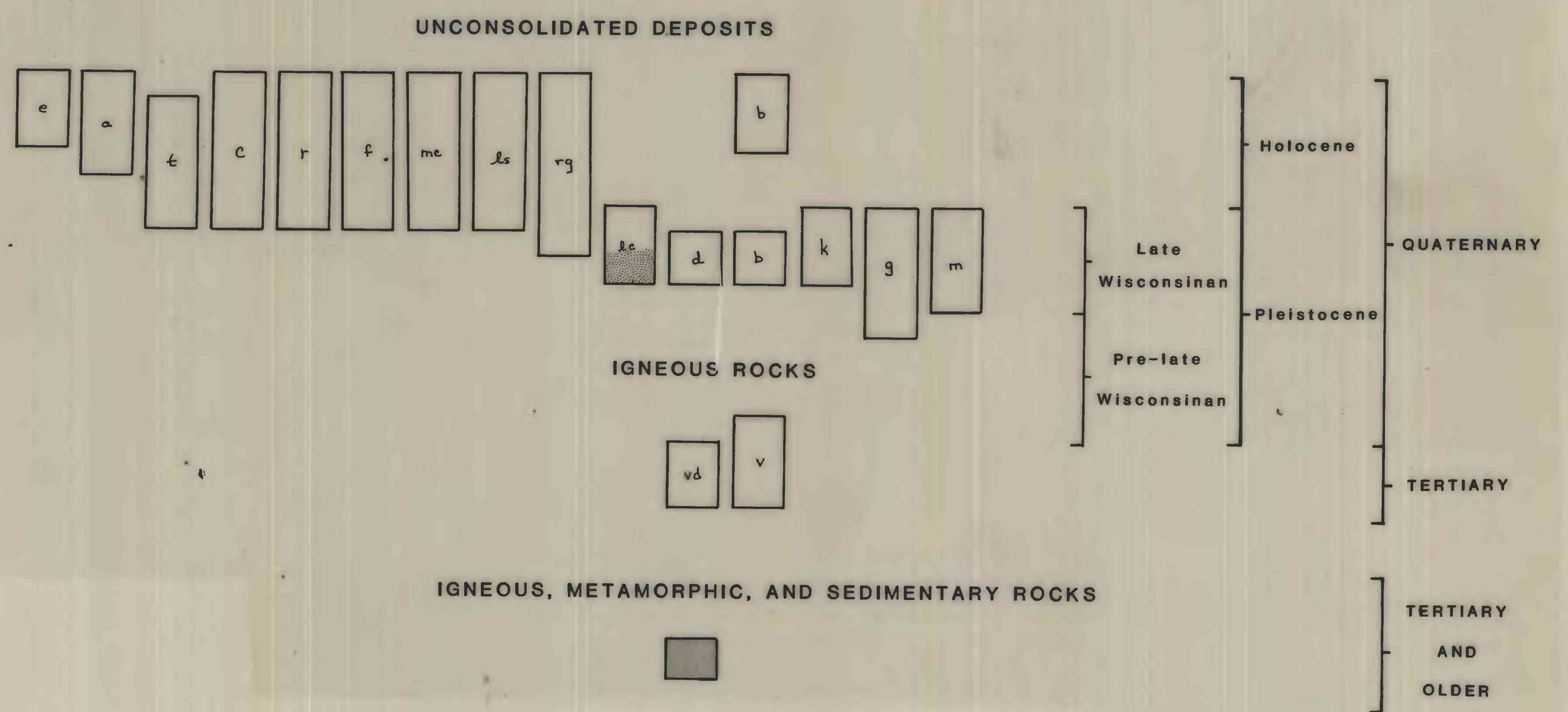
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

