) — Widespread solifluction layer on hilltops and slopes consisting of angular, fractured, and weathered bedrock in a silty sand matrix; locally referred to as "slide rock." Crops out in roadcuts and gravel pits. Poorly stratified and unsorted; elongate or platy fragments oriented parallel to surface. Deposit 3–75 ft thick; greatest thicknesses at base of slopes. Composition varies depending on local bedrock; may range from grus to greasy clay to the most common local platy rock fragments. Unconformably overlain by Gold Hill and Fairbanks Loess; grades downslope into Fox Gravel. Perennially frozen on lower slopes and in valley bottoms.

Qfo FOX GRAVEL (Pleistocene) (Shown in cross section only) — Undisturbed deposit is buried except where exposed in walls of excavations. Undisturbed deposit is an auriferous valley-bottom accumulation of solifluction material reworked by stream action; early or middle Pleistocene age; does not include modern creek gravel. Consists of poorly sorted, angular, sandy, gravel fragments 1–6 in. in diameter with some cobbles 10 inches or larger; poorly to fairly well stratified with lenses of silt and sand as much as 3 ft thick and 7 ft long. Gravel clasts are imbricate in places; they consist of quartz-mica schist, phyllite, slate,gneiss, quartz, quartzite, and igneous rocks. Composition varies depending on local bedrock. Deposit 1–100 ft thick. Color tan owing to iron staining. Unconformably overlain by Gold Hill Loess and Goldstream Formation; unconformably overlies schist and intrusive rocks; grades upslope into Tanana Formation. In most creeks, gravel lies on 1–6 ft of auriferous yellowish to bluish clay. Locally perennially frozen, with little ground ice. Bones of bison and mammoth present but rare

IGNEOUS ROCKS

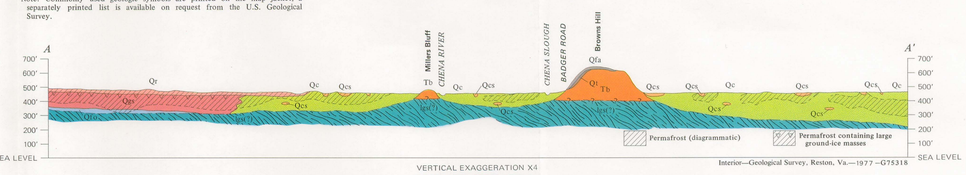
Tb BASALT — Medium-gray to grayish-black, grayish-green, light-yellowish-orange, and dark-reddish-brown basalt transitional between olivine tholeiite and alkali olivine basalt; deeply weathered to moderate brown; closely jointed. Local pillow or columnar structure; palagonite present in the pillow lavas

METAMORPHIC ROCKS

lgsc METAMORPHIC ROCKS OF THE LOWER GREENSCHIST FACIES, UNDIVIDED

Calc-phyllite and calc-mica schist — Typical mineral assemblages in these rocks are carbonate-albite-quartz-sericite and carbonate-quartz-sericite (± phlogopite)

Note: Commonly used geologic symbols are printed on the map jacket; a separately printed list is available on request from the U.S. Geological Survey.



GENERALIZED CROSS SECTION

GEOLOGIC MAP OF THE FAIRBANKS D–1 SW QUADRANGLE, ALASKA

By
Troy L. Péwé, John W. Bell, John R. Williams, and Russell A. Paige

1976

GEOLOGY OF THE FAIRBANKS D–1 SW QUADRANGLE, ALASKA

INTRODUCTION

The Fairbanks D–1 SW quadrangle, an area of about 60 mi², is in central Alaska approximately 100 mi south of the Arctic Circle. It includes the Fairbanks metropolitan area (population 45, 864 in 1970), the second largest city in the State, and the principal trade center of the interior. Fairbanks is strategically located with respect to the highway and railroad net of Alaska and is one of the main hubs for air travel. Fort Wainwright is adjacent to Fairbanks on the east, and the University of Alaska is 3 mi to the west.

PHYSICAL SETTING

Physiography

Fairbanks is on the north side of the broad Tanana River Valley near the base of the hills that constitute part of the Yukon-Tanana Upland, a northwest-trending highland between the Yukon and Tanana Rivers. Most of the Fairbanks D–1 SW quadrangle lies within the Tanana River flood plain at an altitude of 460 ft, and the rest is part of the upland. The Yukon-Tanana Upland is within a larger area of rolling country in central Alaska between the Brooks and Alaska Ranges. It is a maturely dissected area of accordant, rounded ridges 2,000 to 3,000 ft in altitude; scattered discontinuous groups of higher mountains project above the upland ridges to altitudes of 5,000 to 6,000 ft. In the Fairbanks D–1 SW quadrangle, however, the upland consists only of several small hills protruding from the flood plain.

