SUSITNA BASIN PLANNING BACKGROUND REPORT

Surficial Geology of the Susitna-Chulitna River Area, Alaska

Part I: Text

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prepared for

LAND AND RESOURCE PLANNING SECTION
DIVISION OF RESEARCH AND DEVELOPMENT
ALASKA DEPARTMENT OF NATURAL RESOURCES

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ABSTRACT

The landscape of the Susitna-Chulitna River Area of southcentral Alaska is interpreted in fourteen 1:125,000 scale maps of landform and geologic hazard. The landscape is dominated by glacial landforms from late Wisconsin Naptowne Glaciation. Locally, it is continuously being altered by modern active surface processes.

The area's landforms consist of drumlinized landforms including positive relief features composed of till and glaciofluvial deposits, and intervening poorly-drained lowlands often containing lakes, ponds, marshes, swamps and bogs. The extent of the glaciofluvial deposits suggest that water was prevalent beneath the glacier or flowed in troughs between till ridges beyond the glaci ? ice during its recession. Ice-disintegration features along the margins of the former glacier resulted from intermixing of till and meltwater stream deposits typically distorted by slumping. Landforms on the valley floor grade from disintegration features to drumlinized ridges, drumlins, fluted ground moraine and scoured bedrock to the north.

Modern active surface processes often alter the landscape catastrophically, and are called geologic hazards. Geologic hazards in the study area include flooding, surging glaciers, avalanches and landslides. Surfaces most affected by these hazards are floodplains, lowlands, and lower mountain slopes.

PREFACE

The Susitna-Chulitna area investigation was conducted for the Land and Resource Planning Section of the Alaska Department of Natural Resources (DNR). The study was jointly funded by NASA under grant NGL 02-001-092 and DNR, and was conducted by the Northern Remote Sensing Laboratory of the Geophysical Institute, University of Alaska. The investigation is intended to aid DNR in regional planning of relatively inaccessible areas based on interpretations of remote sensing data.

Map units were verified in the field in accessible portions of the study area. Verified map units were extrapolated to inaccessible areas based on similarity of landforms.

Seven landform maps were prepared at a scale of 1:125,000 and seven geologic hazard maps were prepared at the same scale. These are included in Part 2 of this report.

ACKNOWLEDGEMENTS

The author would like to thank Thomas H. George for his comments and especially during the field verification, many of the photographs in this report were taken by him; Dr. Richard D. Reger, John H. Miller and Albert E. Belon for reviewing this manuscript; Deborah C. Coccia for the many hours spent on drafting the maps and figures; and Karen Ruddell and Sheila Finch for repetitively typing the many revisions to this manuscript.

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INTRODUCTION

This study uses primarily Landsat imagery to interpret the landforms and geologic hazards of the Susitna-Chulitna region. The methods, geologic setting, and a discussion of the conclusions are included in this text, Part 1. The fourteen 1:125,000 scale maps of landforms and geologic hazards are contained in an accompanying packet, Part 2.

Landsat imagery provides a current synoptic view of the earth's surface which is effective in small scale mapping of landforms and active surface processes. Interpretations based on Landsat imagery are especially effective when used in conjuction with stereo aerial photography and ground verification.

Repetitive coverage of Landsat (presently every eighteen days at image nadir points) records seasonal fluctuation of the earth's surface under varying lighting conditions enhancing geologic phenomena. Active surficial phenomena, such as avalanches or landslides, and flooding by streams of lowlying areas are recorded by satellite passes during the spring. Also during the spring, the undeveloped vegetation canopy allows observation of the ground surface, provided the snow cover has been removed. The imagery recorded during the summer months exhibits minimal shadows, geobotanical indicators and relatively quiescent surficial processes. During the winter months, variations in surficial expressions are enhanced by the low sun angle (less than 9^0 in Alaska) and by the contrast between the snow cover and dormant vegetation which improves landform interpretations.

Active surface processes are often catastrophic. Hazardous areas should be avoided or special measures taken to mitigate the environmental risks during planning, or studied more closely.

PHYSICAL SETTING

The upper Susitna-Chulitna River area is located in southcentral Alaska approximately 90 km. north of Anchorage (Fig. 1). The study generally includes areas below the 610 m (2,000 ft) contour interval between latitude 62° 00'N and Colorado Station along the Alaskan Railroad. The surrounding mountains include the Alaska Range to the west and north, and the Talkeetna Mountains to the east. The mountains hinder the northward migration of storms coming off of the Pacific Ocean to the south, causing 74 cm. (29 inches)* of precipitation annually (Rieger, 1979) and is the largest amount of precipitation in the state excluding coastal areas.

Major rivers within the study area include the Susitna, Yentna, Kahilitna, Chulitna, Tokositna, and Talkeetna. The Susitna River, the dominant stream in the area, drains southward into Cook Inlet. Glaciers including the Dall, Yentna, Kahiltna, Kanikula, Tokositna, Ruth and Eldridge are located in the Alaska Range at the headwaters of rivers and several subordinate tributaries.

The landscape generally slopes south from 600 m to 60 m elevations. Numerous north-south trending lakes, swamps and low relief ridges occur on the valley floor. Deciduous and coniferous vegetation grow on the low-relief ridges. Most of the present topography has resulted from glacial, glaciofluvial and fluvial processes.

The region is sparsely populated with only one town and several unincorporated settlements (Fig. 1). Transportation routes include the

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*Measurements from the U.S. Weather Service station in Talkeetna, Alaska.

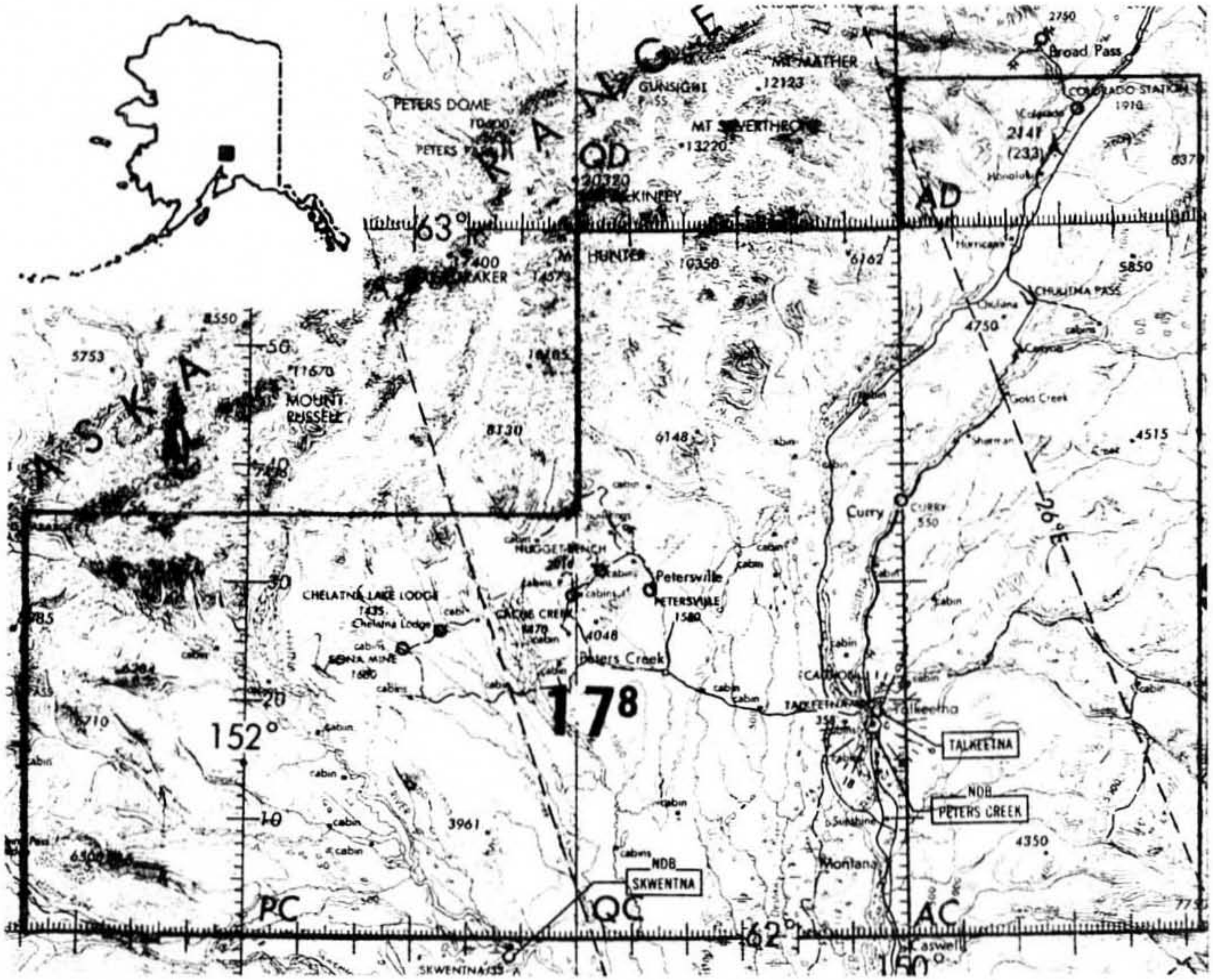

Figure 1. Location of the Susitna-Chulitna area.

Parks Highway and the Alaska Railroad to the east. A secondary road to Petersville traverses the central portion of the area. Some agricultural, timber harvesting, and mining enterprises are centered around Talkeetna, except for lode and placer mining which is concentrated northwest of Talkeetna near the Alaska Range, especially in the Cache Creek area. The minerals or elements being mined include molybdenum, copper, chromium, gold, uranium, platiunum, tin, coal and thorium (Reed and others, 1978).

SURFICIAL GEOLOGY

The surfacial geology of the Susitna-Chulitna River area has been dominated by glaciation. This area is a trough into which mountain glaciers and drainages from the surrounding Alaska Range, Talkeetna, Chugach, Kenai and Aleutian Mountains are funneled (Coulter and others, 1965).

At least six glacial advances have altered the landscape in the Cook Inlet basin. (Table 1)

Table 1. Glacial advances in the Cook Inlet Basin.

Glaciation	Age	Sources
Alaskan	200-4800 years ago[1]	(Nelson and Reed 1978)
Naptowne	6,000-30,000 years ago[1]	(Péwé 1975)
Knik	38,000-65,000[2] years ago	(Karlstrom, 1964)
Eklutna	25,000[1]-110,000[2] years ago	(Karlstrom, 1964)
Caribou Hills	began retreat 155,000-190,000[2] years ago,	(Karlstrom, 1964)
Mt. Susitna	pre-Illonian	(Karlstrom, 1964)

The Mt. Susitna glaciation is the oldest and most extensive glacial advance documented in the Cook Inlet basin by Karlstrom (1964) and Nelson and Reed (1978). Each successive glaciation was less extensive. The Mt. Susitna, Caribou Hills and Eklutna Glaciations completely filled the basin, but during the Knik and Naptowne Glaciations coalescing

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[1] Carbon-14 date

[2] Boulder count date (estimated)

glacial lobes in valleys did not completely fill the basin (Nelson and Reed, 1978). The Alaskan Glaciation was generally confined to narrow mountain valleys where end moraines were often deposited at the confluence with broader valleys.

The Susitna-Chulitna River area contains landforms which resulted from glacial, fluvial, lacustrine, periglacial and paludal processes. During Pleistocene glacial advances bedrock was scoured and debris was transported and deposited by the glaciers and streams. Most of the present topography on the valley floors resulted from the Eklutna, Naptowne, and Alaska glaciations (Nelson and Reed, 1978).

Throughout the Susitna-Chulitna area the Naptowne advance left low, elongated ridges of ice-molded glacial drift. Streams, flowing along and from margins of the glaciers, scoured channels into the drift and bedrock. Complex ice-disintegration terrain resulted from stagnant ice conditions along the east and west sides of the main valley (Fig. 1). The mouth of several valleys were blocked by glaciers, damming the drainages and creating glacier-dammed lakes. Evidence of these lakes are fluviolacustrine deposits in the valleys of Cache, Alder, Peters, Canyon, Granite and Dutch Creek (Nelson and Reed, 1978).

After recession of the glaciers, glacial drift, which covered the valley floors, trapped surface water in depressions or bedrock basins and forming elongated lakes or bogs. Many of these depressions have no obvious drainage outlets.

Streams reworked the drift on the valley floors during interglacial periods after the Naptowne Glaciation. Modern floodplains were established by incision of streams through glacial drift and Tertiary sedimentary rocks. Modern streams are generally braided near their headwaters and sediment laden. Broader floodplains possess oxbow lakes, meander scars, and backwash swamps.

Landforms and deposits, resulting from periglacial activity and mass movement, occur along the margins of broad valleys and on the floors of narrow valleys. These features include talus, landslide scars, avalanche chutes and deposits, and rock glaciers.

MATERIALS AND METHOD OF INVESTIGATION

The investigation utilized multidate Landsat imagery, color-infrared aerial photography, USGS topographic maps and aerial/ground verification procedures.

Each of the 1:250,000 scale USGS topographic maps were divided into seven sections and enlarged to a scale of 1:125,000. Each section covered an area equivalent to four adjacent 1:63,360 scale topographic quadrangles (Plates 1-14). The investigation resulted in the compilation of fourteen geologic maps of the area. Seven of the maps are of landforms (Plates 1-7) and seven of geologic hazards (Plates 8-14).

Landsat imagery, path 76, row 16, was used as both a map base and an interpretation medium (Table 2). Seasonal imagery at the scale of 1:250,000 was utilized throughout the study. A special color enhancement of a summer image was enlarged to a scale of 1:125,000.

Table 2. Landsat imagery used in the study.

Scene Number	Date	Comments
30537-20443	8/24/79	Color scene used for enlargements
1104-20565	11/4/72	B & W (Black and white)
30339-20460	2/7/79	B & W
1266-20572	4/15/73	B & W
2495-20332	5/31/76	Color
5793-19385	6/20/77	B & W
30483-20444	7/1/79	Color
2531-20322	7/6/76	B & W

NASA 1976 and 1977 aerial photography at the scale of 1:120,000 with foreward lap to support stereo viewing, was used in conjunction with the Landsat imagery throughout most of the investigation. The photography which has a higher resolution than the Landsat imagery, aided the identification of mapped features.

Aerial and ground verification was conducted late in the summer of 1979, utilizing both fixed-wing aircraft and a ground vehicle. The verification was conducted such that areas could be studied from both the air and ground (where possible) often during the same day.

DISCUSSION

Landforms

Landforms of the area were formed by glacial, fluvial and mass-movement processes (Plates 1-7). The glacial landforms are the dominant features.

Glacial Processes

The Naptowne Glaciation completely covered the valley floor as far as 40 km. south of the study area (Nelson and Reed, 1978). The resulting topography is dominated by drumlins* and drumlinized terrain on valley floors. Ice-disintegration features along margins of the valleys (Fig. 2 & 3) resulted from stagnant glacial ice and meltwater channels. Till has been formed into fluted ridges beneath the south flowing glacial ice forming drumlins, rock drumlins and scoured bedrock to the north (Fig. 3). These landforms are generally aligned along a north/south axis and grade into each other. The ridges are mostly till. Outwash sand and gravel do comprise some ridges but usually occur on the flanks of till ridges.

Drumlins and fluted till ridges are better drained than the surrounding lower landscape, providing a healthy environment for vegetation (Fig. 4).

The flat, low terrain is poorly drained and typically includes bogs, marshes and swamps. Poor drainage is a result of low a gradient and the impermeable till which blanket on the valley floor. Discontinuous permafrost is suspected in swampy areas.

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*Many of the drumlins" in the study area should possibly be called drumlinoids (term used by Prest, 1969, and others). They have the classic drumlin shape but very low relief. However, for simplicity the term "drumlin" will be used. There are a few distinctive drumlins (rock drumlins?) in the northern portion of the study area (Fig. 6)

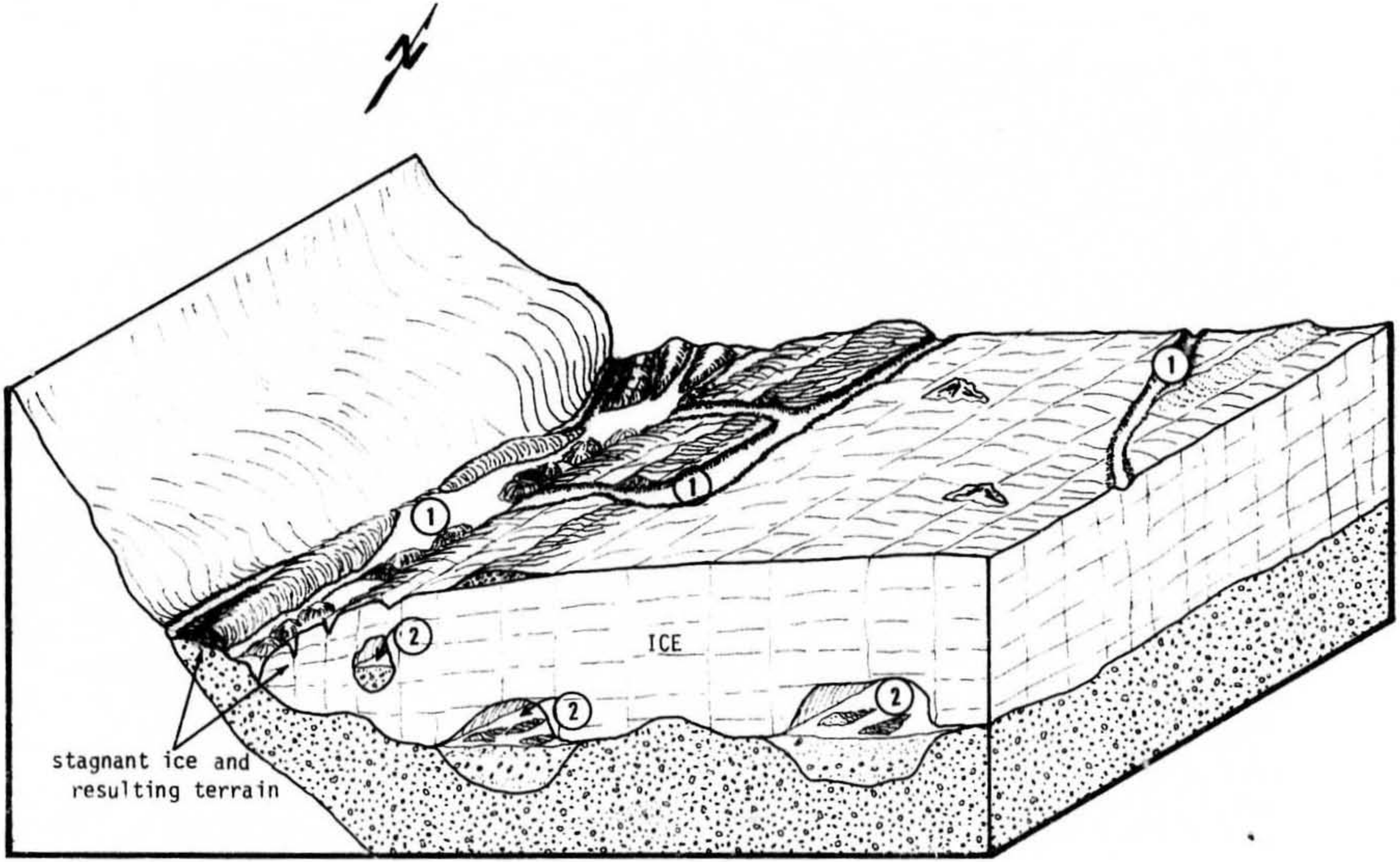

Figure 2 A line drawing of glacial ice in the Susitna Valley. Note the stagnant ice terrain and meltwater channels (1) along the western border of the glacier and subglacial-interglacial drainage channels (2).