OPEN-FILE REPORT
80-892-C
SHEET 1 OF 2

BASE FROM U.S. GEOLOGICAL SURVEY, 1960

CORRELATION OF MAP UNITS



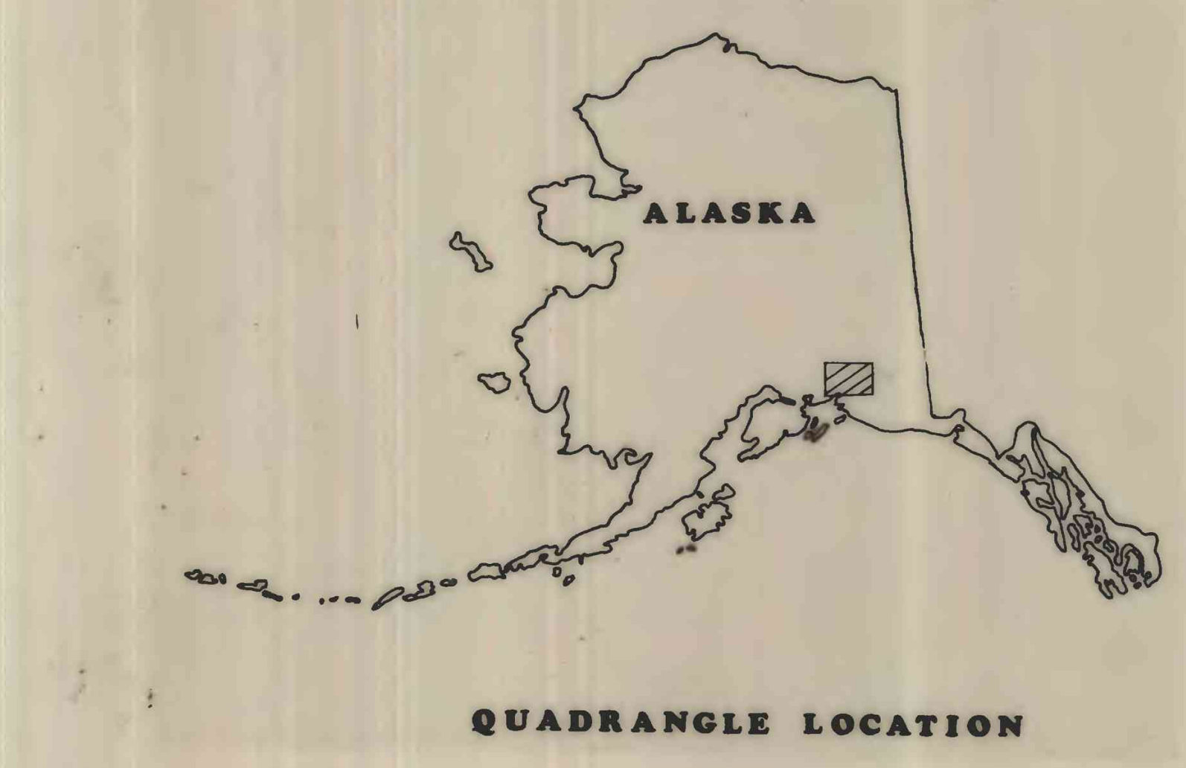
EXPLANATION

—?-?— **Contact, approximately located; queried where uncertain**

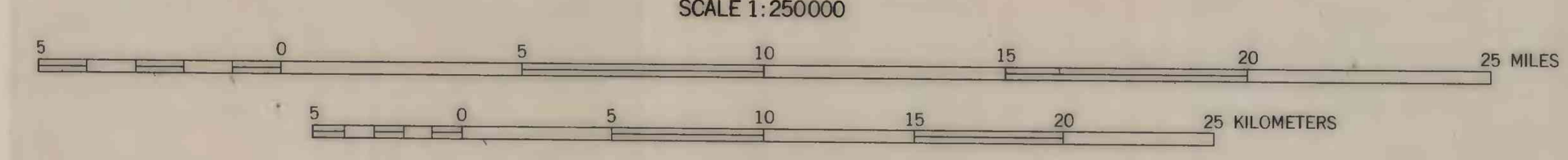
▼▼▼▼▼ **Prominent beach lines**

▨ **Bedrock (Tertiary and older)**

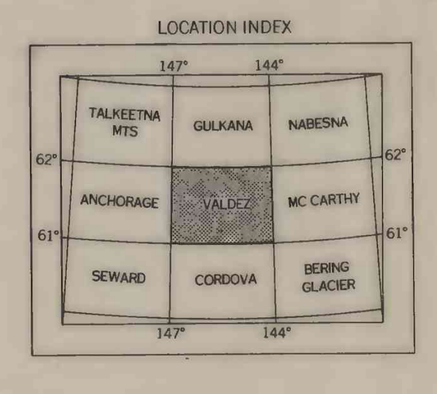
■ **Glacier ice**



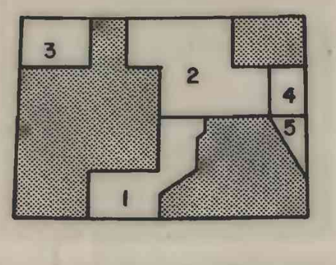
QUADRANGLE LOCATION



CONTOUR INTERVAL 200 FEET
DATUM IS MEAN SEA LEVEL



MAP OF LATE TERTIARY AND QUATERNARY DEPOSITS



INDEX TO MAPPING

1. **Coulter and Coulter (1961, 1962)**
2. **Nichols and Yehle (1969)**
3. **Williams, J. R., unpublished field notes and maps (1952-57)**
4. **Yehle (1980)**
5. **Yehle, L. A., unpublished field notes and maps (1960-66)**

Shaded area: J. R. Williams, assisted by K. M. Johnson, 1978; K. M. Johnson, assisted by C. L. Connor, 1979

This map is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

MAP AND DESCRIPTION OF LATE TERTIARY AND QUATERNARY DEPOSITS, VALDEZ QUADRANGLE, ALASKA

COMPILED BY

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1980

GEOLOGIC SUMMARY

This map and accompanying table show the distribution and character of surficial deposits of the Valdez quadrangle, including the flows and volcaniclastic debris flows of the Wrangell Lava. As part of the folio of maps prepared for the Alaska Mineral Resource Assessment Program this report provides information needed for development of the mineral resources, including sand and gravel, and describes foundation conditions for access roads and structures, availability of granular material for borrow, slope stability, and extent of permafrost.

The Valdez quadrangle in south-central Alaska includes parts of two transportation corridors through the Chugach Mountains between the ice-free coastal ports of Valdez and Cordova and the interior. The main corridor, from Valdez northward via Thompson Pass to the Copper River basin, is followed by the Richardson Highway and the Trans-Alaska Pipeline. The other corridor, through the Copper River canyon, was used to haul copper ore from the Kennicott-McCarthy area to Cordova via Chitina. Recently the route has been proposed as a state highway to connect Cordova to the existing highway system at Chitina. The abandoned Copper River and Northwestern Railroad right-of-way from Chitina eastward to McCarthy has been regraded for use as an access road to mines and prospects. The Edgerton Highway connects Chitina with the Richardson Highway at Willow Lake. An east-west route north of the Chugach Mountains, connecting Anchorage with the Richardson Highway at Glennallen, intersects the northwest corner of the quadrangle. A network of trails and short, unmaintained roads leads from these corridors to recreational sites, as at Klutina Lake, and to the many mineral prospects within the quadrangle.