South of the Yukon-Tanana Upland lies the wide Tanana lowland, a sediment-filled trough between the upland on the north and the towering Alaska Range on the south. Huge alluvial fans extend northward from the mountains, forcing the Tanana River to flow along the north edge of the lowland.

Central Alaska has not been glaciated except in small local mountain masses, but glaciers from the Brooks Range on the north, the Alaska Range on the south, and the Yukon Plateau on the east almost surrounded the interior of Alaska during times of glacial maxima. Glaciers from the Alaska Range probably approached within 50 mi of Fairbanks, and during these glacial advances, the heavily loaded rivers deposited several hundred feet of silt, sand, and gravel in the Tanana and Yukon valleys. Aggradation of the trunk valleys raised base level and caused tributaries from the unglaciated Yukon-Tanana Upland to aggrade their valleys. As much as 300 ft of sediment was deposited in creek valleys of the upland in the vicinity of Fairbanks. Loess, ranging in thickness from a few feet on ridge and hilltops to 200 ft on middle slopes, blankets ridges of the upland.

GEOLOGIC HISTORY

The oldest rock units exposed in the Fairbanks D–1 SW quadrangle are the metamorphic rocks of the Yukon-Tanana complex (King, 1969), which were formerly included within the Birch Creek Schist (Mertie, 1937). The metamorphic terrane is composed primarily of dark-gray slaty slightly micaceous pyritic metasiltstone and quartzite, and dark-gray to silvery-light-gray pelitic schist, with subordinate calc-phyllite and calc-mica schist of the lower greenschist facies. A small exposure of calcareous schist of the lower greenschist facies is present on the east end of Browns Hill, but the major part of this hill, the adjoining part of Lakloey Hill, and Millers Bluff are underlain by basalt.

Although the schists were formerly believed to be of Precambrian age, recent potassium-argon age determinations have shown that they were recrystallized in Jurassic time. Discordant $^{40}K/^{40}Ar$ biotite and hornblende ages indicate that a subsequent thermal disturbance occurred in the Cretaceous and was associated with an episode of granitic plutonism that ranged from Cretaceous to early Tertiary. Lode-gold mineralization is related to the emplacement of small granodiorite and quartz monzonite plutons in the Fairbanks gold belt at that time.

Although the Tertiary record in interior Alaska is imperfectly known, it is believed that continental Tertiary sediments and local lava flows once covered much of the Yukon-Tanana Upland. After orogenic movements, erosion removed most of these sediments from the upland during later Tertiary time. Only small outcrops of continental Tertiary rocks, including basalt flows and breccias, are known to occur in the Fairbanks area.

The basalt was deposited on an erosional surface on schist. The basalt sequence contains both subaerial and submarine flows, and the submarine flows are characterized by pillow structure and breccia with a palagonite matrix. The basalt is medium gray to grayish black and weathers to moderate brown. Chemical analyses show that the basalt is transitional between olivine tholeiite and olivine alkali basalt.

Despite a whole-rock $^{40}K/^{40}Ar$ age determination of 80±2 m.y. on glass-rich basalt from Birch Hill (R. B. Forbes and J. C. Engels, unpub. data), the basalt is considered Tertiary by the writers. The basalt still caps and protects hills that would not be so preserved if they were Cretaceous or older. Mertie (1937) considered the basalt to be late Tertiary. In the basalt on Birch and Lakloey Hills, Péwé discovered silicified coniferous wood that was identified as related to *Metasequoia*, *Sequoia*, or *Taxodium* (R. W. Brown, U.S. Geol. Survey, written commun., 1958), indicating that the basalt is early or middle Tertiary in age. MacNeil, Wolfe, Miller, and Hopkins (1961) listed the basalt as early Tertiary.