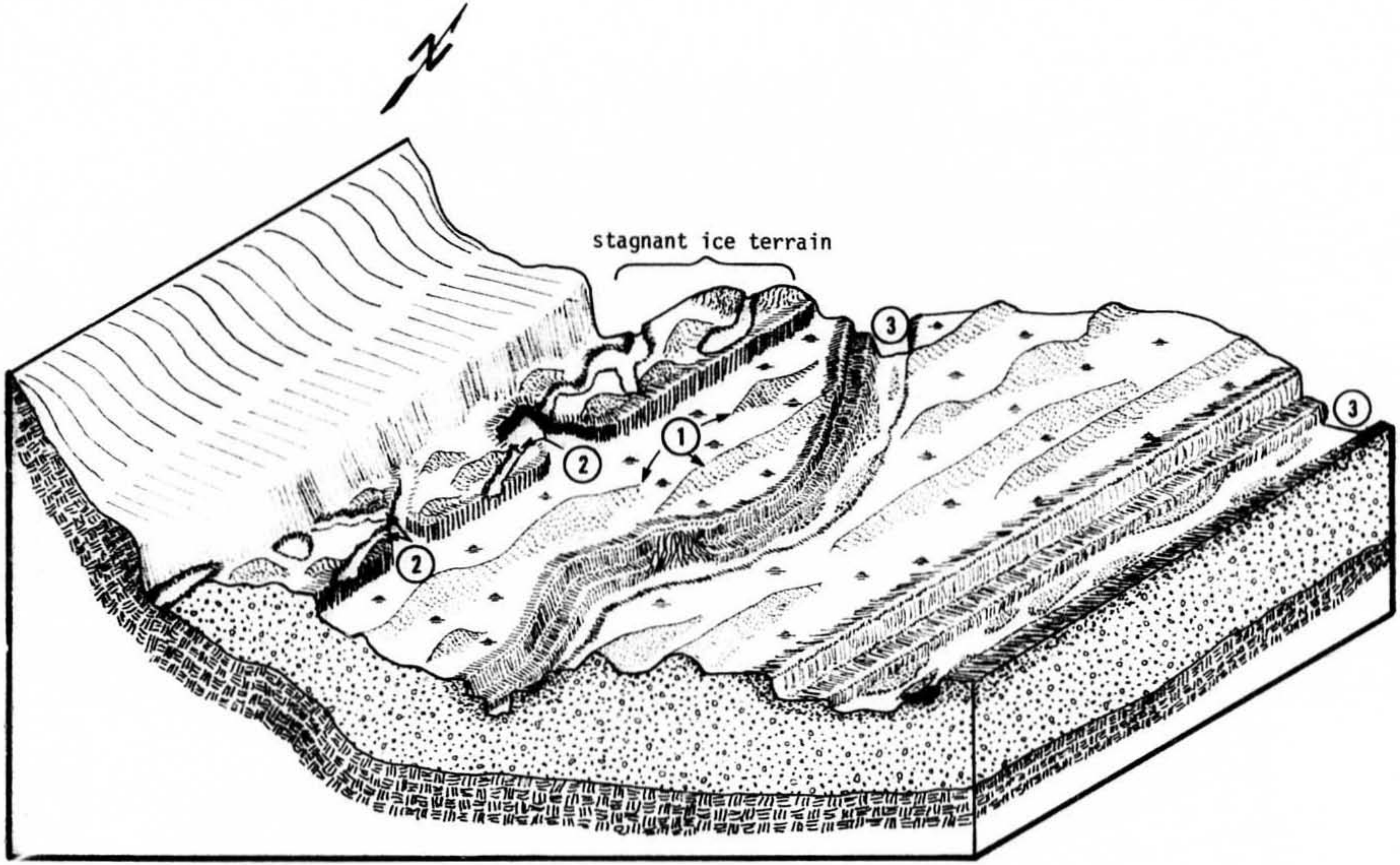

Figure 3 A line drawing of the landforms in the Susitna Valley after the recession of glacial ice. The drumlinized topography (1) with standing water in the intervening troughs, meltwater channels (2), stagnant ice terrain (at the base of the slope), incised stream (3) (remnant subglacial drainage channels), and floodplains are all evident in the valley.

Figure 4. View to the east across the Susitna Valley north of Talkeetna, well-drained drumlinized topography or fluted till ridges have trees growing on their surface, intervening areas have low vegetation and standing water. Photograph by T. George, 1979.

The Susitna-Chulitna Basin was divided into five physiographic zones (Fig. 5) based upon the geometry of the drumlins and fluted topography. The size of larger and more clearly defined drumlins and ridges were crudely measured (Table 3).

Table 3. Physical characteristics of drumlins and fluted topography.

Area (Fig. 5)	Length	Width	Height+	Dominant form
1a	<0.3 km	<100m	<50 ft.	drumlins
1b	1-2 km	<200m	<50 ft.	drumlins & fluted ridges
1c	<1 km	<200m	<50 ft.	drumlins
	several km	<200m	<50 ft.	fluted ridges
2	>6 km	<300m	<50 ft.	coalescing drumlins
3	1-1 1/2 km	1 km	<100 ft.	drumlins grading to rock drumlins and scoured bedrock
4a	<4 km	<700m	<50 ft.	coalescing drumlins
4b	<6 km	<300m	<50 ft.	fluted ridges
4c	1-3 km	<200m	<50 ft.	drumlins
5	No streamlined forms			

+Estimated

Zone 1 contains three sections (Fig. 5 and Table 3). Zone 1a is dominated by broad, flat, poorly-drained terrain with a few, small, discrete drumlins of low relief. To the north 1b, the landscape grades into terrain with more elongated low-relief drumlins and fluted topography. In the northern-most zone, 1c, drumlins coalesce into wider fluted ridges; the area of the poorly-drained terrain between ridges decreases substantially.

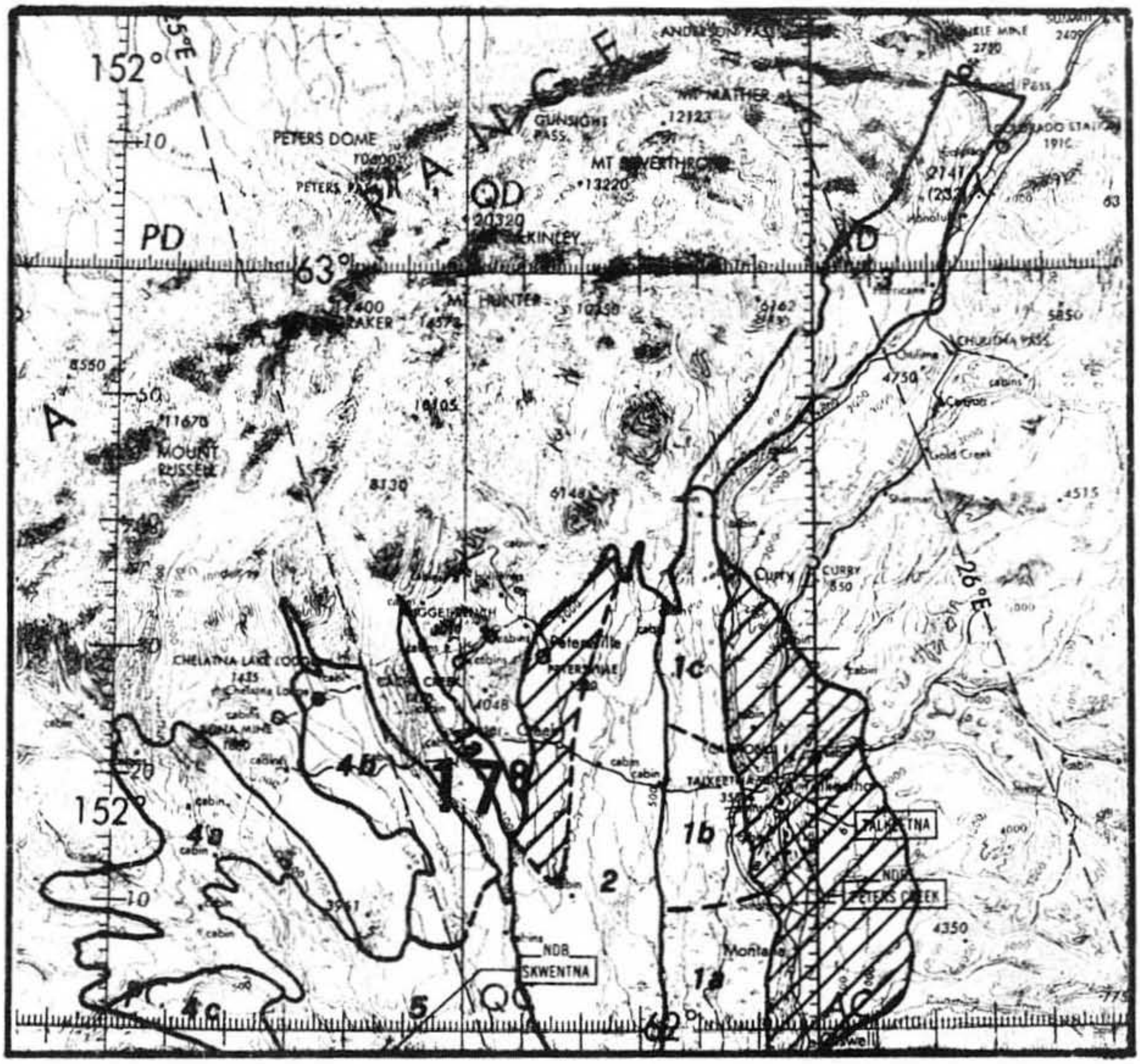

Figure 5. Physiographic divisions of the Susitna-Chulitna area, based on geometry of drumlins and fluted topography (see Table 3). Cross hatched areas are zones composed of ice disintegration features. Map base is 1:1,000,000 aeronautical charts. North is up.

Surface forms, glaciolfluvial deposits and deciduous vegetation extending thru zone 1 from Swan Lake south along Moore and Trapper Creeks indicates the presence of a former glacial-outwash channel (Plate 2). This channel is relatively low, has a gentle gradient and is locally bounded by scarps.

Zone 2 which lies west of zone 1 (Fig. 5) consists of fluted ridges and a relatively large number of coalescing drumlins. The shape and north/south alignment of the fluting are more irregular and likely result from the confluence of glaciers from the west with the main glacier in the Susitna Valley. In zone 2 poorly-drained terrain is less extensive than zone 1.

Zone 3 is situated north of zone 1 and 2 and closer to glacial-source areas (Fig. 5). Included in zone 3 are distinct drumlins, rock drumlins, and fluted topography (Fig. 6). Flat, poorly-drained terrain, has limited extent i this area, tends to be segmented, and is confined to narrow troughs.

Zone 4 is located along the western border of the study area in narrow mountain valleys and is subdivided into three sections; 4a, 4b and 4c (Fig. 5). The landscape has been overrun by tributary glaciers as well as the main glacier. The dominant landforms located on valley floors and mountain flanks are drumlins, coalescing drumlins, and fluted topography. Generally, the intervening troughs are narrower than in previously discussed zones. Many do not trap surface-water runoff. Portions of the area have bedrock at shallow depths. The broad flood-plain of the Yentna River cuts through the drumlinized terrain. Zone 4a is situated on sloping mountain flanks. Landforms include less discrete drumlins that coalesce into fluted ridges. Zone 4b encompassed a

Figure 6. View to the south along the Susitna Valley from in the vicinity of Honolulu. Two drumlins (arrows) and drumlinized landforms are evident. Photograph by the author, 1979.

gently sloping upland. Dominant landforms include long, fluted ridges and few clearly-defined drumlins. The flat, poorly-drained areas dominate intervening areas between ridges. Zone 4c contains the most clearly defined drumlins in the study area with few fluted ridges. Many of the intervening troughs do not appear to trap surface water.

Zone (5) is located in the southwest quarter of the study area. It is dominated by floodplains and till. The till has no streamlined forms and is likely a medial moraine. Many lakes and ponds are concentrated in the area, few with obvious outlets.

In the cross-hatched area along the eastern and western margins, (Fig. 5), the melting of stagnant ice resulted in ice-disintegration features. The landforms consist of hummocky ridges composed of till and glaciofluvial deposits. The till is interbedded with stratified sand and gravel. Folding and faulting due to melting of buried glacial ice is evident in some of the sand layers. The ridges are vegetated with coniferous and deciduous trees, dense alder and willow, and patches of grassy meadows. In the basins between the ridges are many streams, ponds and wetlands.

Glaciofluvial landforms such as outwash fans, eskers and crevasse fillings resulted from stagnant-ice conditions and glacial meltwater. These landforms are evident throughout the valley floor, especially along its margins in the vicinity of Talkeetna and along former melt-water channels. Landforms on the mountain slope and valley floor east of Talkeetna includes a complex of these glaciofluvial features inter-mixed with a lateral moraine. In the vicinity of Amber Lake there is a complex of probable eskers. Generally, many of the intervening troughs in the drumlinized terrain likely were melt-water passageways during recession of the glacial ice, as indicated by glaciofluvial deposits on the flanks of drumlins and till ridges. Areas where no distinct moraines and glaciofluvial landforms could be mapped were grouped together as an ice-disintegration complex. Because the glaciofluvial landforms are composed of sand and gravel, they are well-drained and are good sources of construction materials.

Till of lateral, recessional, and terminal moraines overlay and intermix with the drift of the drumlinized terrain. Some of the lower mountain slopes bear lateral moraines that were not destroyed during ice disintegration or by post glacial, fluvial and mass-movement processes. Till from a large lateral moraine is evident on the mountain slopes east of Talkeetna intermixed with ice-disintegration deposits.

Recessional moraines are evident in the vicinity of Swan Lake and in the southern part of the study area (Plate 2). These moraines were deposited by former glaciers flowing out of the valleys of the Tokositna and Ruth Glacier valley and Kahlitna Glaciers, respectively, during the late Naptowne or Alaskan Glaciation. Many of these moraines have been eroded and segmented by glacial meltwater. Nelson and Reed (1978) mapped several other recession moraines, especially in the vicinity of Schneider Lake. Several anamalous east-west drainages in this area may indicate the presence of recessional moraines.

Fluvial Processes

Superimposed on and incised into glacial deposits are floodplain and terrace deposits originating after recession of the Naptowne Glaciation. Floodplain deposits are composed of stratified gravel, sand and silt, and are likely sources of construction materials. Floodplain surfaces are gently sloping and well drained, providing excellent potential sites for development, although they are susceptible to flooding.

Floodplains are divided into active, partly or infrequently active, and abandoned (Fig. 7). Active floodplain surfaces are subject to annual seasonal flooding and include existing stream channels. Seasonally active channels, oxbow lakes, ponds and wetlands typically occur on active floodplains. Partly or infrequently active floodplains are not necessarily inundated by seasonal flooding but may be susceptible to flooding due to their proximity next to active channels and relatively low height above modern streams. Portions of these floodplains may be flooded by tributary streams. Abandoned floodplains or terraces are considered least likely to be affected by high-water conditions due to their location and height above stream channels.

Small abandoned stream channels are intermixed with the glacial landforms; they are typically not related to present drainages but are a result of drainages established during glacier recession, stream piracy, or channel migrations. These channels commonly contain swamps, bogs or marshes.

Alluvial fans develop where the mountain streams become unconfined and spread out. These landforms are composed of alluvial gravel, sand, and silt. The coarser material being near the apex. Fans in the study area are vegetated and their streams are typically entrenched and braided. A few alluvial fans are located in the Talkeetna Mountains but most are in the Alaska Range. The most extensive fans are along the Yentna River. In several narrow mountain-valleys alluvial fans are

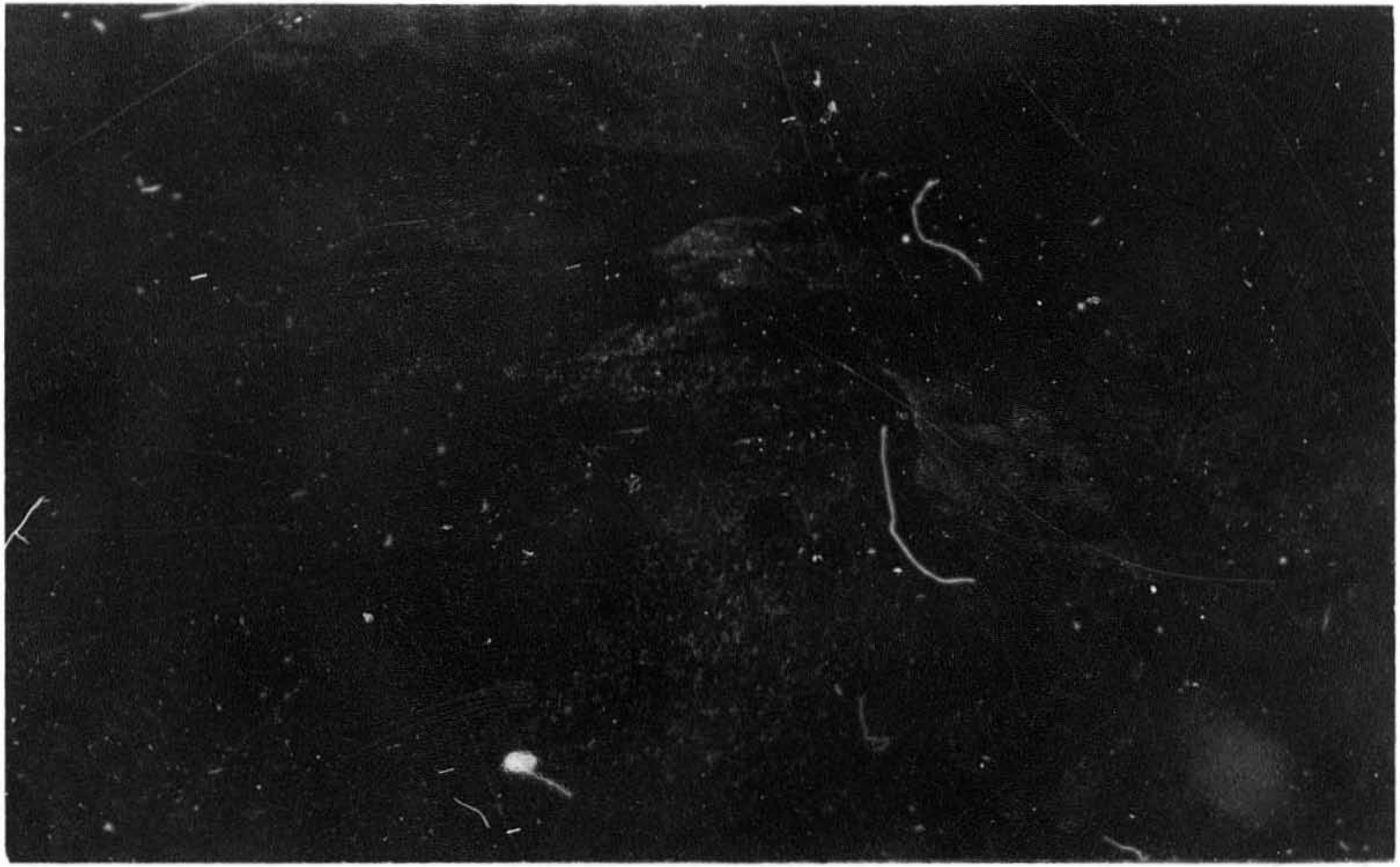

Figure 7. View to the south along the Susitna River from in the vicinity of Sherman. Floodplain map units are evident: active (fa), partly or infrequently active (f_1), and abandoned (f_2). Photograph by T. George, 1979.

partially blocking the valley, forcing stream channels against the opposite valley wall.

Mass Movement

Lower mountain slopes and narrow valley floors contain mass-movement landforms, including talus slopes, avalanche chutes, landslides scars, and rock glaciers. Talus slopes include steep bedrock surfaces, cones and fans. Talus is an accumulation of angular rock fragments formed by frost weathering of bedrock and transported downslope by falling tumbling and rolling primarily during periods of spring thaw. Avalanche chutes are present on steep mountain slopes but are concentrated in the northwestern part of the study area. Chutes are cut or modified by rapidly moving masses of snow, ice, rock and soil. Tongues of boulders or rock debris typically accumulate at the bottom of the chutes near the base of the valley walls. Extensively affected areas include Coffee River, Hidden River and Ohio Creek valleys in the Alaska Range and in the vicinity of Indian River, Hurricane Gulch, Sheep Creek and Kashwitna River valleys in the Talkeetna Mountains. Rock glaciers are located on many floors of narrow mountain valleys in the study area. Over 100 active and inactive rock glaciers were mapped by Nelson and Reed (1978) on the Talkeetna Quadrangle. These landforms are developed from talus and other mass-wasting debris which form tongues of rock fragments moving slowly downslope. In some localities active rock glaciers are overriding inactive ones.

