UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

To Accompany

PRELIMINARY ENGINEERING GEOLOGIC MAPS OF THE PROPOSED NATURAL GAS PIPELINE ROUTE IN THE TANANA RIVER VALLEY, ALASKA

By

L. David Carter and John P. Galloway

OPEN-FILE REPORT 78-794

INTRODUCTION AND ACKNOWLEDGMENTS

The maps in this preliminary report were compiled primarily from published geologic maps as designated on sheets 1 and 2. Field studies carried out by the compilers in 1976, 1977, and 1978, however, resulted in redefining the position of certain contacts, particularly in the Big Delta quadrangle (map B). Additionally, certain map unit designations of the previously published maps have been changed in order to maintain uniformity throughout the area covered by the present maps. Age assignments of moraines are given informally as "older" or "younger" and differ in some cases on map D from those used on published maps. These differences reflect the opinions of the compilers. Quantitative data pertaining to the ages of moraines in this area have not yet been obtained.

Because the area covered by the maps is extensive, descriptions of the map units in the tabular text are necessarily general. The maps and text are not designed to replace the detailed studies necessary prior to the beginning of any kind of construction effort, but may be useful in the planning of those studies.

Access to unpublished reports, field data and geologic mapping was generously allowed by R. D. Reger of the Alaska Division of Geological and Geophysical Surveys, and by T. L. Péwé, F. R. Weber, J. R. Williams, and T. D. Hamilton. Discussions with the above named people were helpful in studying the distribution and characteristics of the unconsolidated deposits. H. L. Foster provided advice on the description and distribution of the rock units shown on the maps. Information on the type and characteristics of the rock at Paradise Hill, map E,

and general geologic information along parts of the Alaska Highway was provided by W. H. Slater, Hal Livingston, and Gary Brazo of the Alaska Department of Transportation and Public Facilities. M. P. Springer assisted in the field in 1977. The report benefited from reviews by O. J. Ferrians, Jr., and J. R. Williams.

QUATERNARY FAULTING AND SEISMICITY

The Tanana Valley near Fairbanks is a seismically active area that has undergone several moderate to severe earthquakes in the past 50 years. In 1937, an earthquake of magnitude 7.3 was centered near Salcha Bluff (map B) and severe shaking caused rockfalls on the Richardson Highway (Bramhall, 1938). In 1947 a magnitude 7 shock with its epicenter 90 km west of Salcha Bluff near Nenana was felt over a wide area (St. Amand, 1948). A 1967 earthquake swarm had magnitudes of as much as 5.6, and epicenters were only a few miles east of Fairbanks (Jordan and others, 1969). Seismic activity east of Fairbanks has persisted since 1967, and in February and March of 1977 an earthquake swarm occurred that consisted of several thousand earthquakes, the largest of which was magnitude 4.1 (Estes and others, 1977); at least 17 of these shocks were feld by residents.

An analysis of the distribution of epicenters of the 1977 earthquake swarm (Estes and others, 1977) shows that they are concentrated in a linear trend that extends from the west side of the Hopper Creek-Steele Creek divide southward to a point at least a mile south of the Chena River (map A), where a large cluster of epicenters is plotted. The cluster centers on the route of the proposed gas pipeline. This area has undergone severe shaking, and mud and sand boils were noted in the alluvium in earlier earthquakes. Plots of hypocenters of the 1977 earthquakes led Estes and others (1977) to speculate that the seismic events occurred along the intersection of two faults, one trending NE-SW and the other trending NW-SE.

In spite of this historic record of seismic activity, faults displacing unconsolidated depoists have not yet been recognized in the mapped area west of the Delta River. This is perhaps because dense vegetation and inaccessibility of the terrain combine to make fault recognition difficult, even in on-site investigations. In the Salcha River valley (map B), however, several linear features of uncertain origin, but possibly caused by faulting, have been mapped. These consist of aligned drainage systems and a linear ridge in the undifferentiated silt (Qsu). A pingo along the southernmost and longest of these features suggests the presence of a ground water barrier. Because the epicenter of the 1937 earthquake of magnitude 7.3 was located near Salcha Bluff, only 20 km west of these features, there is a strong possibility that these features are fault-controlled.

In the Big Delta area (map B) another linear feature has been noted that consists of treeless areas that are aligned with an escarpment that follows the south shore of Clearwater Lakes. Although a fault origin of this linear feature was suggested by Weber (1971), field investigations failed to reveal a topographic discontinuity nor any offset of stratigraphic units (J. R. Williams, personal communication, 1976). The linear feature is not, therefore, mapped as a fault because its fault origin cannot yet be demonstrated.