A complex series of events took place in late Cenozoic time. The deposits show a record of alternating deposition and erosion of silt and gravel, the formation and destruction of permafrost, and climatic fluctuations ranging from a warmer climate than exists now to one colder than the present. In Pliocene and Pleistocene time, gold placers were formed in creek valleys of the upland; later, much gravel alluviation occurred in these valleys. These gold and gravel deposits were named the Cripple Gravel (Péwé, 1975b). This early period of gravel deposition was followed by erosion and removal ofmost of the coarse angular local gravel. Streams reconcentrated much of the gold from the earlier placer deposits and deposited additional gold placers. Most of the stream channels of the second gold concentration are offset from the location of the earlier channels, and some of the first accumulations still exist as fragmentary bench deposits. The deposits from the second cycle of gravel alluviation were named the Fox Gravel by Péwé (1975b). The Cripple and the Fox Gravels represent deposits formed during a period of rigorous climate in Pliocene and Pleistocene time. Solifluction deposits on hillsides and accumulation of stream-washed solifluction debris in valley bottoms were produced in glacial times. The Cripple and Fox Gravels are valley-bottom accumulations of solifluction materials. Stream action has carried the debris short distances and winnowed out some of the fine fractions. The widespread inactive solifluction layer that exists on almost all lower slopes in unglaciated central Alaska, termed the Tanana Formation by Péwé (1975b), grades into the Fox Gravel in valley bottoms.

In later Quaternary time the hills were blanketed with loess (windblown silt) derived from flood plains of the Tanana River and glacial outwash plains south of the Fairbanks D–1 SW quadrangle. Much of the loess was retransported to valley bottoms, incorporated with much organic debris, including vertebrate remains, and became perennially frozen. This early accumulation of silt occurred in Illinoian time. Much of the loess and most of the valley-bottom silt were removed during Sangamon time. It is thought that permafrost thawed and perhaps disappeared during this warm interval. The loess of Illinoian age that lies on lower valley-bottom slopes is the Gold Hill Loess, and the deposit that is undifferentiated from younger loesses on upper hill slopes and hilltops is the Fairbanks Loess (Péwé, 1975b).

In Wisconsinan time more loess was deposited on the hills and valleys of the uplands; organic silt accumulated in valley bottoms and became frozen, and large ground-ice masses formed. Abundant mammal remains, including partial carcasses, became entombed in the frozen organic silt. The valley-bottom facies of Wisconsinan silt was named the Goldstream Formation (Péwé, 1975b). About 10,000 years ago a slight warming of the climate caused a small amount of permafrost to thaw. At this time the taiga forest returned to central Alaska and replaced a mainly tundra environment that was the home of many now-extinct Pleistocene mammals. In the last 10,000 years additional loess was deposited on the hillsides, and organic silt was formed in the valley bottoms. The organic valley-bottom silt of retransported Holocene loess has been called the Ready Bullion Formation, and the uphill facies on middle slopes, the Engineer Loess. On hilltops, Holocene loess has been included in the Fairbanks Loess. After the warming trend of 10,000 years ago, the climate has not become cold enough to permit reactivation or continued growth of the now-dormant buried ice wedges that grew in Wisconsinan time.

During Quaternary time, probably mainly from Illinoian to the present, the sedimentary fill of the Tanana Valley was modified by alternating periods of erosion and deposition with the formation and destruction of permafrost. This sedimentary fill was named the Chena Alluvium (Péwé, 1975b); information is not available, however, to permit reconstruction of a detailed history.

ENVIRONMENTAL GEOLOGY

To provide a background for people concerned with the land, basic data from this geologic map have been recast into other maps that present information concerning foundation problems, flooding, land subsidence, problems with frozen ground, excavation problems, availability of ground water, depth to the water table, and general land-use information.

A companion map (MF-671–A, Péwé and Bell, 1975a) outlines frozen-ground conditions in the quadrangle to assist land users in evaluating problems that may arise in developing the land.

Information on foundation problems in certain land areas is presented in companion map MF-671–D (Péwé and Bell, 1975d): in map MF-671–C (Péwé and Bell, 1975c), location and possible uses of various geologic construction materials such as sand and gravel, riprap, peat, and other natural materials are outlined.

At the present time all domestic and industrial sources for water are from ground water in the area. Map MF-671–B (Péwé and Bell, 1975b) outlines the availability and quality of ground water in the quadrangle in three major areas—the flood plain, the creek valley bottoms, and the middle slopes and hilltops. Depth to the water table is also presented.

SELECTED REFERENCES

Bramhall, E. H., 1938, The central Alaska earthquake of July 22, 1937: Seismol. Soc. America Bull., v. 28, p. 71–75.

Burton, Wayne, 1971, Alaska's agriculture, an analysis of developmental problems, Fairbanks, Alaska: Alaska Univ.,Social,Economic, and Government Research Inst., Rept. No. 30.

Chapman, R. M., and Foster, H. L., 1969, Lode mines and prospects in the Fairbanks district, Alaska: U.S. Geol. Survey Prof. Paper 625–D, 25 p.

Furst, G. A., 1968, Geology and petrology of the Fairbanks basalts, Fairbanks, Alaska: Univ. of Alaska, unpub. M. S. thesis, 53 p.