Geologic Hazards

The geologic hazards (Plates 8-14) are active surface processes that alter the landscape in a potentially catastrophic manner. The alteration may be short or long duration.

The geologic hazards in the study area include flooding, surging glaciers, and mass movement. The map units are derived from the previously mapped landforms, multidate Landsat imagery, and pertinent literature.

Flooding

Flooding is a seasonal event in many river valleys affecting the stream channels and associated floodplains. Certain portions of floodplains are more frequently affected by high-water conditions than others. Proximity, relative heights and vegetation were used to distinguish the relative frequency of flooding on floodplains.

Floodplains are divided into two divisions, primary and secondary, based on their suceptibility to flooding (Plates 8-14). The primary floodplains are subject to seasonal flooding, standing water and channel migrations. This unit includes existing stream channels. Secondary floodplains are surfaces subject to infrequent flooding due to unusually high water-levels. Portions of these floodplains may be annually flooded by tributary streams.

Most of the rivers in the study area have developed floodplains confined by scarps with terraces (Fig. 8). The scarps will confine floodwaters but are susceptible to erosion. Older abandoned floodplains

Figure 8. View to the south along Cache Creek Valley. Streams, such as Cache Creek are typically incised into the landscape. Photograph by T. George, 1979.

or terraces are not typically affected by flood conditions due to their heights above streams.

Standing water is a wide spread condition encountered in the study area. Many low-lying areas trap and retain water, and typically develop into a wetland. The map units (Plates 9, 10 & 13) encompass areas where a large portion of the terrain is wet, especially south of the Petersville Road. North of the Petersville Road standing water conditions decrease steadily. The author observed several areas of standing water along the Parks Highway in early winter, 1979, south of the Parks Highway--Chulitna River crossing. The standing water was not present in these forested areas during the summer field season indicating periods of flooding are short and seasonal. The cause of this flooding is not known.

Flooding is not always a function of surface runoff but is occasionally affected by unusual events including outburst floods, aufeis and torrential floods. Outburst floods are caused by the draining of glacier-dammed lakes. In many areas throughout Alaska outburst floods occur annually and usually by late August (Post and Mayo, 1971). These lakes are generally located along the margins of glaciers, although some are located beneath or within them. These lakes drain when a passageway is opened through the ice dam. Glacier-dammed lakes which affect the study area are identified along the Eldridge, Ruth, Tokositna, Kahiltna, Yentna and West Fork Glaciers (Post, 1971). Primary floodplains of streams draining ice-dammed lakes are affected by periodic outburst floods. There is no evidence that outburst flooding in the study area is an annual event.

Aufeis is a local floodplains phenomenon in high and alpine middle-latitudes. Thick sheets of surface-ice develop on floodplains by the freezing of thin sheets of water during low, winter temperatures, resulting in flooding beyond the stream channel. Aufeis presents difficult engineering problems with respect to buildings, highway or other structures. Locations where icings occur are best avoided. Most braided streams in the study area are susceptible to aufeis. In the study area aufeis conditions were not as severe as areas north of the Alaska Range.

Alluvial fans are susceptible to torrential floods and debris-flows. The alluvial fans in the study area are located in the western mountainous regions (Plates 10, 11, 13 & 14). Most of the fans are vegetated indicating their surfaces are stable. The main stream channel on many of the fans are entrenched, confining the effects of flooding and debris flows to the channel. However channels are susceptible to back-filling and relocation. The portion of the fan within 30° of the medial radial line is thought to be the most active area (Bull, 1964). Alluvial fans are usually an excellent source of groundwater and construction materials but typically poor building sites.

Surging Glaciers

Periodically surging glaciers which could affect streams in the study area include the Yentna, Lacuna Glaciers and the two northeast tributary glaciers of the Eldridge Glacier. The angular crenulations of debris bands on the surface of these glaciers near their termini is indicative of a surge history (Post, 1960). The Tokositna Glacier may possibly be subject to surges, although the geometry of the debris bands indicates pulsing rather than surging (Mayo, 1976).

The hazards of surging glaciers include glacial encroachment, flooding and proglacial sedimentation. Flooding and sedimentation will affect the primary floodplains of the respective glaciers and some secondary floodplains.

Mass Movement

Steep mountainous slopes and parts of valley floors are susceptible to mass movement hazards. These hazards include avalanche and landslides, falling rock, and debris flows typically associated with talus slopes. Most mass movement hazards are especially active during periods of spring thaw. The hazards associated with mass movement are located in mountainous regions throughout the study area (Plates 8-14). The Alaska Range along the northern extremity of the study area is particularly susceptible to mass movement.

CONCLUSIONS

Most of the existing morphology of the Susitna-Chulitna River area resulted from Pleistocene glacial advances. The north/south alignment of the drumlinized terrain, drumlins (often with low profiles) and scoured bedrock (Fig. 9) indicate dominent glacial sources were the Alaska Range to the north and west including areas in the vicinity of Susitna and West Fork Glaciers. Secondary sources were the Talkeetna Mountains to the east. The confluence of the glaciers from their respective directions has affected the alignment of the landforms especially around the margins of the Susitna-Chulitna valley.

The drumlinized ground moraine and intervening troughs have been streamlined by the ice movement but few drumlins fully develop. In previous studies the lack of drumlin development has been attributed to unsuitable basal ice conditions (Hoppe, 1957), or dilatance related to deformation and load (Smalley, 1968).

The drumlinized topography is most evident south of the Tokositna River. There, intervening troughs are poorly drained and usually with standing water. The presence of glaciofluvial deposits on the flanks of several of the drumlinized ridges and beneath the swamps in the troughs indicate meltwater channels once flowed in many of the troughs.

At least one meltwater channel extended thru the study area from Swan Lake south and apparently splayed into several channels south of the Petersville road. The Susitna River was probably an active melt-water channel.

The Tokositna River appears to make a transition in the formation of landforms and hence basal-ice conditions in the once overlying

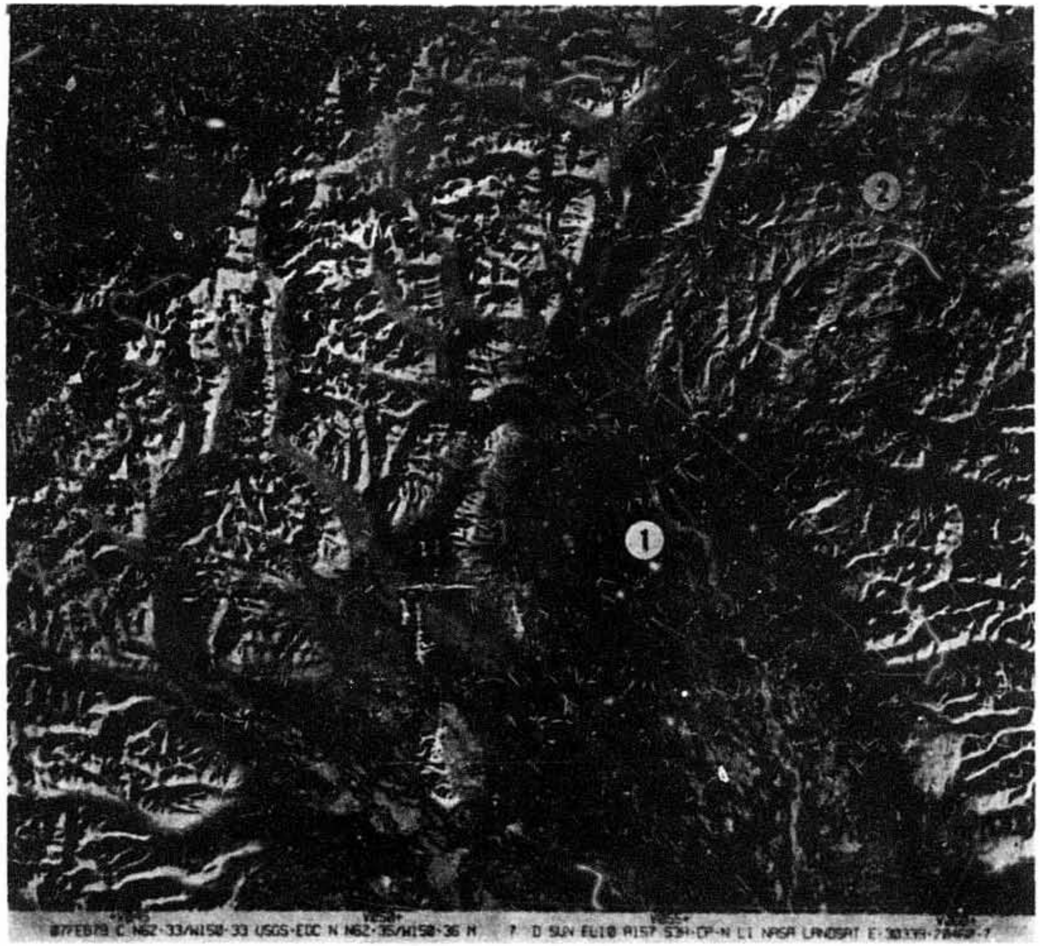

Figure 9. A winter Landsat image of the study area showing the alignment of drumlinized terrain on the valley floor (1) and scoured bedrock in the mountainous regions. (2) Scene #30339-20460, February, 1979.

glacier. Drumlinized till and glaciofluvial deposits are extensive south of the river. The extent of glaciofluvial deposits suggests that water either was prevalent beneath the glacier in this zone or flowed through troughs between till ridges beyond the glacial ice during its recession. If the glaciofluvial deposits are as extensive as the author suspects, then the rapid dissolution of glacial ice is likely.

The modeling of depositional landscapes (Fig. 10) by Sugden and John (1976), describes the Susitna-Chulitna area with some modification. The study area includes the erosion-transition zone, active zone and transition-wastage zone. Drumlinized ridges and drumlins are intermixed. The break between the fluted ground moraine and drumlinized ridges occurs in the vicinity of the Tokositna River. North of the river the glacier was constrained between relatively narrow mountain valley walls and fluted ground moraine is prevalent. South of the river the valley floor

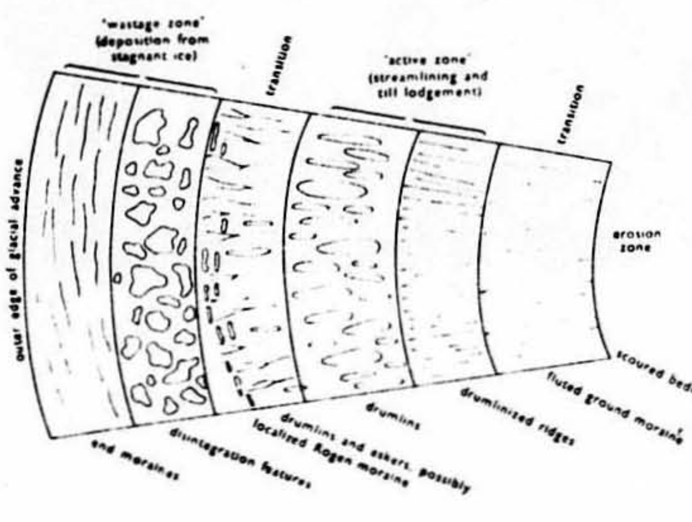

Figure 10. A model of the types of depositional landscapes expected to develop beneath part of the periphery of a mid-latitude Pleistocene ice sheet at, or just after, the phase of maximum glaciation. Not all of these landscapes will develop contemporaneously, and the landscape type is determined above all by the character of the ice above a site when rapid dissolution sets in.

broadens significantly and till lodgement and streamling occur. The change from the active zone to the transition-wastage zone occurs south of Amber Lake. Drumlins, eskers and possible Rogen moraines are evident in this area especially in the vicinity of Trapper Lake. The wastage zone, associated with the ice terminus occurs south of the study area. Fluvial processes have destroyed many of the landforms associated with this zone.

Active surfacial processes are often catastrophic and hence called geologic hazards. Detectable hazards in the study area include flooding, surging glaciers, and mass movement. Flooding which results from surface runoff occurs on low-lying floodplains and troughs. Hazards aassociated with glaciers susceptible to surging include glacial encroachment, flooding and proglacial sedimentation of most river valleys in the area. Local flooding results from unusual events including the bursting of glacier-dammed lakes, development of aufeis and torrential floods. Mass movement including avalanche, landslides, rock falls and debris flow affect lower mountain-slopes and the margins of valley floors.

This study on the Susitna-Chulitna River Basin is intended to provide a regional overview of the area. The study of landforms provides a basic level of information from which active surficial processes can be studied and the distribution of surficial deposits can be inferred. Landsat imagery and small scale aerial photography have shown to be excellent sources of regional data. The results of this investigation are intended to provide a data source for regional planning and help define natural constraints for areas. The maps should not be used for local planning.

Registration of mapped landforms to USGS topographic maps involve map unit boundary shifts as much as 1/2 mile. This shift is attributable to geometric distortion inherent in Landsat data and is evident in mountainous regions along the margins of the study area.

RECOMMENDATION

The regional maps from this study are intended to aid regional planning, target potential areas, eliminate areas with few attributes, provide bench mark data for impact studies and direct more detailed studies. More detailed studies at a future date, may be required in critical areas defined by planning needs.

The following phenomena may require more extensive investigation in the future:

(1) secondary floodplains described under geologic hazards;

(2) early winter standing-water in forested areas;

(3) torrential floods on alluvial fans;

(4) satellite monitoring of glacier-dammed lakes (Miller, 1979); and

(5) larger scale maps of landslide and avalanche zones.

Consideration in the future may be given to the preparation of slope, vegetation and construction material maps.

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SUSITNA BASIN PLANNING BACKGROUND REPORT

Surficial Geology of the Susitna-Chulitna River Area, Alaska

Part 2: Maps

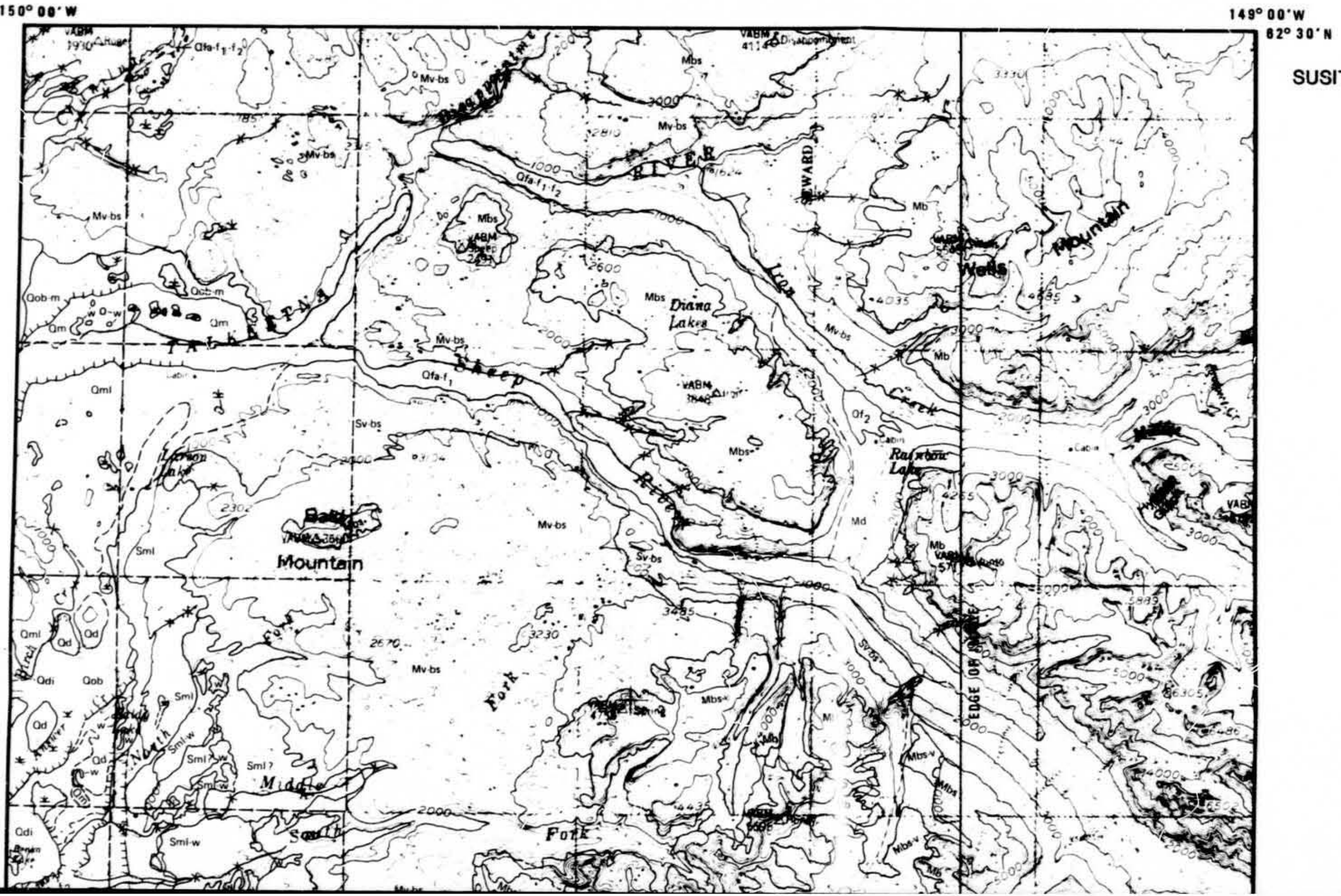
KENNESON G. DEAN
NORTHERN REMOTE SENSING LABORATORY
GEOPHYSICAL INSTITUTE
UNIVERSITY OF ALASKA
FAIRBANKS, ALASKA

prepared for

LAND AND RESOURCE PLANNING SECTION
DIVISION OF RESEARCH AND DEVELOPMENT
ALASKA DEPARTMENT OF NATURAL RESOURCES

MARCH, 1980

Plate 1



PHYSIOGRAPHY OF THE UPPER SUSITNA-CHULITNA RIVER AREA, ALASKA

by
KENNESON G. DEAN
1980

EXPLANATION

Physiographic Divisions

- M - Mountainous Terrain, often blanketed by till
  - bs - subdued, scoured bedrock
  - b - angular bedrock
  - v - vegetated with scattered rock outcrops, bedrock suspected at shallow depth
- S - Sloping Terrain: generally used where terrain gradient covers a distance greater than one-mile along sides of broader valleys
- Q - Broad valley floor
- G - Glaciers
- P - Plateau

Landforms

Glacial

- t - Active glacial terminus
- ob - Suspected abandoned glacial outwash channel
- op - Pitted outwash fans
- ow - Outwash fans
- me - End moraine
- ml - Lateral moraine
- m - Ground moraine
- d - Glacial drift
- Suspected minor outwash channels on drift
- dz - Drumlinized topography: consists of ridges of glacial drift intermixed with poorly drained low lying basins
- di - Ice-disintegration complex
- e - Esker
- Individual drumlinoids
- cv - Crevasse fill ridge
- Direction of water movement in abandoned outwash channels
- Recessional or end moraine; barbs point toward former glacier, dashed where inferred and queried in suspect areas

Paludal

- w - Low lying basins conducive to trapping surface water
- Suspect standing water

150° 00' W

TALKEETNA MTNS. A-5, A-6, B-5, B-6,

Based from U.S. Geological Survey 1:250,000, 1954

62° 00' W

149° 00' N

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Suspect standing water

Fluvial

Entrenched stream
Scarps
af - Alluvial fan
sc - Abandoned stream channel
fa - Active floodplain
f_1 - Partly or infrequently active floodplain
f_2 - Abandoned floodplains

Mass Movement

Talus slopes
Avalanche and landslide chutes

Ls - Debris resulting from a landslide
Rg - Rock glacier
Boundary
Inferred boundary