Seismic events such as those described for the Fairbanks-Salcha River vicinity have not been recorded in the remainder of the mapped area, and only one fault cutting unconsolidated deposits has been recognized (near Yerrick Creek, map D). However, this should not be construed as evidence that this region will not be subjected to severe seismic shaking or to faulting of unconsolidated deposits. Parts of the valley east of the Delta River are within 15 km of faults bounding the north flank of the Alaska Range that have been active within the past 20,000 years (Hudson and Weber, 1977), and within 40 to 70 km of the active strike-slip Denali and Totschunda fault systems that pass through the range. The results of an examination of the average rate of late Cenozoic displacement along the Denali and Totschunda fault systems suggests that a major earthquake could be overdue in eastern Alaska (Plafker and others, 1977). Earthquakes with magnitudes of as much as 8 can be expected along these faults with attendant seismic shaking and liquefaction in adjacent parts of the Tanana Valley.

SELECTED REFERENCES

Ager, T. A., 1972, Surficial geology and Quaternary history of the Healy Lake area, Alaska: University of Alaska unpublished Master's thesis, 127 p.

_____1975, Late Quaternary environmental history of the Tanana Valley, Alaska: Ohio State University, Institute of Polar Studies Report No. 54, 117 p.

Alaska Department of Highways, 1962a, Centerline soils investigation, Richardson Highway, Shaw Creek-Tanana River Station 4118+18 to Station 4577+72: Materials Division, Engineering Geology Section, Project No. F-062-3 (5).

_____1962b, Centerline soils and material sites report, Richardson Highway, Tanana River Crossing at Big Delta, "L" Station 4577+71.7 to Station 4651+11.1: Materials Division, Engineering Geology Section, Project No. F-062-3 (5).

_____1962c, Foundation study report, Little Salcha River, Richardson Highway, Eielson to Shaw Creek Bridge Number 350: Materials Division, Engineering Geology Section, Project No. F-062-4 (11).

_____1962d, Material site investigation, Shaw Creek-Tanana River: Materials Division, Engineering Geology Section, Project No. F-062-3 (5).

_____1962e, Materials site investigation, Rip Rap Source, Little Salcha River: Materials Division, Engineering Geology Section, Project No. F-062-4 (1).

_____1962f, Materials site investigation, Rip Rap Source, Munson Slough and Salcha River: Materials Division, Engineering Geology Section, Project No. F-062-4 (1).

Alaska Department of Highways, 1962g, Rip Rap investigation, Big Gerstle Bank Protection, Mile 1391.9, Alaska Highway: Materials Division, Engineering Geology Section, Project No. F-062-3 (8).

_____1963a, Materials report, Bitters Creek and vicinity, Milepost 1281, Alaska Highway: Materials Division, Engineering Geology Section.

_____1963b, Materials site investigation, Fairbanks Eielson, Section I: Materials Division, Engineering Geology Section, Project No. F-062-4 (13).

_____1963c, Supplementary materials report, Tanana River Crossing at Big Delta, Material Site No. 623-004-2: Materials Division, Engineering Geology Section, Project No. F-062-3 (5).

_____1964a, Drainage report, Salcha River Eielson-Silver Fox Richardson Highway: Materials Division, Engineering Geology Section, Project No. F-062-4 (11).

_____1964b, Materials investigation, Johnson River to M.P. 1386: Materials Division, Engineering Geology Section, Project No. F-062-3 (12).

_____1964c, Materials report, Canadian Border N.W.: Materials Division, Engineering Geology Section, Project No. F-062-1 (8).

_____1964d, Materials report, Eielson-Silver Fox, Fairbanks District Folder No. 1: Materials Division, Engineering Geology Section, Project No. F-062-4 (11).

_____1964e, Scottie Creek and Desper Creek Highway Crossing on the Alaska Highway: Materials Division, Engineering Geology Section, Project No. F-062-1 (8).

Alaska Department of Highways, 1964f, Supplemental report material sources, Eielson-Silver Fox: Materials Division, Engineering Geology Section, Project No. 062-4 (11).

_____1964g, Supplementary materials report, Tanana River Crossing at Big Delta, Material Site No. 623-086-2: Materials Division, Engineering Geology Section, Project No. F-062-3 (5).

_____1965, Supplemental report material sources, Eielson-Silver Fox Supplemental Report No. 2: Materials Division, Engineering Geology Section, Project No. F-062-4 (11).

_____1966a, Material site investigation, Rip Rap source Tanana Bank Protection Richardson Highway Mile 279.3 to Mile 277.7: Materials Division, Engineering Geology Section, Project No. F-062-3 (13).

_____1966b, Materials investigation, Richardson Highway, Silver Fox to Canyon Creek: Materials Division, Engineering Geology Section, Projection No. F-062-4 (11).