The Valdez quadrangle includes part of the Chugach Mountains, the southern part of the Copper River basin, and the southwestern flank of Mount Wrangell. The Chugach Mountains border the Gulf of Alaska with a fiord-indented coastline that includes Port Valdez. Much of the southern and central parts of the moutains is covered by snowfields and glaciers, the distribution of which reflects a snowline that slopes southward toward the source of moisture-laden winds off the ocean. During late Wisconsinan time snowline also sloped southward but was 200-300 m lower (Péwé, 1975, fig. 9), and snowfields extended farther north, feeding valley glaciers in the northern Chugach Mountains that reached into the Copper River basin beyond the northern limits of the quadrangle. Some of the front ranges of the northern Chugach Mountains did not support local glaciers in late Wisconsinan time and were invaded by glaciers moving down the major valleys to form complex morainal systems and local glacial lakes, such as in the area between Hudson and St. Anne Lakes. Retreat of these glaciers beginning about 11,000-12,000 years ago (Ferrians and Nichols, 1965, p. 111) left a mosaic of glacial till, kame-esker deposits, alluvial fans, and talus cones, which have been cut by outwash channels and modern streams. Heads of the mountain valleys that supported local glaciers have complexes of end moraines and rock glaciers, the position of which depends on the extent to which the surrounding mountains intercepted local firn line during its post-late Wisconsinan rise. Before 8,000 years ago glaciers in most mountain valleys had retreated to positions near or headward of their present positions (Williams and Ferrians, 1961); many readvanced to form Holocene moraines within 1-3 km of present glacier termini. Late Wisconsinan glaciers filled Port Valdez, a fiord connected to Prince William Sound, to as much as 1,000 m above present sea level, but by 9,520 years ago the glaciers had retreated up-fiord from the new city of Valdez, and the fiord was invaded by the sea, at first 20 m below present sea level, but rising while the alluvial deposits from principal tributary streams formed fan deltas at the margin of the fiord (Williams and Coulter, 1980).