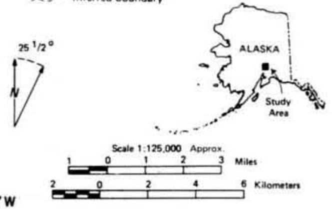
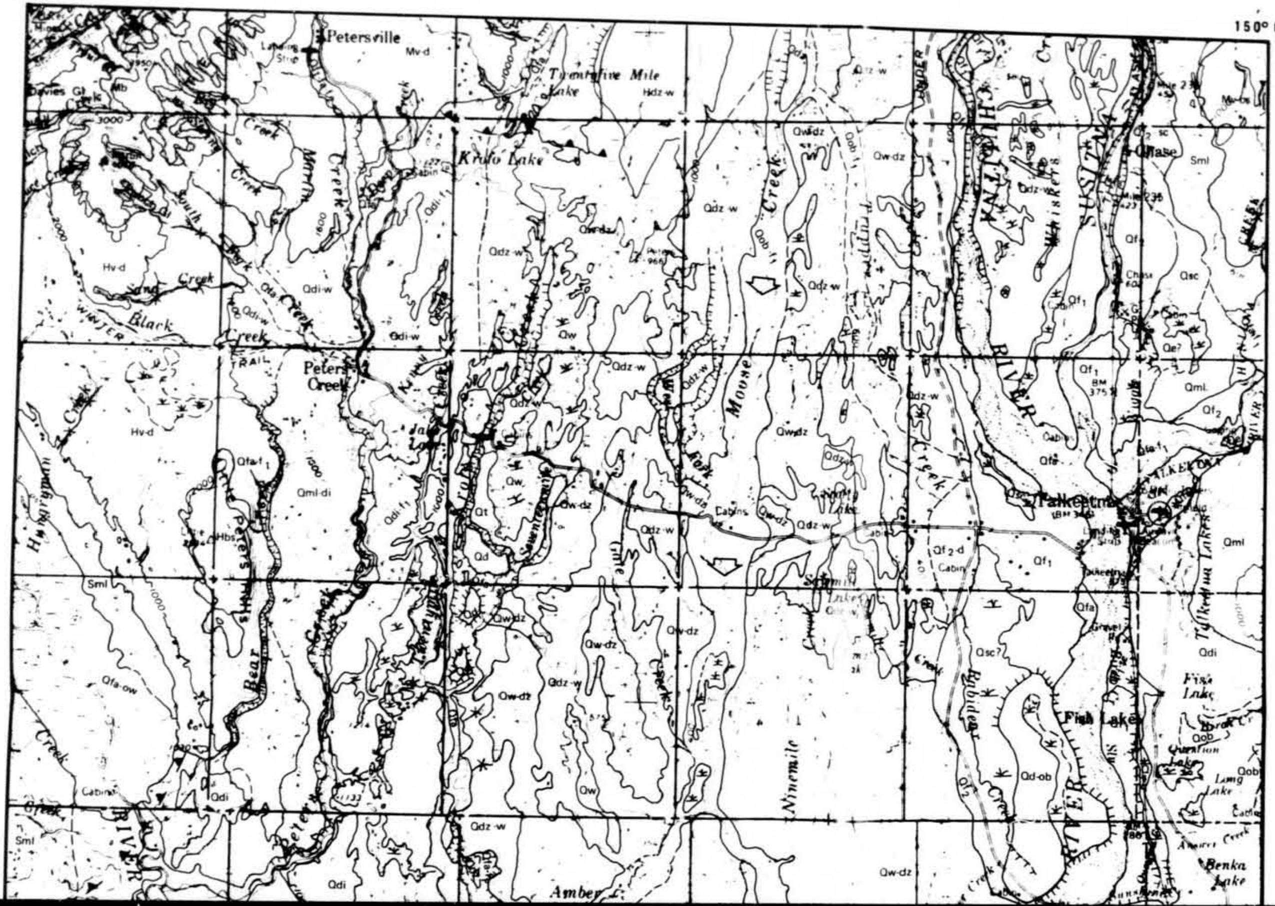


Plate 2



PHYSIOGRAPHY OF THE UPPER SUSITNA-CHULITNA RIVER AREA, ALASKA

by

KENNESON G. DEAN

1980

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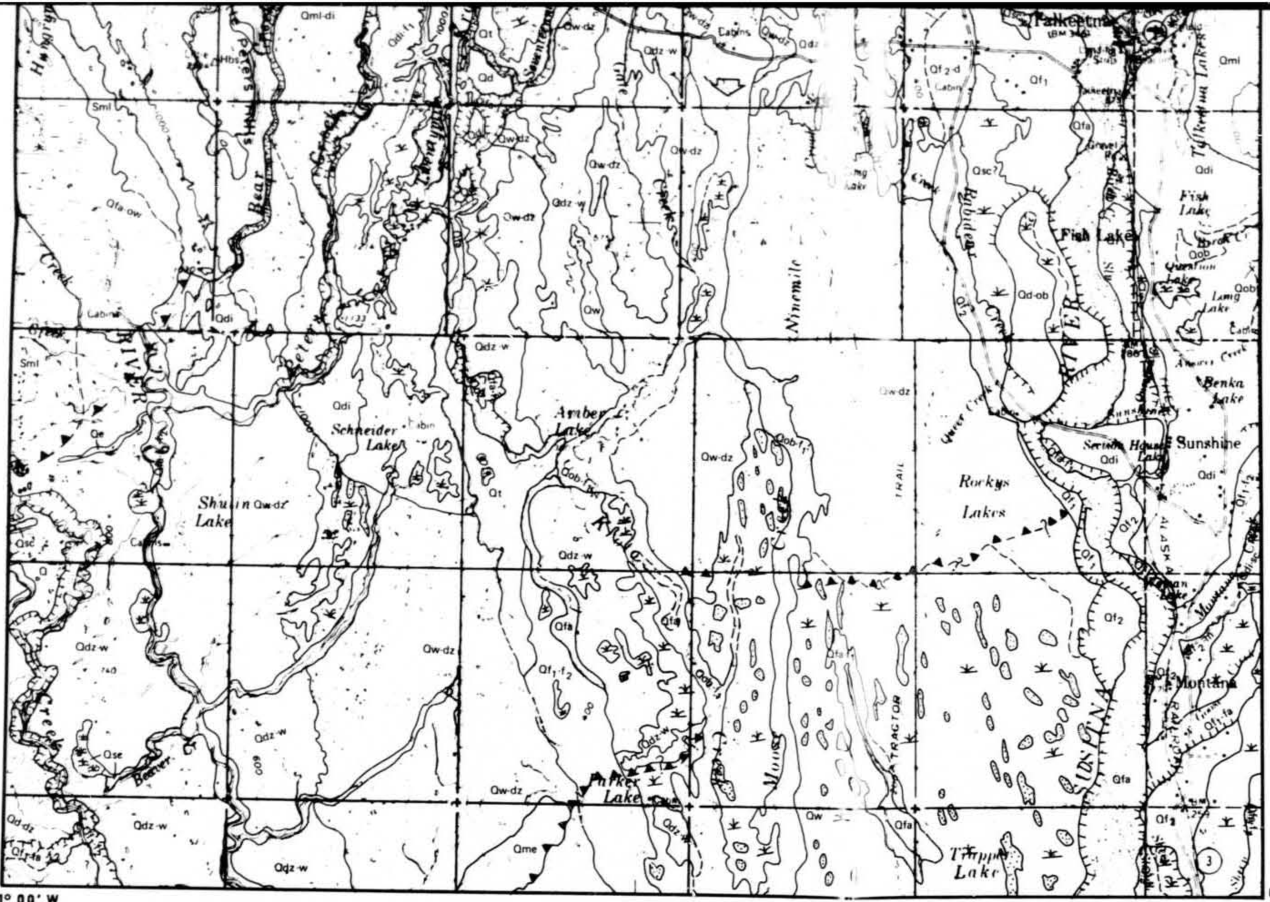
- Recessional or end moraine; barbs point toward former glacier, dashed where inferred and queried in suspect areas

Paludal

- w - Low lying basins conducive to trapping surface water
- Suspect standing water



151° 00' W

62° 00' W

150° 00' N

Based from U.S. Geological Survey
1:250,000 , 1958

TALKEETNA A-1,A-2,B-1,B-2

ob - Suspected abandoned glacial outwash channel
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m - Ground moraine
d - Glacial drift

Suspected minor outwash channels on drift

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Individual drumlinoids
cv - Crevasse fill ridge
Direction of water movement in abandoned outwash channels
Recessional or end moraine; barbs point toward former glacier, dashed where inferred and queried in suspect areas

Paludal

w - Low lying basins conducive to trapping surface water
Suspect standing water

Fluvial

Entrenched stream

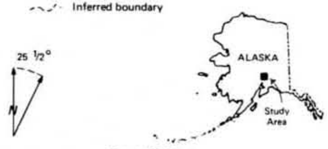
Scarps
af - Alluvial fan
sc - Abandoned stream channel
fa - Active floodplain
f_1 - Partly or infrequently active floodplain
f_2 - Abandoned floodplains

Mass Movement

Talus slopes

Avalanche and landslide chutes

Ls - Debris resulting from a landslide
Rg - Rock glacier
Boundary
Inferred boundary



Scale 1:125,000 Approx.

1 0 1 2 3 Miles

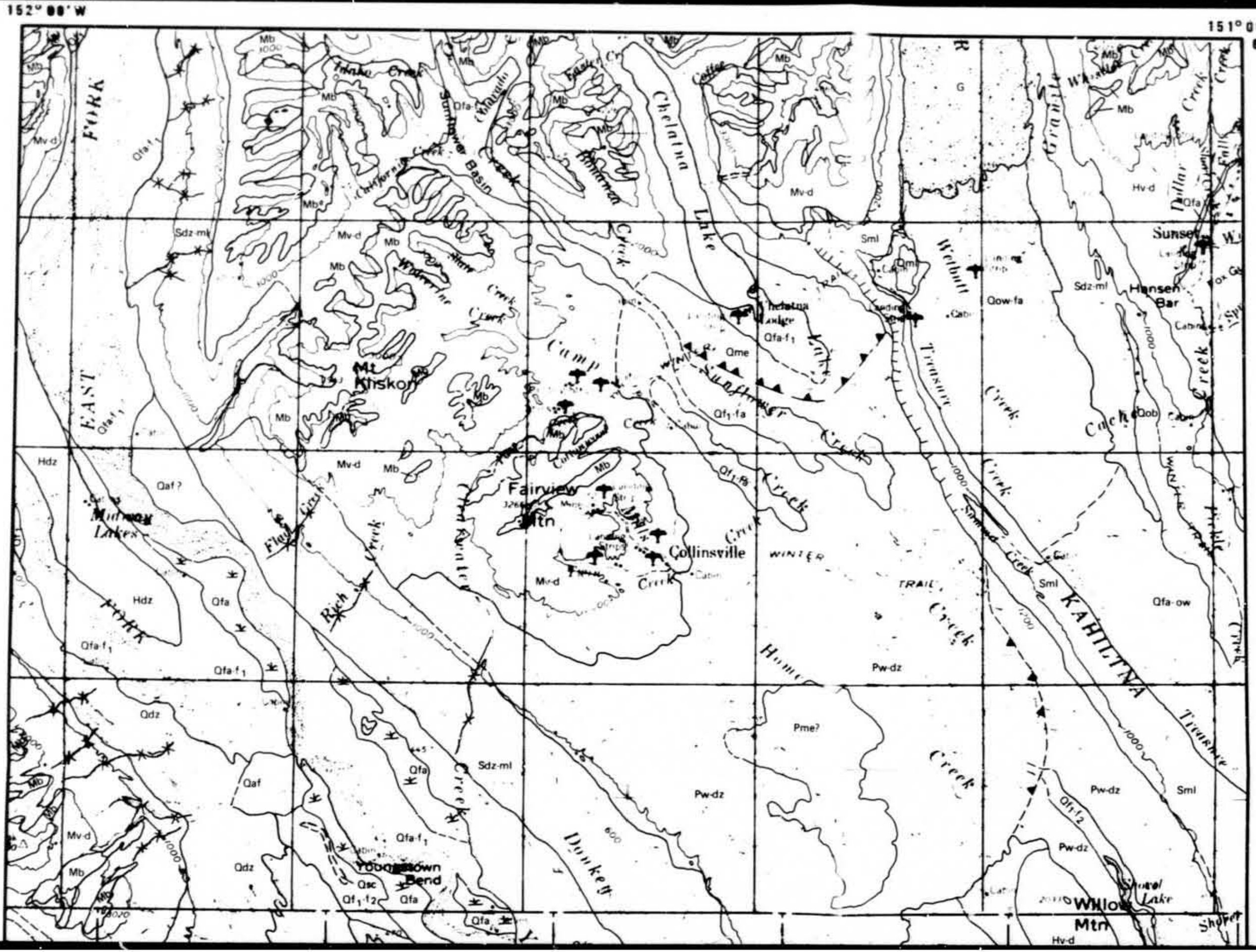
2 0 2 4 6 Kilometers

Plate 3

PHYSIOGRAPHY OF THE UPPER SUSITNA-CHULITNA RIVER AREA, ALASKA

by
KENNESON G. DEAN

1980



EXPLANATION

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Q - Broad valley floor

G - Glaciers

P - Plateau

Landforms

Glacial

t - Active glacial terminus

ob - Suspected abandoned glacial outwash channel

op - Pitted outwash fans

ow - Outwash fans

me - End moraine

ml - Lateral moraine

m - Ground moraine

d - Glacial drift

Suspected minor outwash channels on drift

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di - Ice-disintegration complex

e - Esker

Individual drumlinoids

cv - Crevasse fill ridge

Direction of water movement in abandoned outwash channels

Recessional or end moraine; barbs point toward former glacier, dashed where inferred and queried in suspect areas

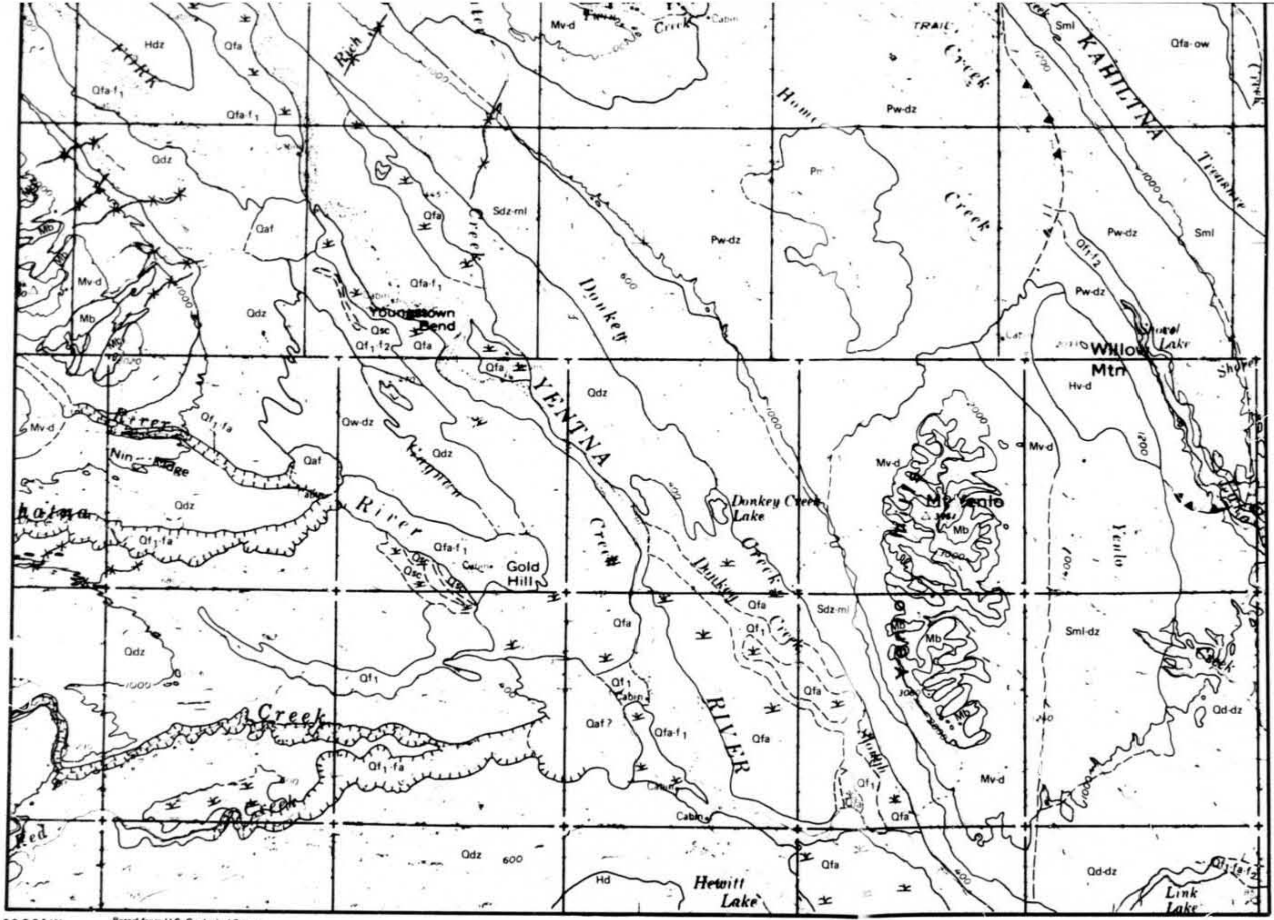
Paludal

w - Low lying basins conducive to trapping surface water

Suspect standing water

Fluvial

Entrenched stream



me - End moraine
ml - Lateral moraine
m - Ground moraine
d - Glacial drift

Suspected minor outwash channels on drift

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Individual drumlinoids
cv - Crevasse fill ridge
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Recessional or end moraine; barbs point toward former glacier, dashed where inferred and queried in suspect areas

Paludal

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Suspect standing water

Fluvial

Entrenched stream
Scarps
af - Alluvial fan
sc - Abandoned stream channel
fa - Active floodplain
f_1 - Partly or infrequently active floodplain
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Mass Movement

Talus slopes
Avalanche and landslide chutes

Ls - Debris resulting from a landslide
Rg - Rock glacier
Boundary
Inferred boundary

25 1/2°

N

Scale 1:125,000 Approx.