_____1967, Foundation report on the Shaw Creek Bridge, Bridge No. 533: Materials Division, Engineering Geology Section, Project No. F-062-3 (5).

_____1969a, Delta-Secondary-Remington Road: Materials Division, Engineering Geology Section, Project No. S-0711 (1).

_____1969b, Material site report supplemental no. 1, Johnson River M.P. 1386: Materials Division, Engineering Geology Section, Project No. F-062-3 (12).

_____1969c, Materials report, Jack Warren Road: Materials Division, Engineering Geology Section, Project No. S-077 (1).

Alaska Department of Highways, 1969d, Moose Creek Bridges, Bridge No. 857: Materials Division, Engineering Geology Section, Project No. F-062-4 (13).

_____1970, Materials site report, Supplement No. 1, Silver Fox to Canyon Creek: Materials Division, Engineering Geology Section, Project No. F-062-4 (11).

_____1971a, Engineering geology and soils report, Moose Creek-Boodox: Materials Division, Engineering Geology Section, Project No. F-062-4 (11).

_____1971b, Engineering geology and soils report, Silver Fox-Canyon Creek: Materials Division, Engineering Geology Section, Project No. F-062-4 (11).

_____1974, Engineering geology and soils report, Canyon Creek to Shaw Creek: Materials Division, Engineering Geology Section, Project No. F-062-4 (11).

_____1975, Materials site report, Northway Village to Northway Junction: Materials Division, Engineering Geology Section, Project No. S-079-1 (1).

_____1976a, Alaska Highway Realignment M.P. 1378 to 1376.5: Materials Division, Engineering Geology Section, Project No. HHS-062-2 (11).

_____1976b, Engineering geology and soils report, Alaska Highway realignment, M.P. 1378 to 1376.5: Materials Division, Engineering Geology Section, Project No. HHS-062-2 (11).

Alaska Division of Geological and Geophysical Surveys, 1973a, Aeromagnetic map, Mt. Hayes quadrangle, Alaska: Open-file report 10, 1 sheet, scale 1:250,000.

_____ 1973b, Aeromagnetic map, southeastern part of Fairbanks quadrangle, Alaska: Open-file report 8, 1 sheet, scale 1:250,000.

_____ 1973, Aeromagnetic map, Tanacross quadrangle, Alaska: Open-file report 11, 1 sheet, scale 1:250,000.

_____ 1975, Aeromagnetic map, Big Delta quadrangle, Alaska: Open-file report 73, 1 sheet, scale 1:250,000.

Albert, N. R. D., 1975, Interpretation of Earth Resources Technology Satellite imagery of the Nabesna quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-655-J, 2 sheets, scale 1:250,000.

Albert, N. R. D., and Steele, W. C., 1976, Interpretation of Landsat imagery of the Tanacross quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-767-C, 3 sheets, scale 1:250,000.

Anderson, G. S., 1970, Hydrologic reconnaissance of the Tanana basin, central Alaska: U.S. Geological Survey Hydrologic Investigations Atlas HA-319, 4 sheets.

Andreasen, G. E., Wahrhaftig, Clyde, and Zietz, Isidore, 1964, Aeromagnetic reconnaissance of the east-central Tanana Lowland, Alaska: U.S. Geological Survey Geophysical Investigations Map GP-447, 2 sheets, scale 1:250,000, 3 p.

Barnes, D. F., 1961, Gravity low at Minto Flats, Alaska, in Short papers in geologic and hydrologic sciences: U.S. Geological Survey Professional Paper 424-D, p. D254-257.

Barnes, D. F., and Morin, R. L., 1975, Gravity map of the Nabesna quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-655-I, 1 sheet, scale 1:250,000.

Blackwell, J. M., 1965, Surficial geology and geomorphology of the Harding Lake area, Big Delta quadrangle, Alaska: University of Alaska unpublished Master's thesis, 91 p.

Bramhall, E. H., 1938, The central Alaska earthquake of July 22, 1937: Bulletin of the Seismological Society of America, v. 28, p. 71-75.

Brogan, G. E., Cluff, L. S., Korringa, M. K., and Slemmons, D. B., 1975, Active faults of Alaska: Tectonophysics, v. 29, p. 73-85.

Capps, S. R., 1961a, An ancient volcanic eruption in the upper Yukon Basin: U.S. Geological Survey Professional Paper 95-D, p. 59-64.

_____1916b, The Chisana-White River district, Alaska: U.S. Geological Survey Bulletin 630, 130 p.

Carey, K. L., 1970, Icing occurrence, control and prevention - an annotated bibliography: U.S. Army Cold Regions Research and Engineering Laboratory Special Report 151, 59 p.