The late Wisconsinan glaciers filled the Copper River basin to an altitude of 1,150-1,310 m above sea level at the northern margin of the Valdez quadrangle and fronted in a glacial lake (Ferrians and Schmoll, 1957; Lake Atna of Nichols, 1965a). The lake persisted during retreat of the ice, as shown by lake sediments extending far into mountain valleys and by a locally prominent shoreline at about 750 m above sea level. Stability of this shoreline probably reflects the presence of a threshold to the north of the quadrangle while the waters were held in by a solid glacier dam along the Copper River in the Chugach Mountains. Retreat of the glaciers weakened the ice dam, and the lake drained southward through the Copper River canyon before 9,000 years ago (Ferrians and Nichols, 1965, p. 93, 111), or perhaps before 10,000 years ago. As the lake drained, many transitory shorelines (mapped by Nichols and Yehle, 1969) were formed. The only levels of stability are shown by strandlines at 700 m above sea level that are most prominent north of the quadrangle (Ferrians and Nichols, 1965, fig. 8-40) and by deltas on several tributaries to the Copper River at 457-488 m above sea level. After final drainage of the glacial lake through the Copper River canyon, the Copper River and its tributaries rapidly incised the former lake floor, exposing lacustrine, glacial, fluvial, and diamicton deposits of late Wisconsinan age and underlying deposits of the same types, indicating that similar sequences of events took place in earlier glacial episodes. Post-late Wisconsinan deposits include cliffhead dune, flood plain, terrace, and fan deposits.

Mount Wrangell, a 4,371-m-high shield volcano, is the only active volcano in the Wrangell Mountains. The summit caldera is about 6 km long, 4 km wide, and 1 km deep and includes three post-calderan craters that have active fumaroles (Benson and Motyka, 1979). The Geophysical Institute and other personnel of the University of Alaska have been studying glacier-volcano interaction on Mount Wrangell since 1953 (Benson and Motyka, 1979). The summit is covered by a large snowfield that supplies glaciers that flow or cascade into the upper ends of deep valleys cut through the flanks of the mountain. In late Wisconsinan time these valleys were filled with glaciers that flowed toward the northward-moving glacier in the Copper River basin. Lava flows and volcaniclastic debris flows from the volcano are interbedded with Quaternary unconsolidated deposits and are overlain by late Wisconsinan lacustrine and glacial deposits everywhere on the flanks of the moutain and in the adjacent Copper River basin. Volcaniclastic debris flow deposits are exposed as far west as the lower Tonsina River valley, as far south as Chitina, and southeast beyond the edge of the map in the Chitina River valley. The overlying lava flows are generally restricted to the area east of the Copper River between the Dadina and Kotsina River valleys (Yehle and Nichols, 1980). Despite statements that the age of one ash flow east of the Copper River is as young as 2,000 years (Benson and Motyka, 1979), or not much older than a near-surface radiocarbon-dated horizon above the ash flow (1,760 ± 200 years) (Miller and Smith, 1976), the cover of lacustrine and glacial deposits of late Wisconsinan or older age shows that volcanic activity within the Valdez quadrangle has been restricted to the Mt. Wrangell caldera since pre-late Wisconsinan time. Two potassium-argon dates at the southern end of the flow exposed along the Kotsina River (Yehle and Nichols, 1980) indicate an age of no older than 200,000 years.

Natural hazards in the Valdez quadrangle include both geologic and hydrologic hazards. The hydrologic hazards (Post and Mayo, 1971) are flooding by high runoff from snow melt and by glacier-outburst floods, flooding by icings in winter, and avalanches in the high mountains where snowfall is heavy. The geologic hazards include the effects of permafrost, earthquake risk, and volcanic activity.