1 0 1 2 3 Miles

2 0 2 4 6 Kilometers

152°00'W

Based from U.S. Geological Survey 1:250,000, 1958

TALKEETNA A-3,A-4,B-3,B-4,

82°00'W

151°00'N

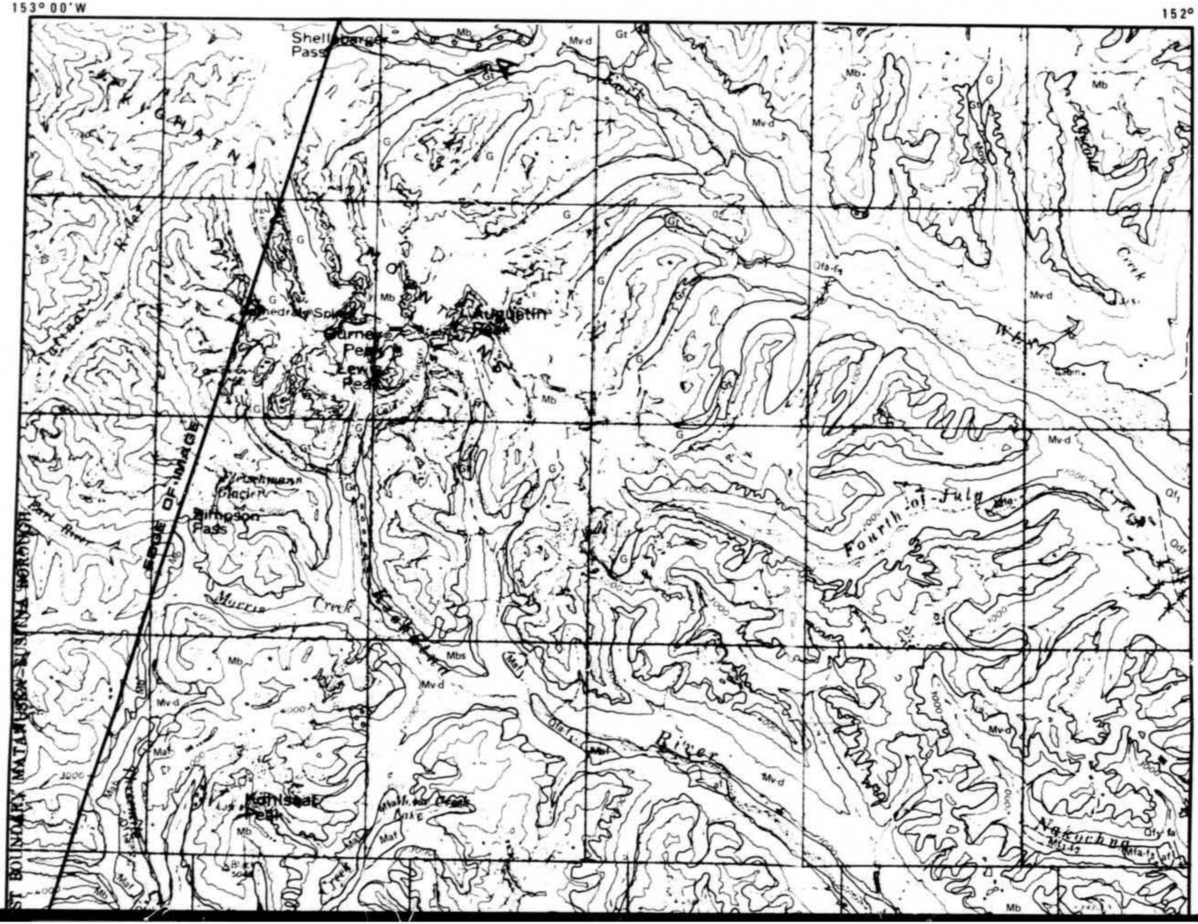

Plate 4

PHYSIOGRAPHY OF THE UPPER SUSITNA-CHULITNA RIVER AREA, ALASKA

by

KENNESON G. DEAN

1980

EXPLANATION

Physiographic Divisions

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S - Sloping Terrain: generally used where terrain gradient covers a distance greater than one-mile along sides of broader valleys

Q - Broad valley floor

G - Glaciers

P - Plateau

Landforms

Glacial

t - Active glacial terminus

ob - Suspected abandoned glacial outwash channel

op - Pitted outwash fans

ow - Outwash fans

me - End moraine

ml - Lateral moraine

m - Ground moraine

d - Glacial drift

Suspected minor outwash channels on drift

dz - Drumlinized topography: consists of ridges of glacial drift intermixed with poorly drained low lying basins

di - Ice-disintegration complex

e - Esker

Individual drumlinoids

cv - Crevasse fill ridge

Direction of water movement in abandoned outwash channels

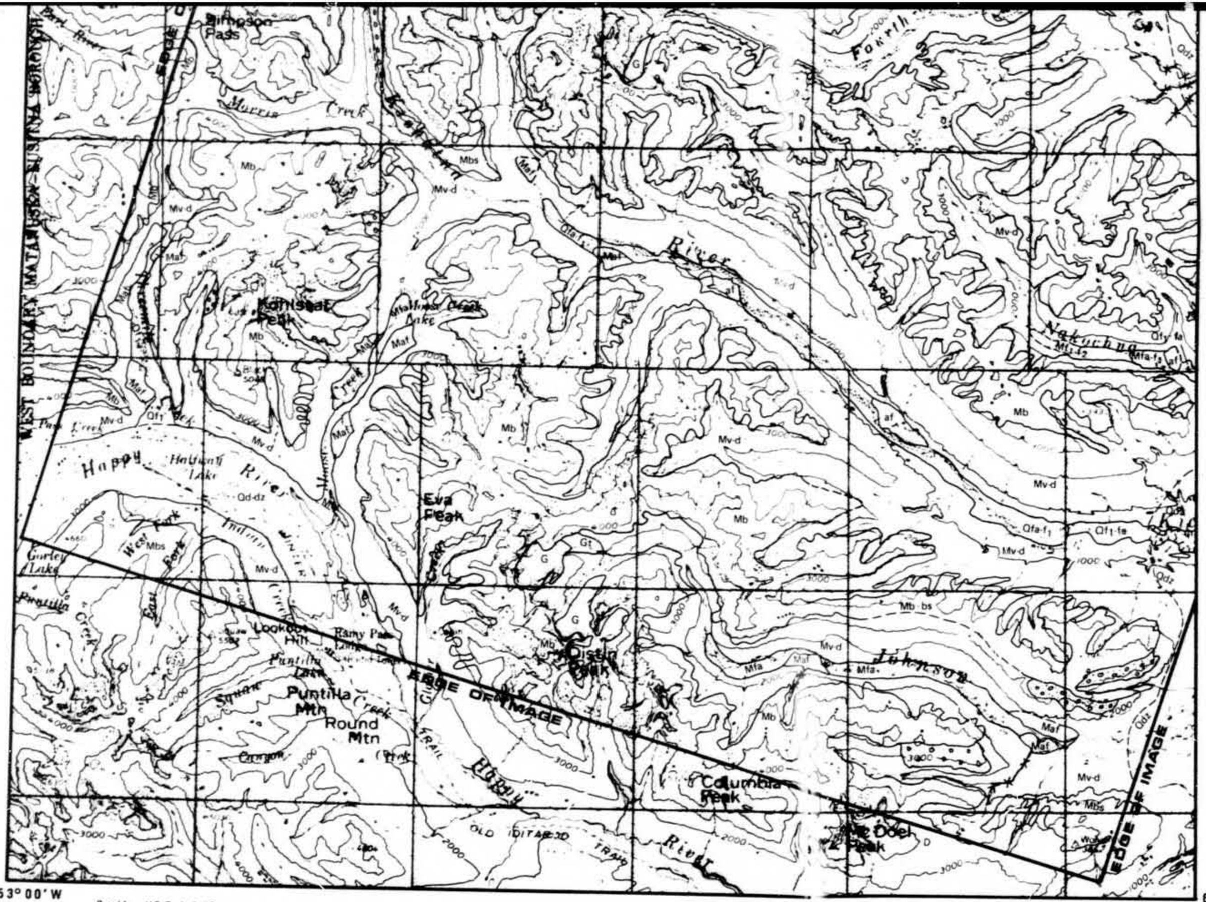
Recessional or end moraine, barbs point toward former glacier, dashed where inferred and queried in suspect areas

Paludal

w - Low lying basins conducive to trapping surface water

Suspect standing water

Fluvial



153° 00' W

Based from U.S. Geological Survey 1:250,000 , 1954

TALKEETNA A-5, A-6, B-5, B-6

62° 00' W
152° 00' N

so - Suspected abandoned glacial outwash channel
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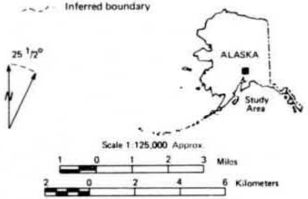
Mass Movement

Talus slopes
Avalanche and landslide chutes

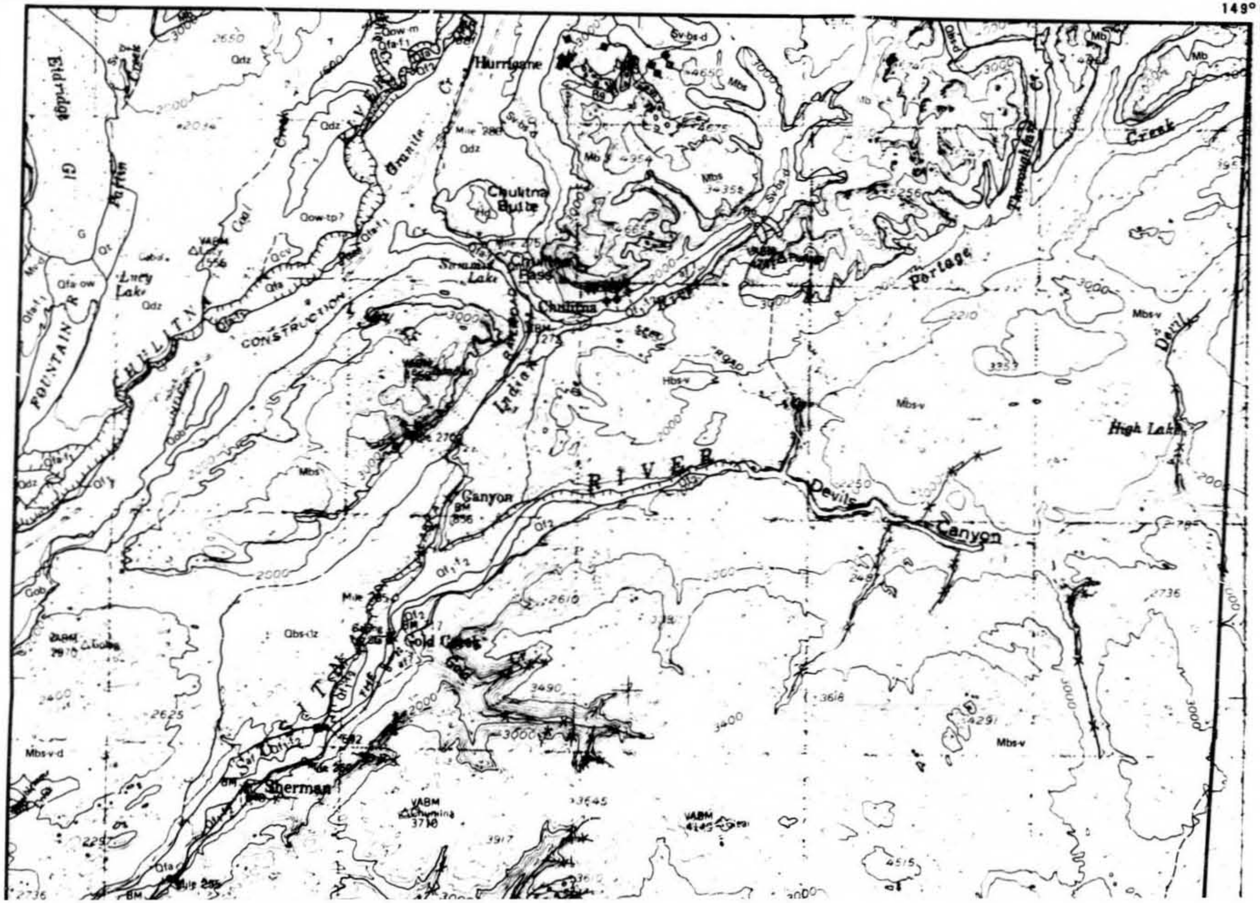
Ls - Debris resulting from a landslide
Rg - Rock glacier
Boundary
Inferred boundary



150° 00' W

149° 00' W

63° 00' N



PHYSIOGRAPHY OF THE UPPER SUSITNA-CHULITNA RIVER AREA, ALASKA

by
KENNESON G. DEAN
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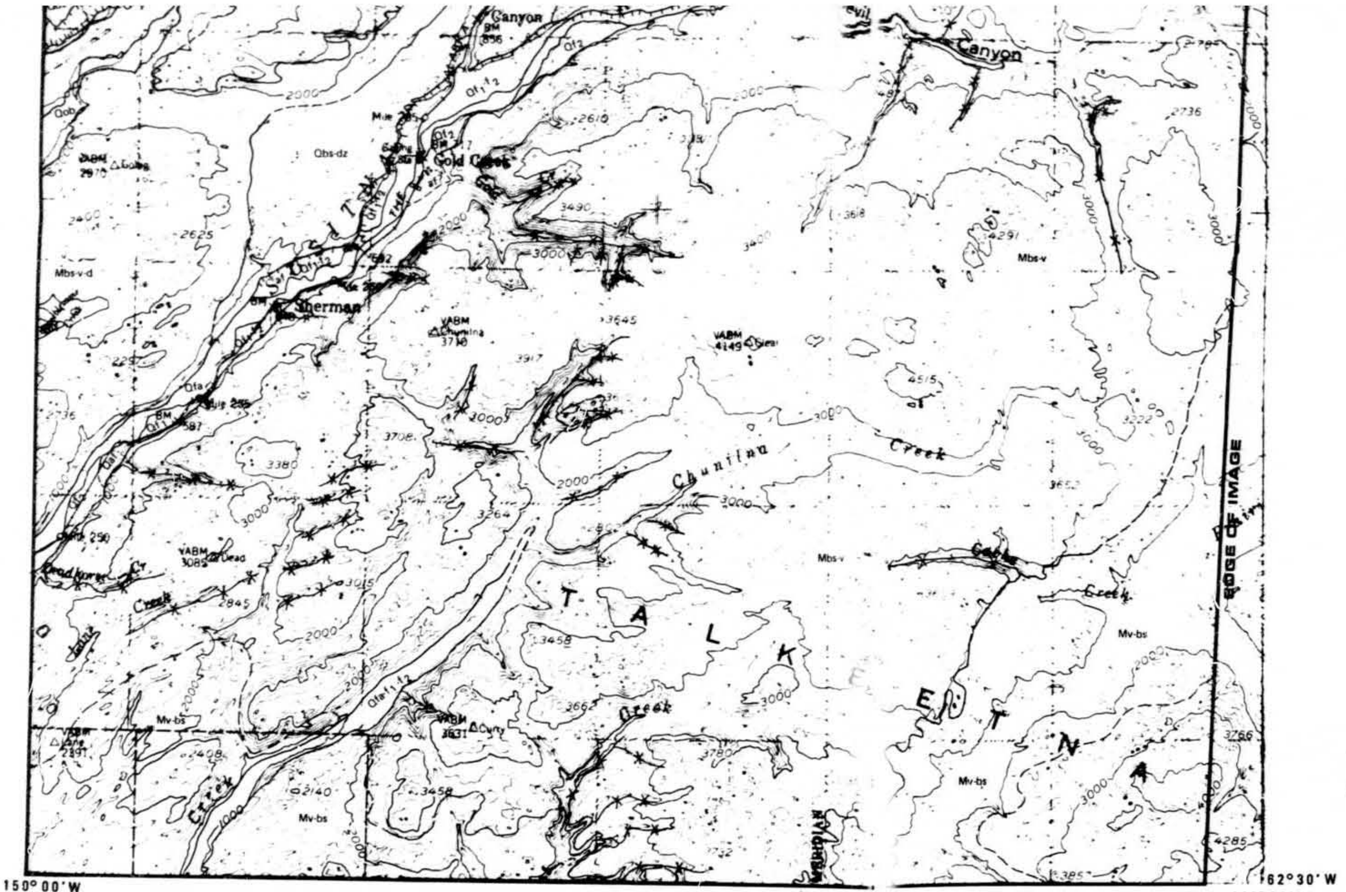
Fluvial



Based from U.S. Geological Survey
1:250,000 , 1954

TALKEETNA MTNS. C-5, C-6, D-5, D-6,

outwash channel
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Mass Movement

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- Avalanche and landslide chutes
- Ls - Debris resulting from a landslide
- Rg - Rock glacier
- Boundary
- Inferred boundary

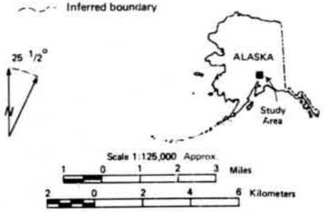
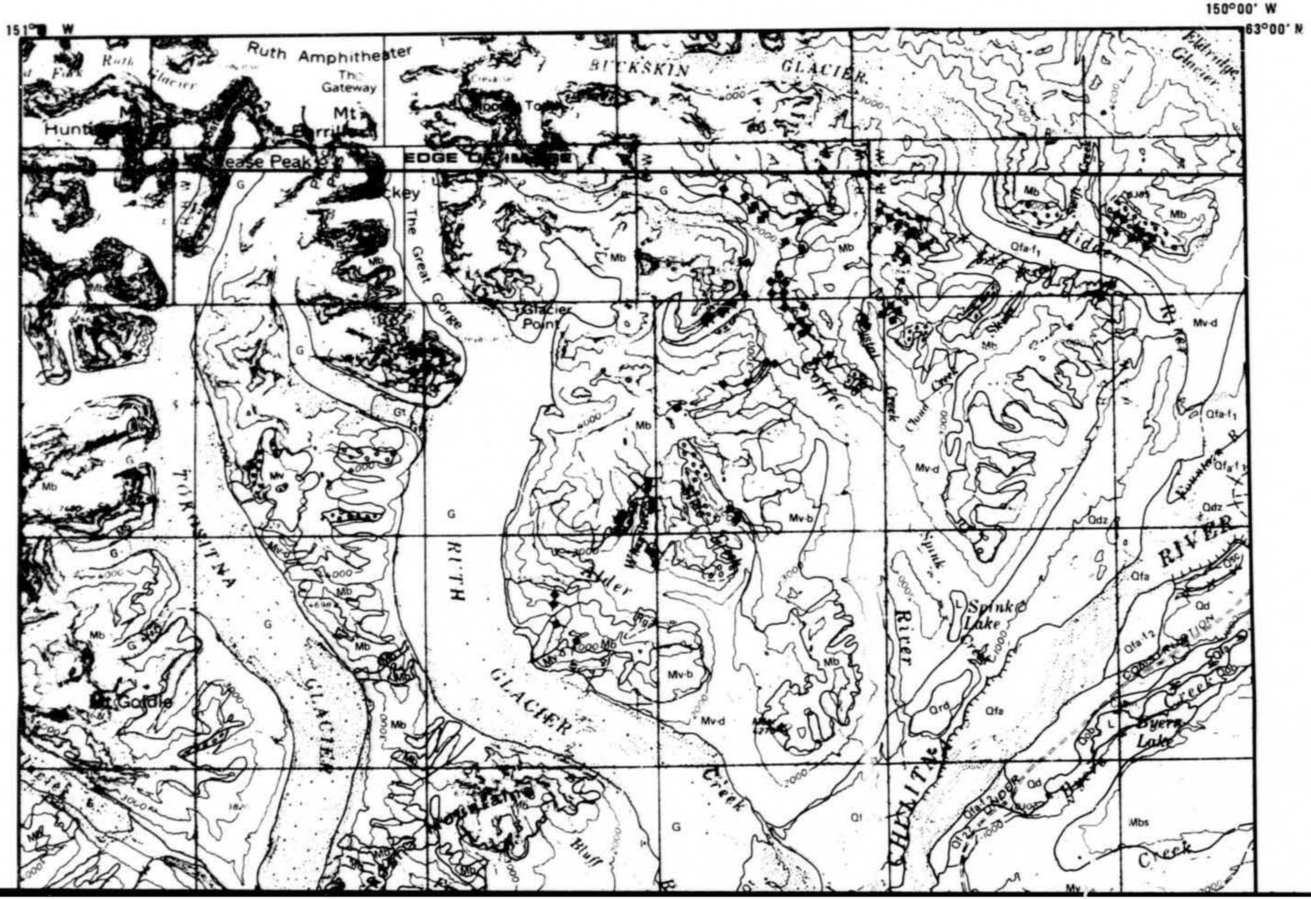