Cederstrom, D. J., 1963, Ground-water resources of the Fairbanks area, Alaska: U.S. Geological Survey Water-Supply Paper 1590, 84 p.

Childers, J. M., 1972, Channel erosion surveys along proposed TAPS route, Alaska, July, 1971: U.S. Geological Survey open-file report, 79 p.

_____1974, Flood surveys along TAPS route, Alaska: U.S. Geological Survey open-file report, 16 p.

Childers, J. M., and Meckel, J. P., 1967, Flood of August 1967 at Fairbanks, Alaska: U.S. Geological Survey Hydrologic Investigations Atlas HA-294, 1 sheet.

Childers, J. M., Meckel, J. P., and Anderson, G. S., 1972, Floods of August 1967 in east-central Alaska, with a section on weather features contributing to the floods, by E. D. Diemer: U.S. Geological Survey Water-Supply Paper 1880-A, p. A1-A77.

Church, R. E., Péwé, T. L., and Andresen, M. J., 1965, Origin and environmental significance of large scale polygonal ground near Big Delta, Alaska: U.S. Army Cold Regions Research and Engineering Laboratory Research Report No. 159.

Clark, E. F., and Simoni, O. W., 1976, A survey of road construction and maintenance problems in central Alaska: U.S. Army Cold Regions Research and Engineering Laboratory Special Report SR-76-8, 42 p.

Crory, F. E., 1975, Bridge foundations in permafrost areas, Moose and Spinach Creeks, Fairbanks, Alaska: U.S. Army Cold Regions Research and Engineering Laboratory Technical Report TR-266, 37 p.

Emmett, W. W., 1972, The hydraulic geometry of some Alaskan streams south of the Yukon River: U.S. Geological Survey open-file report no. 545, 102 p.

Emmett, W. W., Burrows, R. L., and Parks, Bruce, 1978, Sediment transport in the Tanana River in the vicinity of Fairbanks, Alaska, 1977: U.S. Geological Survey open-file Report 78-290, 28 p.

Estes, S., Huang, P., Gedney, L., and Biswas, N., 1977, The Fairbanks earthquake swarm of February and March, 1977: University of Alaska Geophysical Institute, Alaska Earthquake Analysis Center, Seismological Report No. 2, 11 p.

Federal Power Commission Staff, 1966, Alaska natural gas transportation systems final Environmental Impact Statement, Supplement, Alcan pipeline project: Washington, D.C., 226 p.

Fernald, A. T., 1962, Radiocarbon dates relating to a widespread volcanic ash deposit, eastern Alaska, in Short papers in geology, hydrology and topography, 1962: U.S. Geological Survey Professional Paper 450-B, p. B29-B30.

_____1965a, Glaciation in the Nabesna River area, upper Tanana River Valley, Alaska, in Geological Survey Research 1965: U.S. Geological Survey Professional Paper 525-C, p. C120-C123.

_____1965b, Recent history of the upper Tanana River lowland, Alaska, in Geological Survey Research 1965: U.S. Geological Survey Professional Paper 525-C, p. C124-C127.

Ferrians, O. J., Jr., 1966, Effects of the earthquake of March 27, 1964 in the Copper River Basin area, Alaska: U.S. Geological Survey Professional Paper 543-E, 28 p.

_____1969, Selected references on permafrost, and related engineering problems in Alaska: U.S. Geological Survey open-file report, 21 p.

Ferrians, O. J., Jr., Kachadoorian, Reuben, and Greene, G. W., 1969, Permafrost and related engineering problems in Alaska: U.S. Geological Survey Professional Paper 678, 37 p.

Feulner, A. J., 1960, Data on Wells at Ladd Air Force Base, Alaska: State of Alaska Department of Health and Welfare Hydrologic Data Report 13, 16 p.

Feulner, A. J., and Williams, J. R., 1962, Data on wells at Eielson AFB: Administrative report.

Foster, H. L., 1967, Geology of the Mount Fairplay area, Alaska: U.S. Geological Survey Bulletin 1241-B, p. B1-B18.

_____1970, Reconnaissance geologic map of the Tanacross quadrangle, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-593, 1 sheet, scale 1:250,000.

Foster, H. L., Albert, N. R. D., Barnes, D. F., Curtin, G. C., Griscom, Andrew, Singer, D. A., and Smith, J. G., 1976, The Alaska Mineral Resources Assessment Program; background information to accompany folio of geologic and mineral resource maps of the Tanacross quadrangle, Alaska: U.S. Geological Survey Circular 734, 23 p.

Foster, H. L., and Holmes, G. W., 1965, A large transitional rock glacier in the Johnson River area, Alaska Range, in Geological Survey Research 1965: U. S. Geological Survey Professional Paper 525-B, p. B112-B116.