Hydrologic hazards, including inundation by high water during the spring runoff and by summer and winter floods caused by glacier outbursts (the sudden release of water stored within or adjacent to glaciers), have damaged roads and bridges in the Valdez quadrangle. The most damaging floods have been outburst floods on Tazlina River, on the Chitina River from Kennicott Glacier, on Tsina River, and on Sheep Creek near Valdez (Post and Mayo, 1971). Winter icings on the Klutina River caused by blockage of streamflow by deep freezing during cold weather have inundated the village of Copper Center with ice and are common on the Copper River and some of its tributaries. Surging advances of glaciers, similar to that of Black Rapids Glacier toward the Richardson Highway in the Alaska Range in 1937 (Hance, 1937), have not been reported in the quadrangle, but are a possible hazard where the works of man are located close to the termini of glaciers. Avalanches are common on steep slopes under certain snow conditions, particularly in the central Chugach Mountains where snowfall is heavy.

Of the geologic hazards, the effect of permafrost is widespread north of the crest of the Chugach Mountains which forms the approximate boundary between the discontinuous-permafrost zone and the permafrost-free zone in the Valdez quadrangle. Permafrost is generally warmer than -1.0°C at Glennallen (Nichols, 1965b, p. 173) and -1.1°C at Bonanza Mine near Kennicott (Bateman and McLaughlin, 1920), north and east of the quadrangle respectively. Permafrost 9 km north of Glennallen is about 84 m thick (Williams, 1970), and that in the Bonanza Mine is 164-196 m thick (Bateman and McLaughlin, 1920). Wells and borings for the Trans-Alaska Pipeline within the quadrangle show that permafrost is common along the highway/pipeline corridor as far south as Mile 43 on the Richardson Highway in the Tsina River valley. From Mile 43 southward to Valdez no permafrost has been recorded in wells and borings, probably because of the heavy winter snow cover in Thompson Pass and in the Valdez area and a generally more marine and less continental temperature regime. Permafrost with temperatures near the freezing point is especially sensitive to thawing during construction activities. Observations and test holes within the quadrangle show that permafrost in fine-grained sediments, particularly the surficial glaciolacustrine silt and clay, is ice rich and is subject to differential settlement upon thawing if the permafrost thermal regime is disturbed. As a result, the Trans-Alaska Pipeline was elevated over most of these sensitive deposits. Although it is possible to define in a general way the distribution of permafrost, the available data do not suggest a correlation of permafrost thickness with map unit, other than to suggest that it is generally absent beneath medium to large lakes and beneath rivers and most of the flood plain alluvium bordering these rivers.

The earthquake risk in the Valdez quadrangle is high; ground-motion values for a Richter magnitude 8.5 earthquake were used to formulate design criteria for the Trans-Alaska Pipeline from Valdez to Willow Lake, and values for a Richter magnitude 7.0 earthquake were used from Willow Lake northward to the quadrangle boundary (Page and others, 1972, p. 2). These values are based on the Richter magnitude 8.3 earthquake of March 27, 1964, the epicenter of which was about 40 km west of the southwest corner of the quadrangle. During this earthquake the city of Valdez was destroyed by ground cracking, by sliding of the face of the deltaic part of the alluvial deposits bordering Port Valdez, and by slide-generated waves (Coulter and Migliaccio, 1966). Effects of the earthquake were less spectacular in the Copper River basin (Ferrians, 1966), but included numerous slumps of the lakeward (deltaic) portion of alluvial deposits bordering Klutina and Tazlina Lakes.

As noted above, the volcanic activity of Mount Wrangell within the quadrangle has been largely fumarolic since before late Wisconsinan time. Benson and Motyka (1979) report that there has been a major increase in heat flux at the summit in the past decade. The most likely hazards of a small eruption would be flooding and mud flows. Based on its past record, however, a large eruption could produce lava flows and debris flows extending to and perhaps beyond the Copper and Chitina Rivers and showers of volcanic ash that might, depending on wind direction at the time, extend over large areas of the quadrangle.

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