Plate 6



PHYSIOGRAPHY OF THE UPPER SUSITNA-CHULITNA RIVER AREA, ALASKA

by
KENNESON G. DEAN
1980

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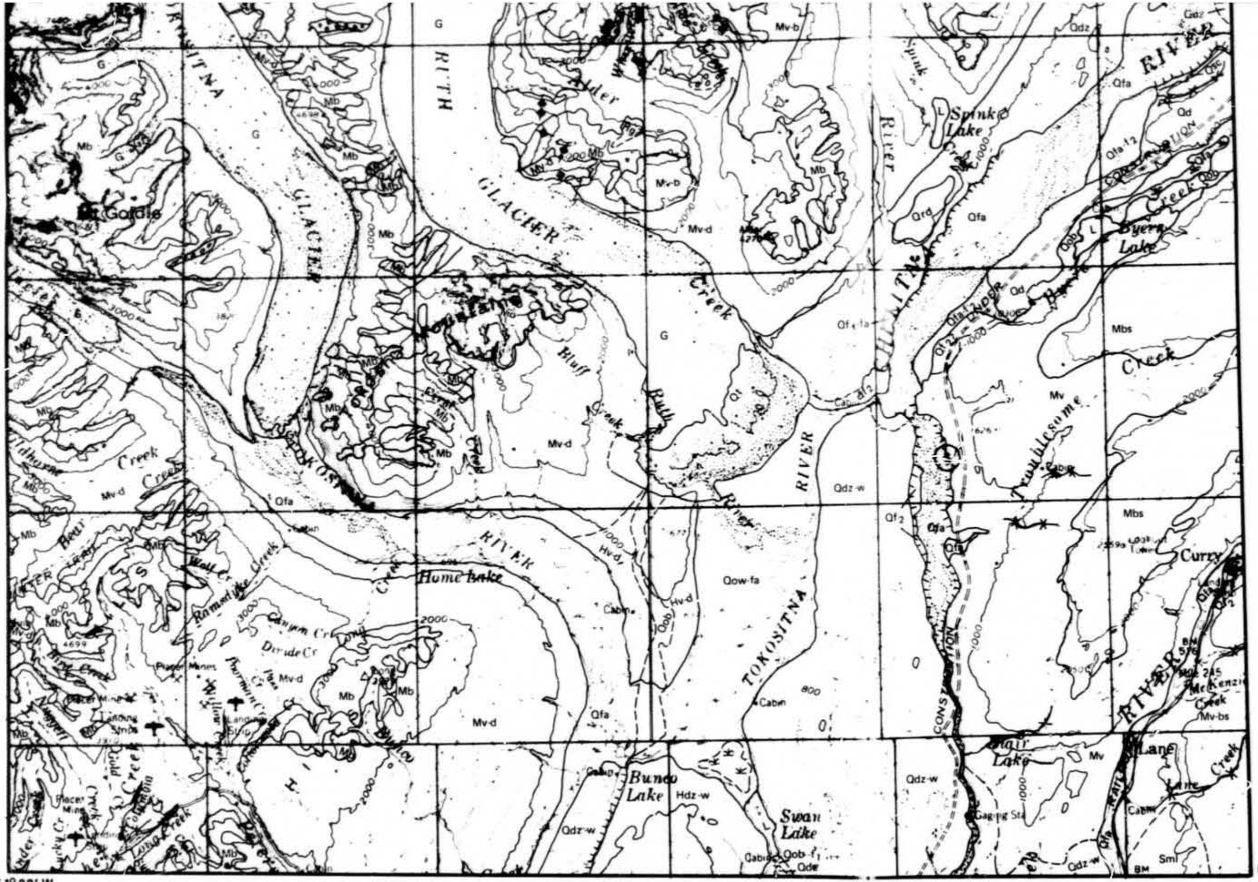


151°00' W

Based from U.S. Geological Survey
1:250,000 , 1958

TALKEETNA C-1, C-2, D-1, D-2,

62°30'W

150°00'N

op - Pitted outwash fans
ow - Outwash fans
me - End moraine
ml - Lateral moraine
m - Ground moraine
d - Glacial drift

Suspected minor outwash channels on drift

dz - Drumlinized topography: consists of ridges of glacial drift intermixed with poorly drained low lying basins
di - Ice-disintegration complex
e - Esker
Individual drumlinoids
cv - Crevasse fill ridge
Direction of water movement in abandoned outwash channels
Recessional or end moraine; barbs point toward former glacier, dashed where inferred and queried in suspect areas

Paludal

w - Low lying basins conducive to trapping surface water
Suspect standing water

Fluvial

Entrenched stream
Scarps
af - Alluvial fan
sc - Abandoned stream channel
fa - Active floodplain
f_1 - Partly or infrequently active floodplain
f_2 - Abandoned floodplains

Mass Movement

Talus slopes
Avalanche and landslide chutes

Ls - Debris resulting from a landslide
Rg - Rock glacier
Boundary
Inferred boundary

25 1/2°

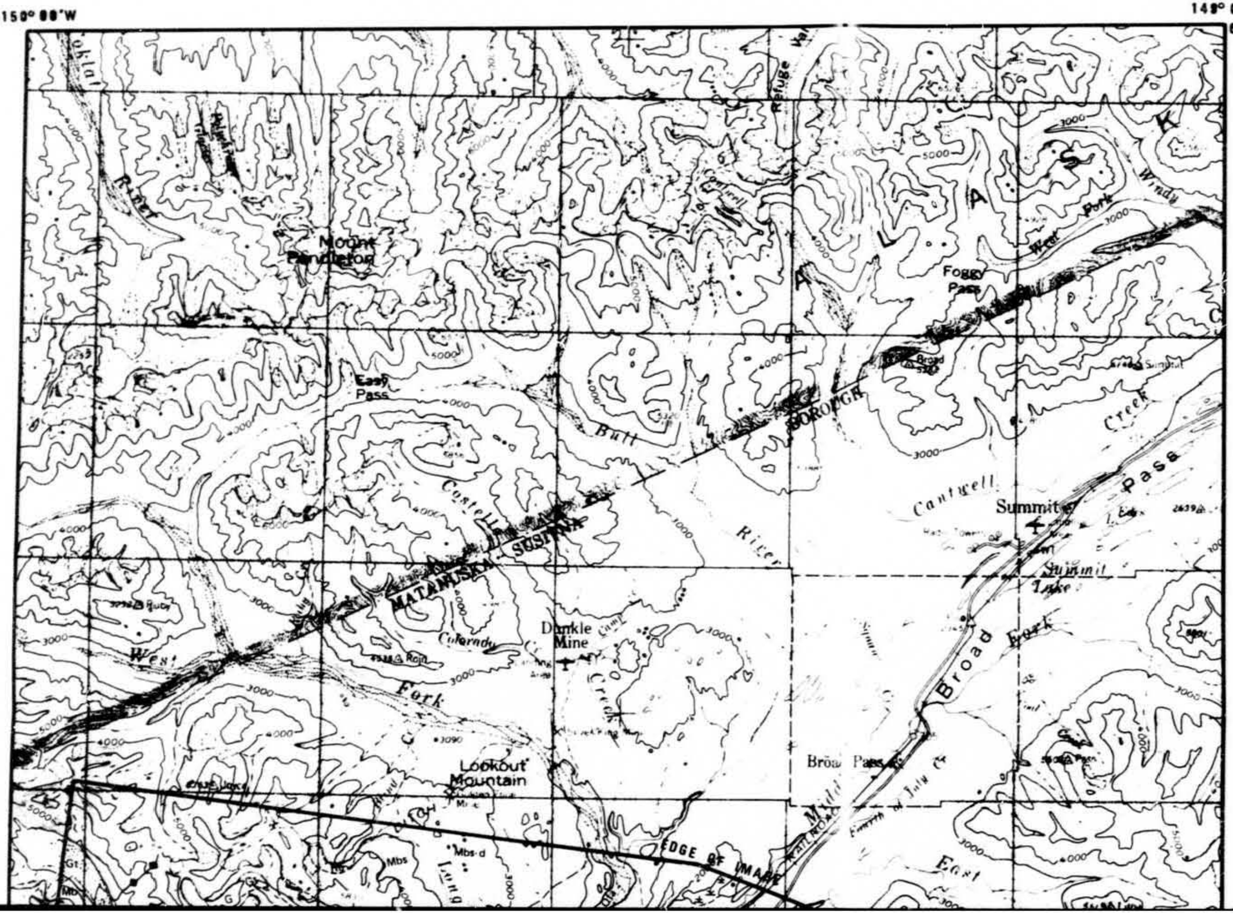
N

Scale 1:125,000 Approx.

1 0 1 2 3 Miles

2 0 2 4 6 Kilometers

PLATE 7



PHYSIOGRAPHY OF THE UPPER SUSITNA-CHULITNA RIVER AREA, ALASKA

by

KENNESON G. DEAN

1980

EXPLANATION

Physiographic Divisions

M - Mountainous Terrain, often blanketed by till
- bs - subdued, scoured bedrock
- b - angular bedrock
- v - vegetated with scattered rock outcrops, bedrock suspected at shallow depth

S - Sloping Terrain: generally used where terrain gradient covers a distance greater than one-mile along sides of broader valleys

Q - Broad valley floor

G - Glaciers

P - Plateau

Landforms

Glacial

t - Active glacial terminus

ob - Suspected abandoned glacial outwash channel

op - Pitted outwash fans

ow - Outwash fans

me - End moraine

ml - Lateral moraine

m - Ground moraine

d - Glacial drift

Suspected minor outwash channels on drift

dz - Drumlinized topography: consists of ridges of glacial drift intermixed with poorly drained low lying basins

di - Ice-disintegration complex

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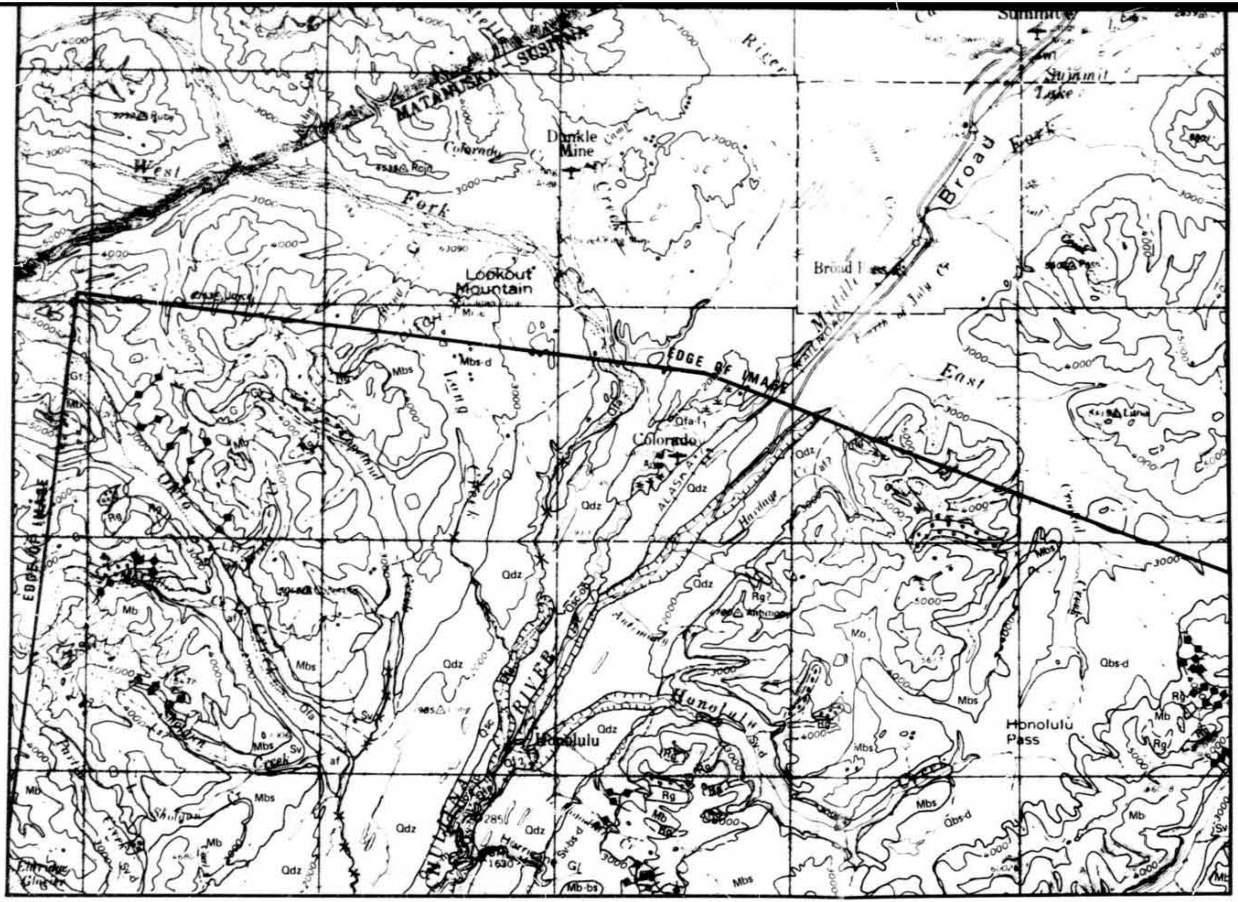
Paludal

w - Low lying basins conducive to trapping surface water

- Suspect standing water

Fluvial



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Mass Movement

Talus slopes

Avalanche and landslide chutes

Ls - Debris resulting from a landslide
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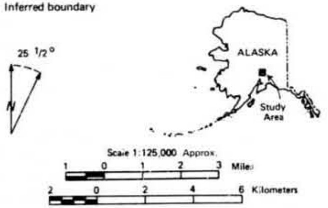
Boundary
Inferred boundary



63° 00′ N

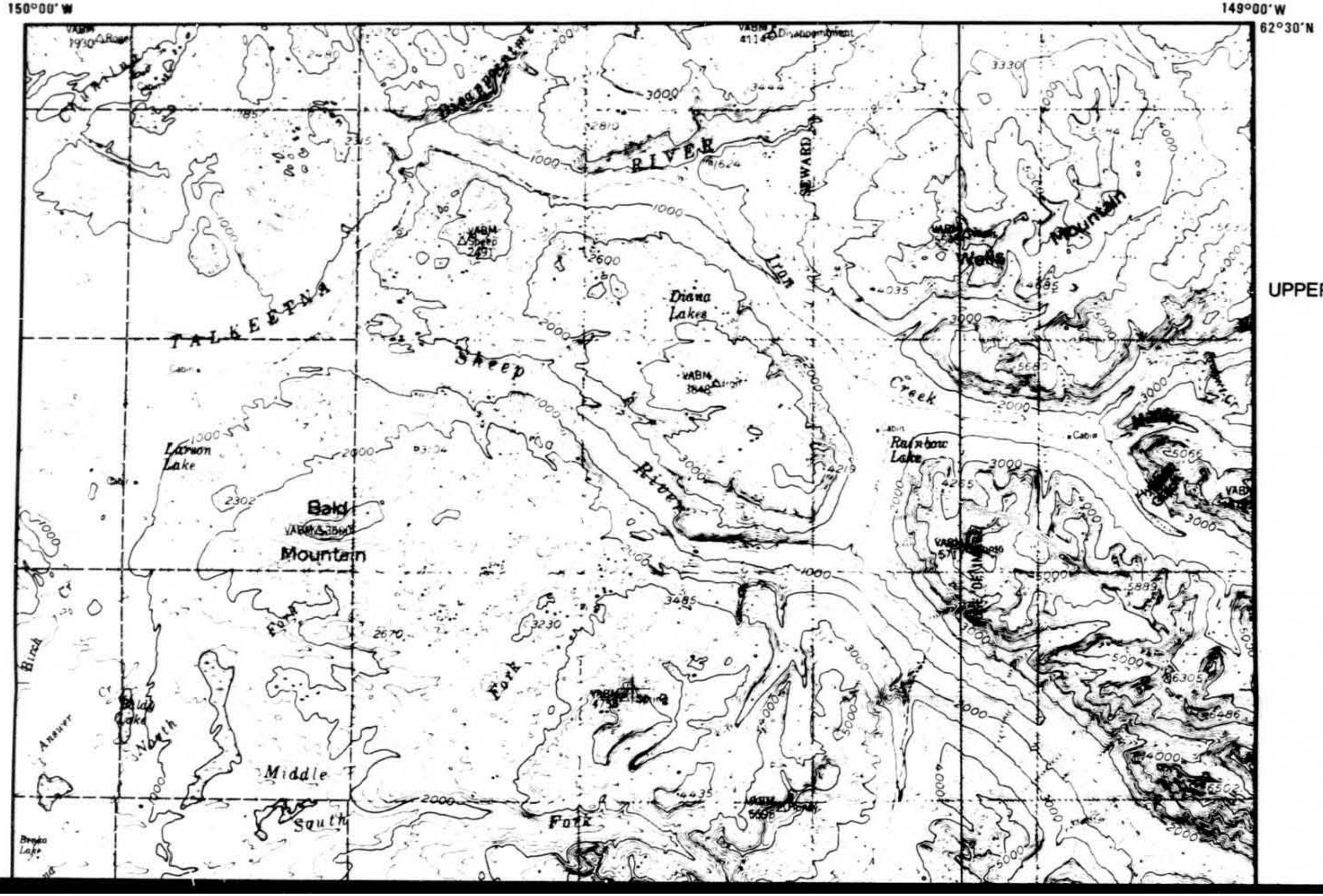
150° 00′ W

149° 00′ W

Based from U.S. Geological Survey 1:250,000, 1956

HEALY A-5, A-6, B-5, B-6

Plate 8



GEOLOGIC HAZARDS OF THE UPPER SUSITNA-CHULITNA RIVER AREA, ALASKA

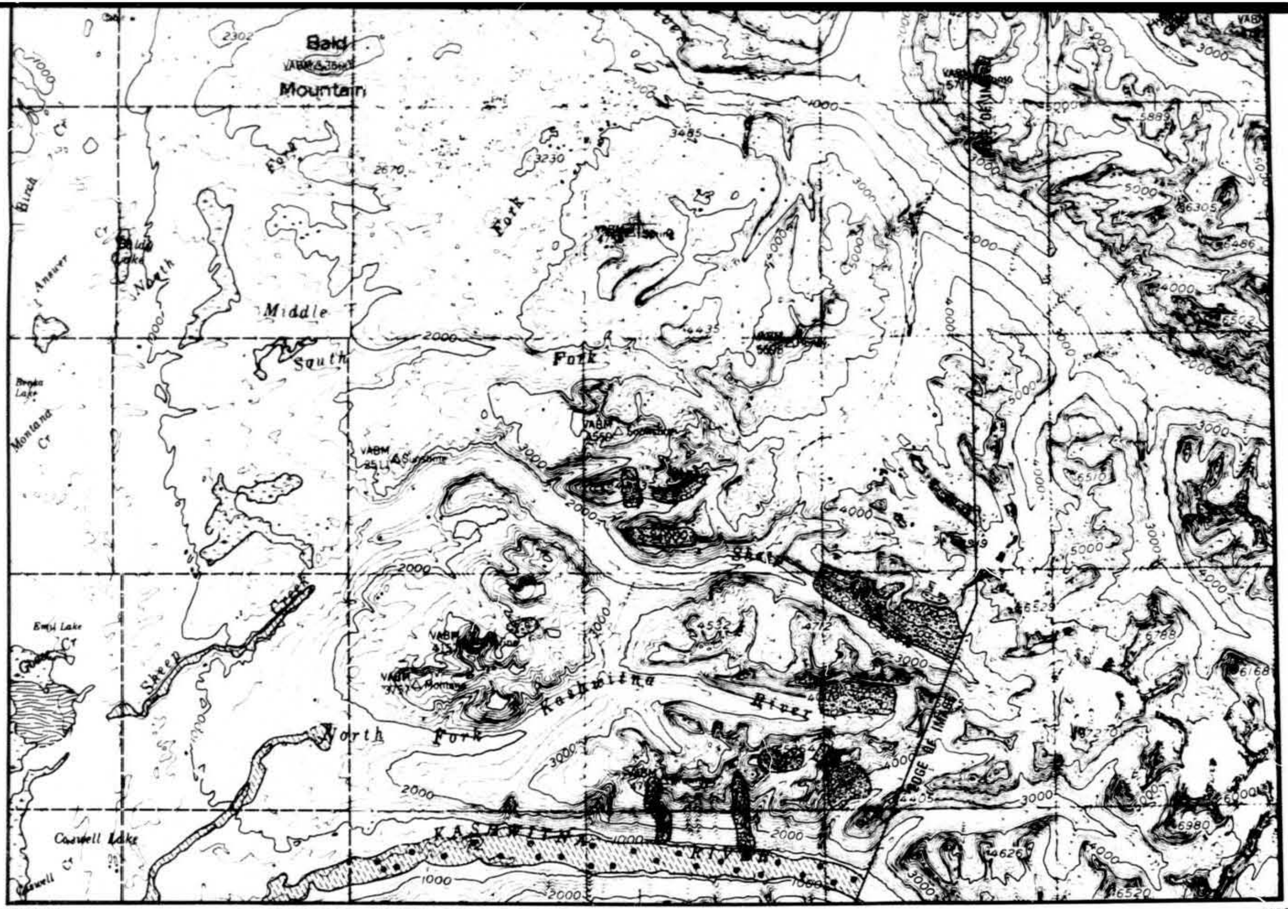
by

KENNESON G. DEAN

1980

EXPLANATION

- Primary floodplain: subject to annual seasonal flooding, and channel migration; includes existing stream channels
- Secondary floodplain: subject to periodic flooding not usually annual, portions may be active
- Glacier–dammed lakes
- Areas subject to outburst floods
- Probable extensive aufeis area
- Area with greater than about 50 percent standing water
- Zones subject to mass movement including avalanche chutes, landslides, and talus slopes with associated rock glaciers
- Alluvial fans; susceptible to torrential floods and debris flows



150°00' W
Based from U.S. Geological Survey
1:250,000, 1954

TALKEETNA MTNS. A-5, A-6, B-5, B-6,

149°00'W
62°00'N

Secondary floodplain: subject to periodic flooding not usually annual, portions may be active