Foster, H. L., and Keith, T. E. C., 1969, Geology along the Taylor Highway, Alaska: U.S. Geological Survey Bulletin 1281, 36 p.

Foster, H. L., Weber, F. R., Forbes, R. B., and Brabb, E. E., 1973, Regional geology of Yukon-Tanana Upland, Alaska, in Pitcher, M. G., ed., Arctic Geology: American Association of Petroleum Geologists Memoir 19, p. 388-395.

Furst, G. A., 1968, Geology and petrology of the Fairbanks basalts, Alaska: University of Alaska unpublished Master's thesis, 53 p.

Gedney, L., and Berg, E., 1969, The Fairbanks earthquakes of June 21, 1967; aftershock distribution, focal mechanisms, and crustal parameters: Bulletin of the Seismological Society of America, v. 59, p. 73-100.

Gedney, L., Shapiro, L., Van Warmer, D., and Weber, F., 1972, Correlation of epicenters with mapped faults, east-central Alaska 1968-1971: U.S. Geological Survey open-file report no. 535, 7 p.

Grantz, Arthur, 1966, Strike-slip faults in Alaska: U.S. Geological Survey open-file report no. 267, 82 p.

Griscom, Andrew, 1975, Aeromagnetic map and interpretation of the Nabesna quadrangle, Alaska: U. S. Geological Survey Miscellaneous Field Studies Map MF-655-H, 2 sheets, scale 1:250,000.

_____ 1976, Aeromagnetic map and interpretation of the Tanacross quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-767-A, 2 sheets, scale 1:250,000.

Hollick, Arthur, 1936, The Tertiary floras of Alaska, with a chapter on the geology of the Tertiary deposits, by P. S. Smith: U.S. Geological Survey Professional Paper 182, 185 p.

Holmes, G. W., 1965, Geologic reconnaissance along the Alaska Highway Delta River to Tok Junction, Alaska: U.S. Geological Survey Bulletin 1181-H, 19 p.

Holmes, G. W., and Benninghoff, W. S., 1957, Terrain study of the Army Test area, Fort Greely, Alaska: U.S. Geological Survey, Military Geology Branch, for U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Miss., 287 p.

Holmes, G. W., and Foster, H. L., 1968, Geology of the Johnson River area, Alaska: U.S. Geological Survey Bulletin 1249, 49 p.

Holmes, G. W., Hopkins, D. M., and Foster, H. L., 1968, Pingos in central Alaska: U.S. Geological Suryey Bulletin 1241-H, 40 p.

Holmes, G. W., and Péwé, T. L., 1965, Geologic map of the Mount Hayes (D-3) quadrangle, Alaska: U.S. Geological Survey Quadrangle Map GQ-366, 1 sheet, scale 1:63,360.

Hudson, Travis, Foster, H. L., and Weber, F. R., 1977, The Shaw Creek fault, east-central Alaska, in Blean, K. M., ed., The United States Geological Survey in Alaska; accomplishments during 1976: U.S. Geological Survey Circular 751-B, p. B33-B34.

Hudson, Travis, and Weber, F. R., 1977, The Donnelly Dome and Granite Mountain faults, south-central Alaska, in Blean, K. M., ed., The United States Geological Survey in Alaska; accomplishments during 1976: U.S. Geological Survey Circular 751-B, p. B64-B66.

Iroquois Research Institute, 1976, Geotechnical evaluation of the Alcan pipeline system in Alaska: report 1455-1, 292 p.

Jordan, J. N., Dunphy, G. J., and Harding, S. T., 1969, The Fairbanks, Alaska earthquakes of June 21, 1967, preliminary seismological report: U.S. Coast and Geodetic Survey, ESSA, 32 p.

Krinsley, D. B., Davies, W. E., Rachlin, Jack, and Newton, E. G., 1971, Existing environment of natural corridors from Prudhoe Bay, Alaska, to Edmonton, Canada: U.S. Geological Survey open-file report no. 502, 104 p.

Lamke, R. D., 1972, Floods in the summer of 1971 in south-central Alaska: U.S. Geological Survey open-file report no. 542, 88 p.

Lerbekmo, J. F., and Campbell, F. A., 1969, Distribution, composition, and source of the White River Ash, Yukon Territory: Canadian Journal of Earth Sciences, v. 6, no. 1, p. 109-116.

Lindholm, G. G., Thomas, L. A., Davidson, D. T., Handy, R. L., and Roy, C. J., 1957, Geologic and engineering properties of silts near Big Delta and Fairbanks, Alaska: Iowa State University of Science and Technology, Iowa Engineering Experiment Station Project 320-S, 113 p.