Gasser, G. W., 1946, The Tanana Valley: Alaska Development Board, 29 p.

Hill, J. M., 1933, Lode deposits of the Fairbanks district, Alaska: U.S. Geol. Survey Bull. 849–B, p. 29–163.

Jordan, J. N., and others, 1968, The Fairbanks, Alaska, earthquakes of June 21, 1967: Washington, U.S. Dept. Commerce, Environmental Science Services Admin., 60 p.

King, Philip B., 1969, Tectonic map of North America (1:5,000,000): U.S. Geol. Survey Map.

McDonald, G. A., and Katsura, T., 1964, Chemical composition of Hawaiian lavas: Jour. Petrology, v. 5, p. 82–133.

MacNeil, F. S., Wolfe, J. A., Miller, D. J., and Hopkins, D. M., 1961, Correlation of Tertiary formations of Alaska: Am. Assoc. Petroleum Geologists Bull., v. 45, no. 11, p. 1801–1809.

Mertie, J. B., Jr., 1937, The Yukon-Tanana region, Alaska: U.S. Geol. Survey Bull. 872, 276 p.

Muller, S. W., 1945, Permafrost or permanently frozen ground and related engineering problems: U.S. Engineers Off., Strategic Eng. Study Spec. Rept. 62, 2d ed., also lithoprinted by Edwards Brothers, Ann Arbor, Mich., 1947, 231 p.

Péwé, T. L., 1952, Preliminary report on the late Quaternary history of the Fairbanks area, Alaska: Geol. Soc. America Bull., v. 63, p. 1289–1290.

_____ 1954, Effect of permafrost on cultivated fields, Fairbanks area, Alaska: U.S. Geol. Survey Bull 989–F, p. 315–351.

_____ 1955a, Origin of the upland silt near Fairbanks, Alaska: Geol. Soc. America Bull., v. 66, p. 699–724.

_____ 1955b, Basalt near Fairbanks, Alaska: Geol. Soc. America Bull., v. 66, p. 1708.

_____ 1958, Geologic map of the Fairbanks D–2 quadrangle, Alaska: U.S. Geol. Survey Geol. Quad. Map GQ–110, scale 1:63,360.

_____ 1966, Permafrost and its effect on life in the north: Corvallis, Ore., Oregon State Univ. Press, 40 p.

_____ 1975a, Quaternary geology of Alaska: U.S. Geol. Survey Prof. Paper 835, 145 p.

_____ 1975b, Quaternary stratigraphic nomenclature in unglaciated central Alaska: U.S. Geol. Survey Prof. Paper 862, 32 p.

Péwé, T. L., and Bell, J. W., 1975a, Map showing distribution of permafrost in the Fairbanks D–1 SW quadrangle, Alaska: U.S. Geol. Survey Misc. Field Studies Map MF–671–A, scale 1:24,000.

_____ 1975b, Map showing ground-water conditions in the Fairbanks D–1 SW quadrangle, Alaska: U.S. Geol. Survey Misc. Field Studies Map MF–671–B, scale 1:24,000.

_____ 1975c, Map showing construction materials in the Fairbanks D–1 SW quadrangle, Alaska: U.S. Geol. Survey Misc. Field Studies Map MF–671–C, scale 1:24,000.

_____ 1975d, Map showing foundation conditions in the Fairbanks D–1 SW quadrangle, Alaska: U.S. Geol. Survey Misc. Field Studies Map MF–671–D, scale 1:24,000.

Péwé, T. L., and Paige, R. A., 1963, Frost heaving of piles with an example from the Fairbanks area, Alaska: U.S. Geol. Survey Bull. 1111–I, p. 333–407.

Prindle, L. M., and Katz, F. J., 1913, Detailed description of the Fairbanks district, *in* Prindle, L. M., A geologic reconnaissance of the Fairbanks quadrangle, Alaska: U.S. Geol. Survey Bull. 525, p. 59–152.

St. Amand, Pierre, 1948, The central Alaska earthquake swarm of October 1947: Am. Geophys. Union Trans., v. 29, p. 613–623.

Williams, J. R., Péwé, T. L., and Paige, R. A., 1959, Geologic map of the Fairbanks D–1 quadrangle, Alaska: U.S. Geol. Survey Geol. Quad. Map GQ–124, scale 1:63,360.

For sale by Alaska Distribution Section, U.S. Geological Survey, 310 First Avenue, Fairbanks, AK 99701 and Branch of Distribution, U.S. Geological Survey Box 25286, Federal Center, Denver, CO 80225.

Interior—Geological Survey, Reston, Va.—1977 —G75318