Glacier–dammed lakes

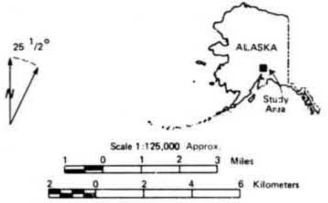
Areas subject to outburst floods

Probable extensive aufeis area

Area with greater than about 50 percent standing water

Zones subject to mass movement including avalanche chutes, landslides, and talus slopes with associated rock glaciers

Alluvial fans; susceptible to torrential floods and debris flows



151°00'W

150°00'W
62°30' N

Plate 9

GEOLOGIC HAZARDS OF THE UPPER SUSITNA-CHULITNA RIVER AREA, ALASKA

by
KENNESON G. DEAN
1980

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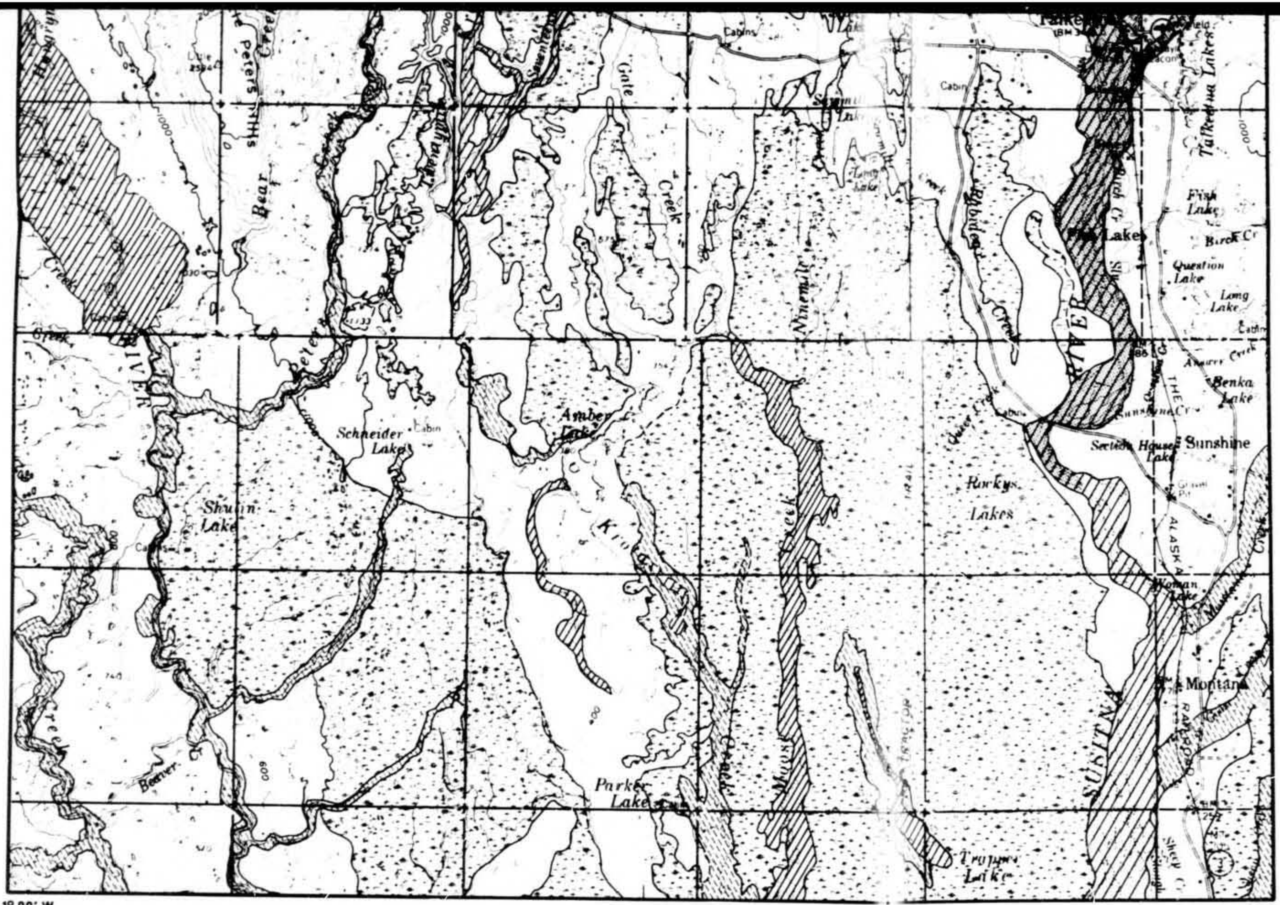


existing stream channels

Secondary floodplain: subject to periodic flooding not usually annual, portions may be active

Glacier–dammed lakes

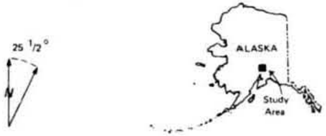
Areas subject to outburst floods

Probable extensive aufeis area

Area with greater than about 50 percent standing water

Zones subject to mass movement including avalanche chutes, landslides, and talus slopes with associated rock glaciers

Alluvial fans; susceptible to torrential floods and debris flows



Scale 1:125,000 Approx.

1 0 1 2 3 Miles

2 0 2 4 6 Kilometers

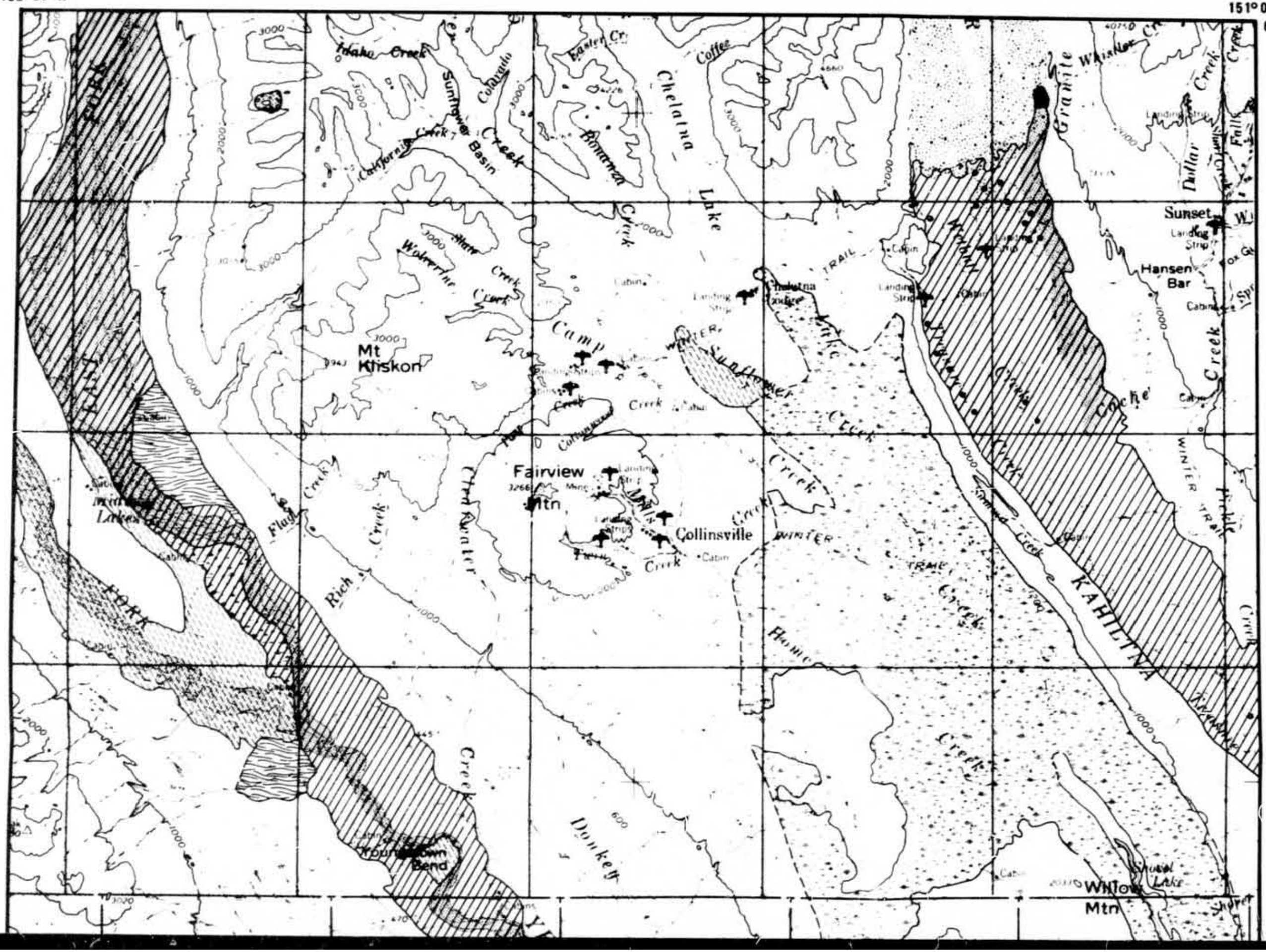
151° 00' W

62°00' N
150°00' W

Based from U.S. Geological Survey 1:250,000, 1958

TALKEETNA A-1, A-2, B-1, B-2

Plate 10



GEOLOGIC HAZARDS OF THE UPPER SUSITNA-CHULITNA RIVER AREA, ALASKA

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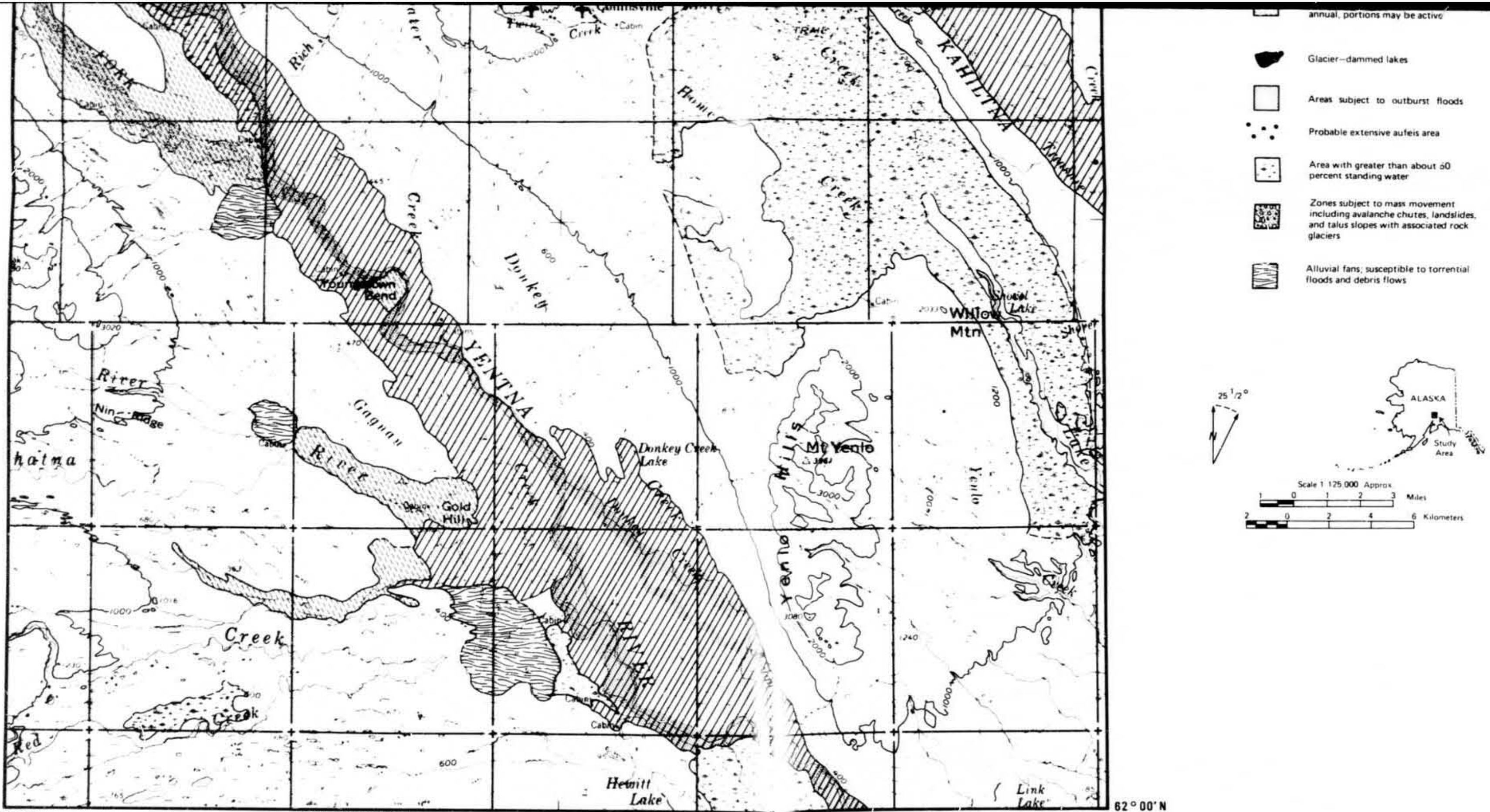
- Alluvial fans; susceptible to torrential floods and debris flows



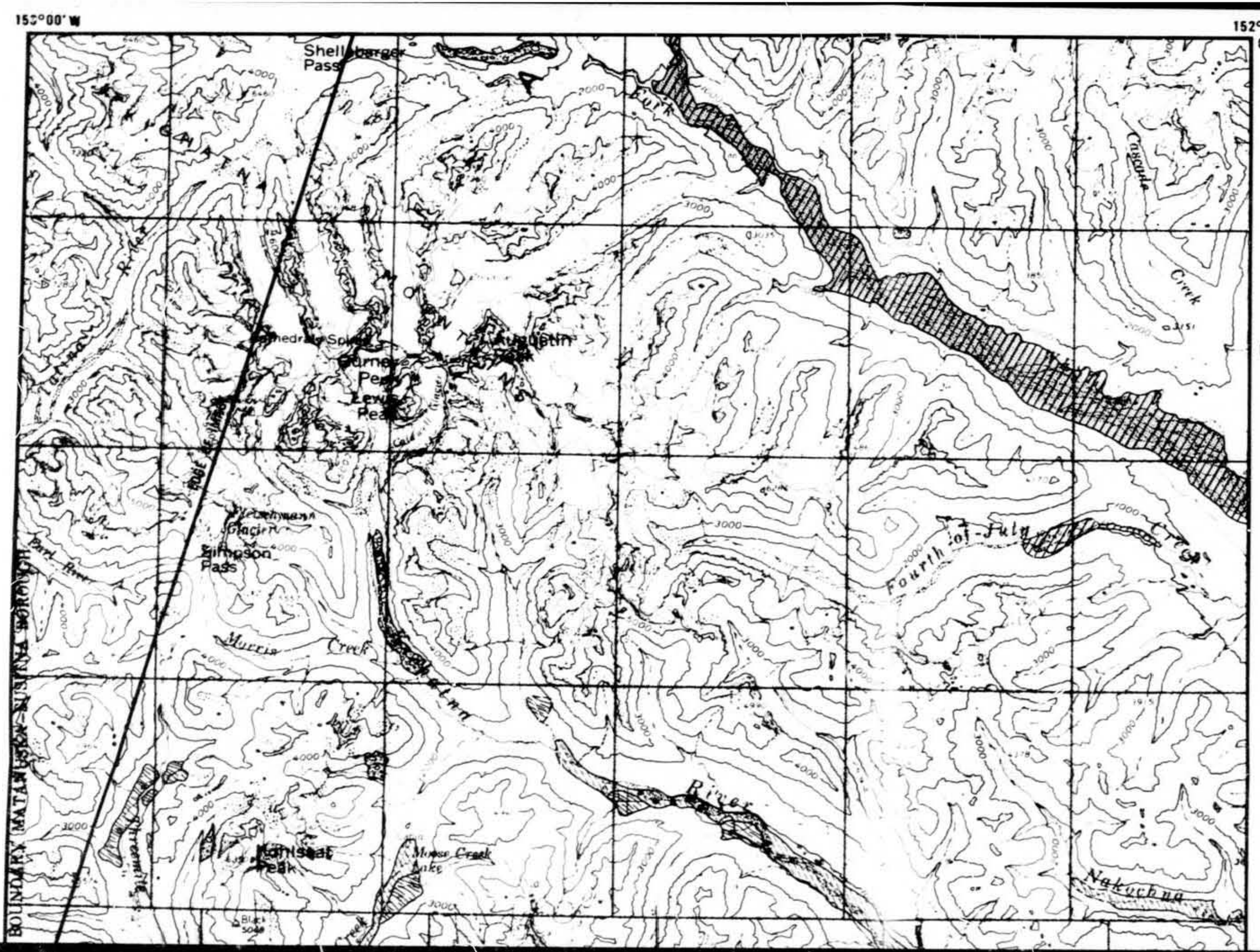
152°00'W

Based from U.S. Geological Survey 1:250,000, 1958

TALKEETNA A-3, A-4, B-3, B-4

151°00'W

Plate 11



GEOLOGIC HAZARDS OF THE UPPER SUSITNA-CHULITNA RIVER AREA, ALASKA

by

KENNESON G. DEAN

1980

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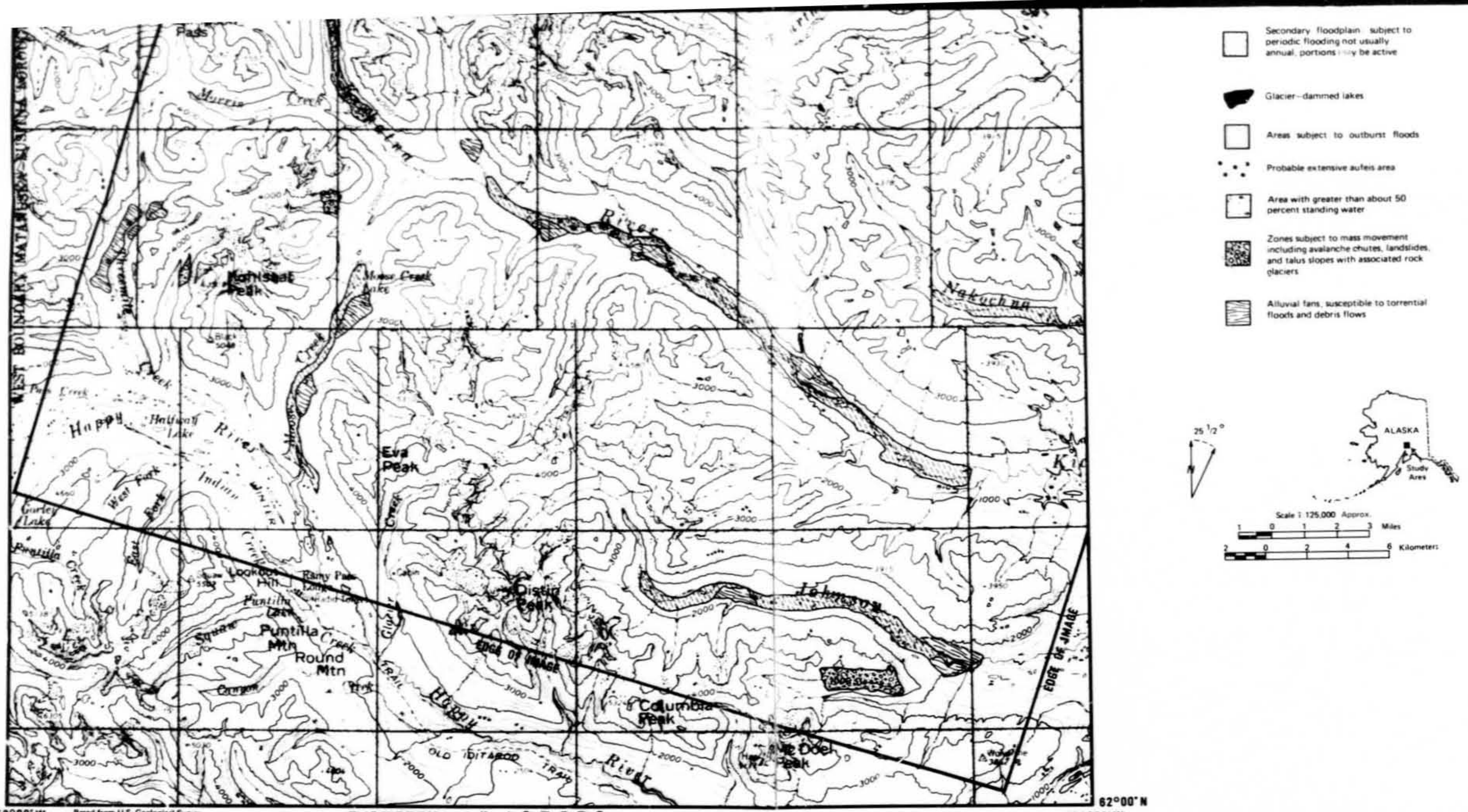
- Alluvial fans, susceptible to torrential floods and debris flows