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

Moffit, F. H., 1936, Upper Copper and Tanana Rivers: U.S. Geological Survey Bulletin 868-C, p. 135-143.

______1938, Geology of the Slana-Tok district, Alaska: U.S. Geological Survey Bulletin 904, 54 p.

_____1941, Geology of the upper Tetling River district, Alaska: U.S. Geological Survey Bulletin 917-B, p. 115-157.

______1942, Geology of the Gerstle River district, Alaska, with a report on the Black Rapids Glacier: U.S. Geological Survey Bulletin 926-B, p. 107-160.

______1943, Geology of the Nutzotin Mountains, Alaska, with a section on the igneous rocks, by R. G. Wayland: U.S. Geological Survey Bulletin 933, p. 103-174.

______1954, Geology of the eastern part of the Alaska Range and adjacent area: U.S. Geological Survey Bulletin 989-D, 218 p.

Moffit, F. H., and Knopf, Adolph, 1910, Mineral resources of the Nabesna-White River district, Alaska, with a section on the Quaternary by S. R. Capps: U.S. Geological Survey Bulletin 417, 64 p.

Péwé, T. L., 1954, Effect of permafrost on cultivated fields, Fairbanks area, Alaska: U.S. Geological Survey Bulletin 989-F, p. 315-351.

_____1955a, Middle Tanana Valley, in Hopkins, D. M., and others, eds., Permafrost and ground water in Alaska: U.S. Geological Survey Professional Paper 264-F, p. 126-130.

_____1955b, Origin of the upland silt near Fairbanks, Alaska: Geological Society of America Bulletin, v. 66, p. 699-724.

_____1958, Geology of the Fairbanks (D-2) quadrangle, Alaska: U.S. Geological Survey Geologic Quadrangle Map GQ-110, 1 sheet, scale 1:63,360.

_____1961, Multiple glaciation in the headwaters area of the Delta River, central Alaska, in Geological Survey Research 1961: U.S. Geological Survey Professional Paper 424-D, p. D200-D201.

_____1965a, Fairbanks area, in Péwé, T. L., and others, eds., INQUA Field Conference F, central and south-central Alaska, Guidebook: Lincoln, Nebr., Nebraska Academy of Science, p. 6-36.

_____1965b, Middle Tanana River Valley, in Péwé, T. L., and others, eds., INQUA Field Conference F, central and south-central Alaska, Guidebook: Lincoln, Nebr., Nebraska Academy of Science, p. 36-54.

_____1975a, Map showing construction materials in the Fairbanks D-1 SW quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-671-A, scale 1:24,000.

Péwé, T. L., 1975b, Map showing construction materials in the Fairbanks D-2 NE quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-670-C, scale 1:24,000.

_____1975c, Map showing construction materials in the Fairbanks D-2 NW quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-668-C, scale 1:24,000.

_____1975d, Map showing construction materials in the Fairbanks D-2 SE quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-669-C, scale 1:24,000.

_____1975e, Map showing ground water conditions in the Fairbanks D-1 SW quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-671-B, scale 1:24,000.

_____1975f, Map showing foundation conditions in the Fairbanks D-1 SW quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-671-D, scale 1:24,000.

_____1975g, Map showing foundation conditions in the Fairbanks D-2 NE quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-670-D, scale 1:24,000.

_____1975h, Map showing foundation conditions in the Fairbanks D-2 NW quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-668-D, scale 1:24,000.

_____1975i, Map showing foundation conditions in the Fairbanks D-2 SE quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-669-D, scale 1:24,000.

Péwé, T. L., 1975j, Quaternary geology of Alaska: U.S. Geological Survey Professional Paper 835, 145 p.

_____1975k, Quaternary stratigraphic nomenclature in unglaciated central Alaska: U.S. Geological Survey Professional Paper 862, 32 p.

_____1976, Geologic map of the Fairbanks D-2 SW quadrangle, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-829-A, scale 1:24,000.

Péwé, T. L., and Bell, J. W., 1974, Map showing distribution of permafrost in the Fairbanks D-2 SW quadrangle, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Folio I-829-B, scale 1:24,000.

_____1975a, Map showing distribution of permafrost in the Fairbanks D-1 SW quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-671-A, scale 1:24,000.

_____1975b, Map showing distribution of permafrost in the Fairbanks D-2 NE quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-670-A, scale 1:24,000.

_____1975c, Map showing distribution of permafrost in the Fairbanks D-2 NW quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-668-A, scale 1:24,000.

_____1975d, Map showing distribution of permafrost in the Fairbanks D-2 SE quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-669-A, scale 1:24,000.

_____1975e, Map showing ground water conditions in the Fairbanks D-2 NE quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-670-B, scale 1:24,000.