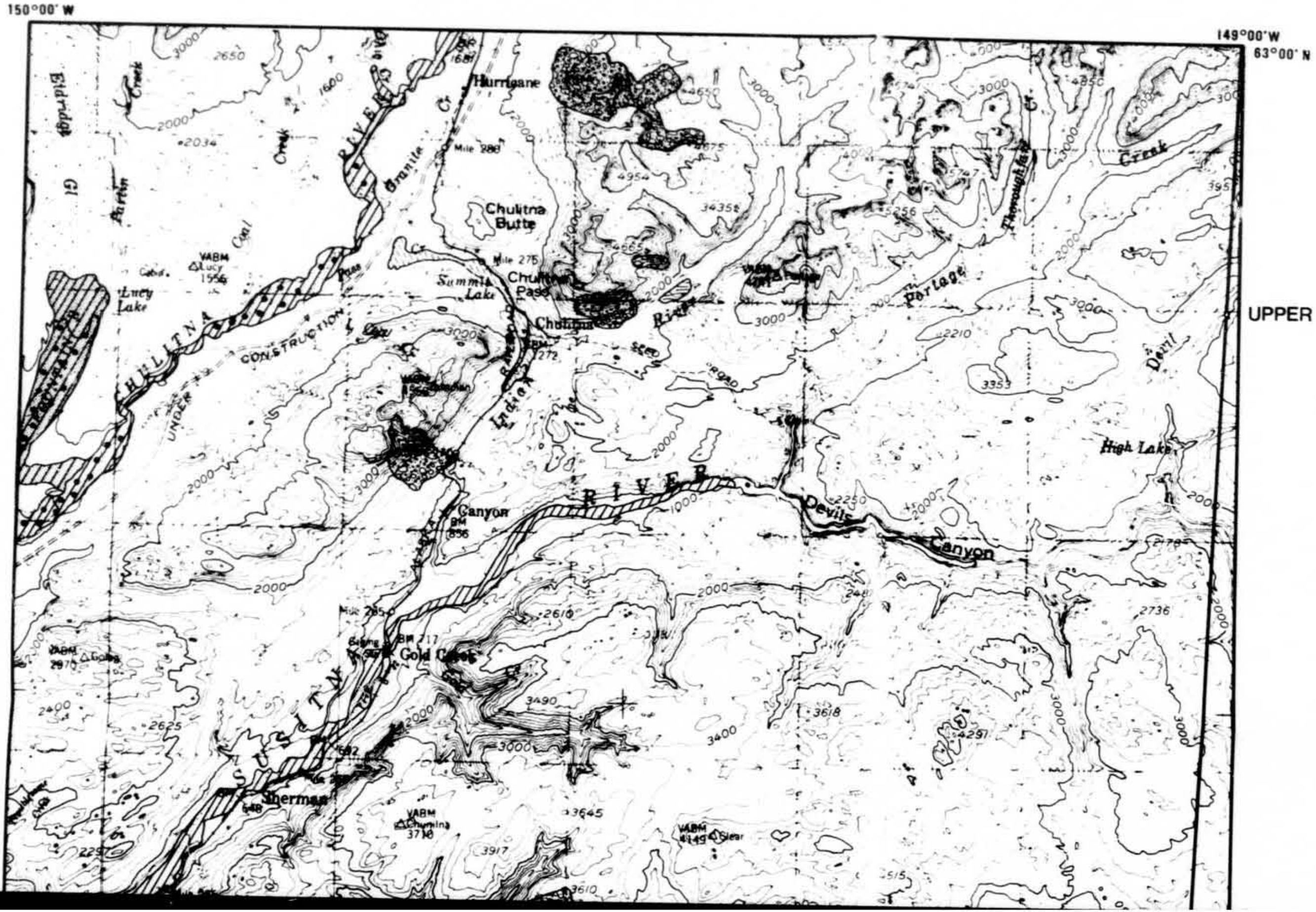


153°00' W
Based from U.S. Geological Survey 1:250,000, 1954

TALKEETNA A-5, A-6, B-5, B-6

62°00' N
152°00' W

Plate 12



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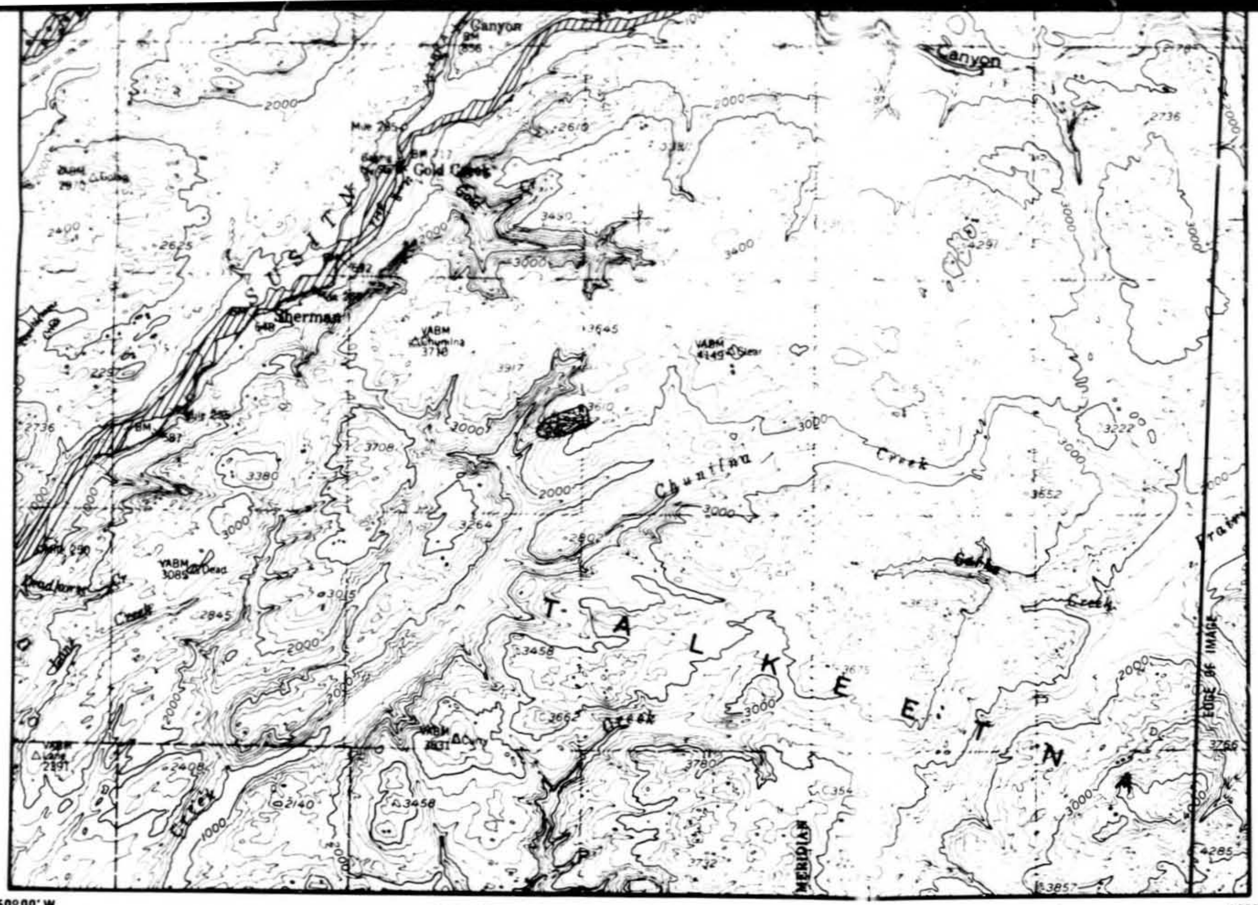

150°00' W

62°30' N

149°00' W

TALKEETNA MTNS. C-5, C-6, D-5, D-6,

Based from U.S. Geological Survey 1:250,000, 1954

existing stream channels

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Glacier–dammed lakes

Areas subject to outburst floods

Probable extensive aufeis area

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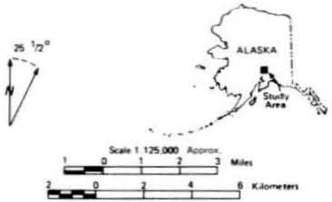

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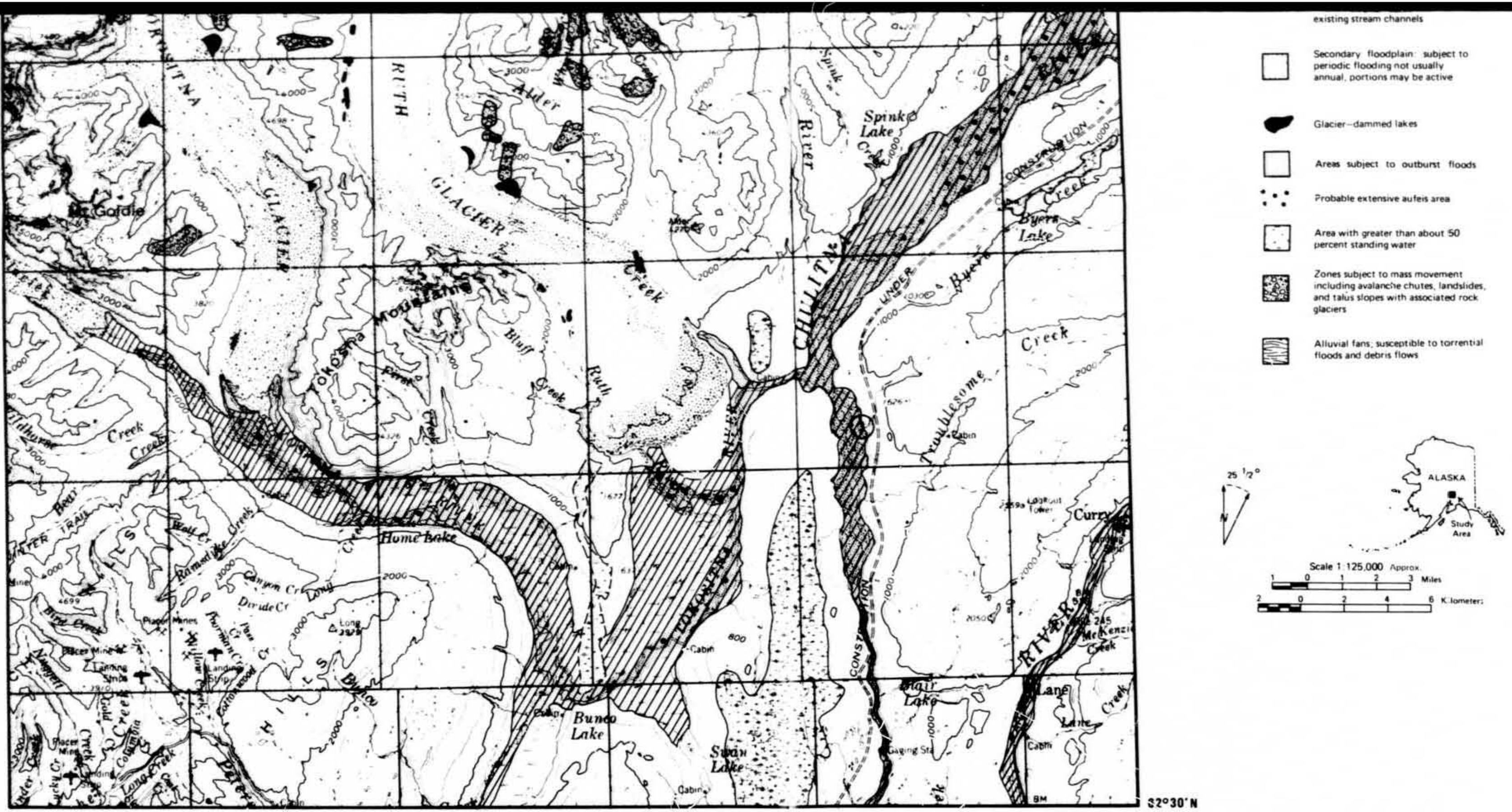

150°00' W

151°00' W

62°30' N

TALKEETNA C-1, C-2, D-1, D-2,

Based from U.S. Geological Survey 1:250,000, 1958

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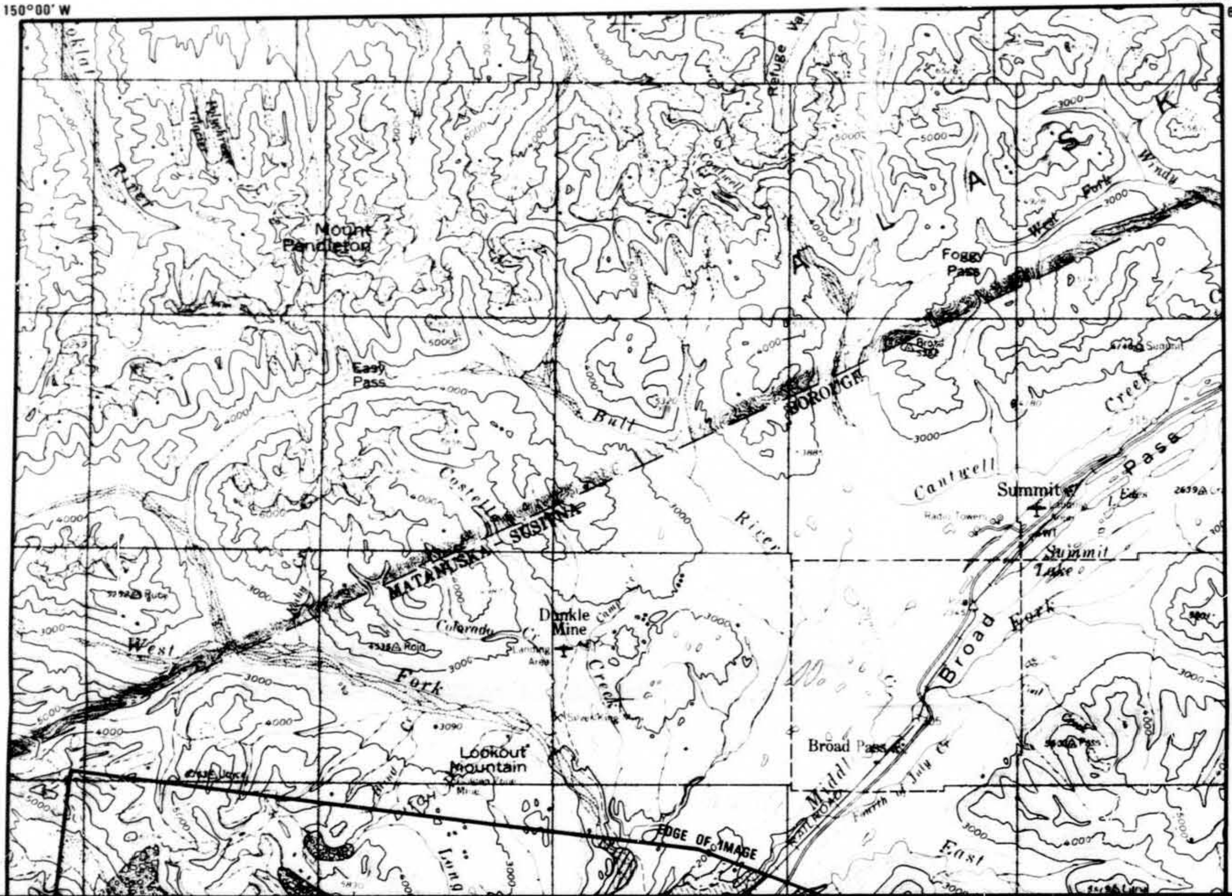
Plate 14



GEOLOGIC HAZARDS OF THE UPPER SUSITNA-CHULITNA RIVER AREA, ALASKA

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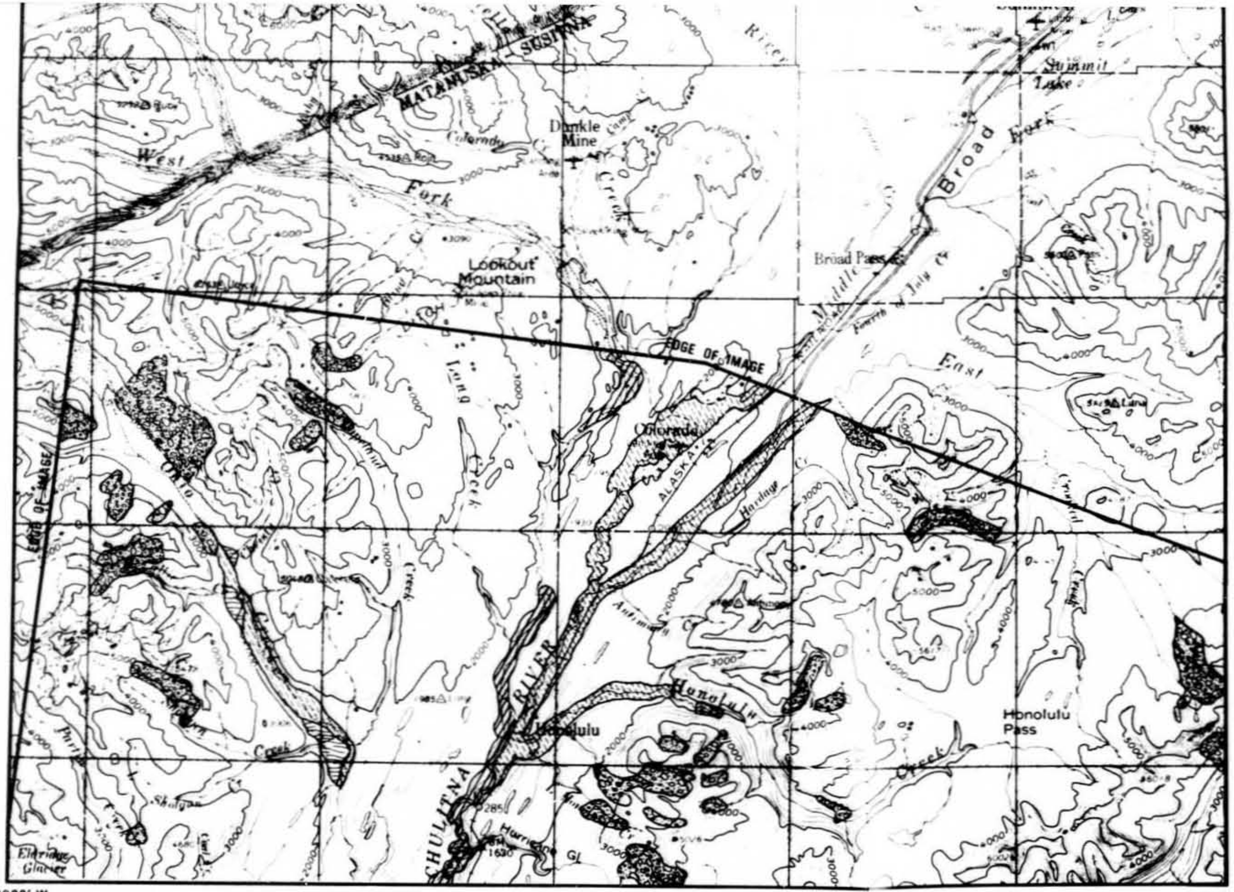

HEALY A-5, A-6, B-5, B-6,

Based from U.S. Geological Survey
1:250,000, 1956

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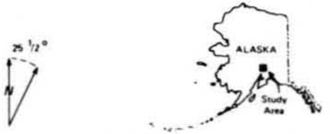

Scale 1:125,000 Approx.

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