Péwé, T. L., and Bell, J. W., 1975f, Map showing ground water conditions in the Fairbanks D-2 NW quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-668-B, scale 1:24,000.

_____1975g, Map showing ground water conditions in the Fairbanks D-2 SE quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-669-B, scale 1:24,000.

_____1976a, Geologic map of the Fairbanks D-1 SW quadrangle, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-949, scale 1:24,000.

_____1976b, Map showing construction materials in the Fairbanks D-2 SW quadrangle, Alaska: U.S. Geological Survey Miscellaneous Investigation Series Map I-829-D, scale 1:24,000.

_____1976c, Map showing foundation conditions in the Fairbanks D-2 SW quadrangle, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-829-E, scale 1:24,000.

_____1976d, Map showing ground water conditions in the Fairbanks D-2 SW quadrangle, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-829-C, scale 1:24,000.

Péwé, T. L., Bell, J. W., Forbes, R. B., and Weber, F. R., 1975, Geologic map of the Fairbanks D-2 NW quadrangle, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-907, scale 1:24,000.

Péwé, T. L., Church, R. E., and Andresen, M. J., 1969, Origin and paleoclimatic significance of large-scale patterned ground in the Donnelly Dome area, Alaska: Geological Society of America Special Paper 103, 87 p.

Péwé, T. L., and Holmes, G. W., 1964, Geology of the Mt. Hayes (D-4) quadrangle, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-394, 2 sheets, scale 1:63,360.

Péwé, T. L., and Paige, R. A., 1963, Frost heaving of piles with an example from Fairbanks, Alaska: U.S. Geological Survey Bulletin 1111-I, p. 333-407.

Péwé, T. L., and Rivard, N. R., 1961, Geologic map and section of the Fairbanks D-3 quadrangle, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-340, 1 sheet, scale 1:63,360.

Péwé, T. L., Wahrhaftig, Clyde, and Weber, F. R., 1966, Geologic map of the Fairbanks quadrangle, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-455, 1 sheet, scale 1:250,000, 5 p.

Plafker, George, Hudson, Travis, and Richter, D. H., 1977, Preliminary observations on late Cenozoic displacements along the Totschunda and Denali fault system, in Blean, K. M., ed., The United States Geological Survey in Alaska; accomplishments during 1976: U.S. Geological Survey Circular 751-B, p. B67-B69.

Post, Austin, and Mayo, L. R., 1971, Glacier dammed lakes and outburst floods in Alaska: U.S. Geological Survey Hydrologic Investigations Atlas HA-455.

Prindle, L. M., and Katz, F. J., 1913, Geology of the Fairbanks district, in Prindle, L. M., ed., A geologic reconnaissance of the Fairbanks quadrangle, Alaska: U.S. Geological Survey Bulletin 525, p. 59-152.

Rampton, Vern, 1971a, Late Pleistocene glaciations of the Snag-Klutlan area, Yukon Territory: Arctic, v. 24, p. 277-300.

Rampton, Vern, 1971b, Late Quaternary vegetational and climatic history of the Snag-Klutlan area, southwestern Yukon Territory, Canada: Geological Society of America Bulletin, v. 82, p. 959-978.

_____1972, Surficial deposits; Alaska Highway, Whitehorse to Alaska-Yukon boundary: Geological Survey of Canada Paper 72-1, part B, p. 119-122.

Richter, D. H., 1967, Geology of the upper Slana-Mentasta Pass area, southcentral Alaska: State of Alaska Department of Natural Resources, Division of Mines and Minerals Geologic Report 30, 25 p.

_____1975a, Geologic map of the Nabesna quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-655-A, 1 sheet, scale 1:250,000.

_____1975b, Geologic map of the Nabesna quadrangle, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-932, 1 sheet, scale 1:250,000.

Richter, D. H., Albert, N. R. D., Barnes, D. F., Griscom, Andrew, Marsh, S. P., and Singer, D. A., 1975, The Alaskan Mineral Resource Assessment Program; background information to accompany folio of geologic and mineral resource maps of the Nabesna quadrangle, Alaska: U.S. Geological Survey Circular 718, 11 p.

Richter, D. H., and Jones, D. L., 1973, Structure and stratigraphy of eastern Alaska Range, Alaska in Arrctic Geology: American Association of Petroleum Geologists Memoir 19, p. 408-420.

Richter, D. H., and Matson, N. A., Jr., 1971, Quaternary faulting in eastern Alaska: Geological Society of America Bulletin, v. 82, p. 1529-1540.

St. Amand, Pierre, 1948, The central Alaska earthquake swarm of October 1947: Transactions of the American Geophysical Union, v. 29, p. 613-623.

_____1957, Geological and geophysical synthesis of the tectonics of portions of British Columbia, the Yukon Territory, and Alaska: Geological Society of America Bulletin, v. 68, p. 1343-1370.

Sellmann, P. V., 1967, Geology of the USA CRREL permafrost tunnel, Fairbanks, Alaska: U.S. Army Material Command, Cold Region Research and Engineering Laboratory, Technical Report 199, 22p.

Sloan, C. E., Zenone, Chester, and Mayo, L. R., 1976, Icings along the trans-Alaska pipeline route: U.S. Geological Survey Prof-fessional Paper 979, 31 p.

Stout, J. H., Brady, J. B., Weber, Florence, and Page, R. A., 1973, Evidence for Quaternary movement on the McKinley strand of the Denali fault in the Delta River area, Alaska: Geological Society of America Bulletin, v. 84, p. 939-948.

U.S. Department of the Interior, 1972, Final Environmental Impact Statement proposed trans-Alaska pipeline: 6 volumes.

_____1976, Alaska natural gas transportation system final Environmental Impact Statement: Washington, Alternatives Volume, 822 p.

U.S. Geological Survey, Military Geology Branch, 1960, Terrain study of Delta River region, Alaska: U.S. Department of the Army, Office of the Chief of Engineers, Engineer Intelligence Study, no. 264, 30 p., 22 plates.

U.S. Geological Survey, Military Geology Branch, 1961, Terrain study for Exercise Great Bear: U.S. Department of the Army, Office of the Army, Office of the Chief of Engineers, Engineer Intelligence Study, no. 315, 31 maps, 1 plate (prepared by D. B. Krinsley, W. E. Davies, A. T. Fernald, H. L. Foster, and H. R. Schmoll).

_____1963, Terrain study of the Exercise Polar Siege area Yukon, Alaska: U.S. Department of the Army, Office of the Chief of Engineers, 39 plates.

_____1964, Terrain study of the Exercise Polar Strike area, Yukon-Tanana region, Alaska: U.S. Department of the Army, Office of the Chief of Engineers, 29 maps, 13 plates.

Wallace, R. E., 1946, Terrain analysis in the vicinity of Northway, Alaska, with special reference to permafrost: U.S. Geological Survey, Permafrost Program Progress Report No. 3, 34 p.

_____1948, Cave-in lakes in the Nabesna, Chisana, and Tanana River Valleys, eastern Alaska: Journal of Geology, v. 56, p. 171-181.

Waller, R. M., 1962, Data on wells and springs along the Richardson Highway (State 4), Alaska: State of Alaska Department of Health and Welfare Hydrologic Data Report 16, 30 p.

Waller, R. M., Feulner, A. J., and Tisdel, F. E., 1962, Ground-water movement in the Fort Greely area, Alaska (abs.), in Alaskan Scientific Conference, 12th, College, 1961, Proceedings: Science in Alaska, 1961, p. 133-134.

Waller, R. M., and Tolen, D. A., 1962, Data on wells along the Alaska Highway (State 2), Alsaska: State of Alaska Department of Health and Welfare Hydrologic Data Report 18, 26 p.

Weber, F. R., 1971a, Preliminary engineering geologic maps of the proposed trans-Alaska pipeline route, Fairbanks and Big Delta quadrangles: U.S. Geological Survey open-file map 488, 2 sheets, scale 1:250,000.

_____1971b, Preliminary engineering geologic maps of the proposed trans-Alaska pipeline route, Mt. Hayes quadrangle: U.S. Geological Survey open-file map 493, 2 sheets, scale 1:250,000.

Weber, F. R., Foster, H. L., Keith, T. E. C., and Cantelow, A. L., 1975, Reconnaissance geologic map of the Big Delta A-1 and B-1 quadrangles, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-676, scale 1:63,360.

Williams, J. R., 1959, Geology of the western part of the Big Delta (D-6) quadrangle, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-297, 1 sheet, scale 1:63,360.

_____1965, Ground water in permafrost regions - an annotated bibliography: U.S. Geological Survey Water-Supply Paper 1792, 294 p.

_____1970, Ground water in the permafrost regions of Alaska: U.S. Geological Survey Professional Paper 696, 83 p.

Williams, J. R., Péwé, T. L., and Paige, R. A., 1959, Geology of the Fairbanks (D-1) quadrangle, Alaska: U.S. Geological Survey Quadrangle Map GQ-124, 1 sheet, scale 1:63,360.

Wright, H. E., Jr., 1953, Glacial history of the Mentasta Mountains, southeastern Alaska Range (abs.): Geological Society of America Bulletin, v. 64, no. 12, part 2, p. 1495.