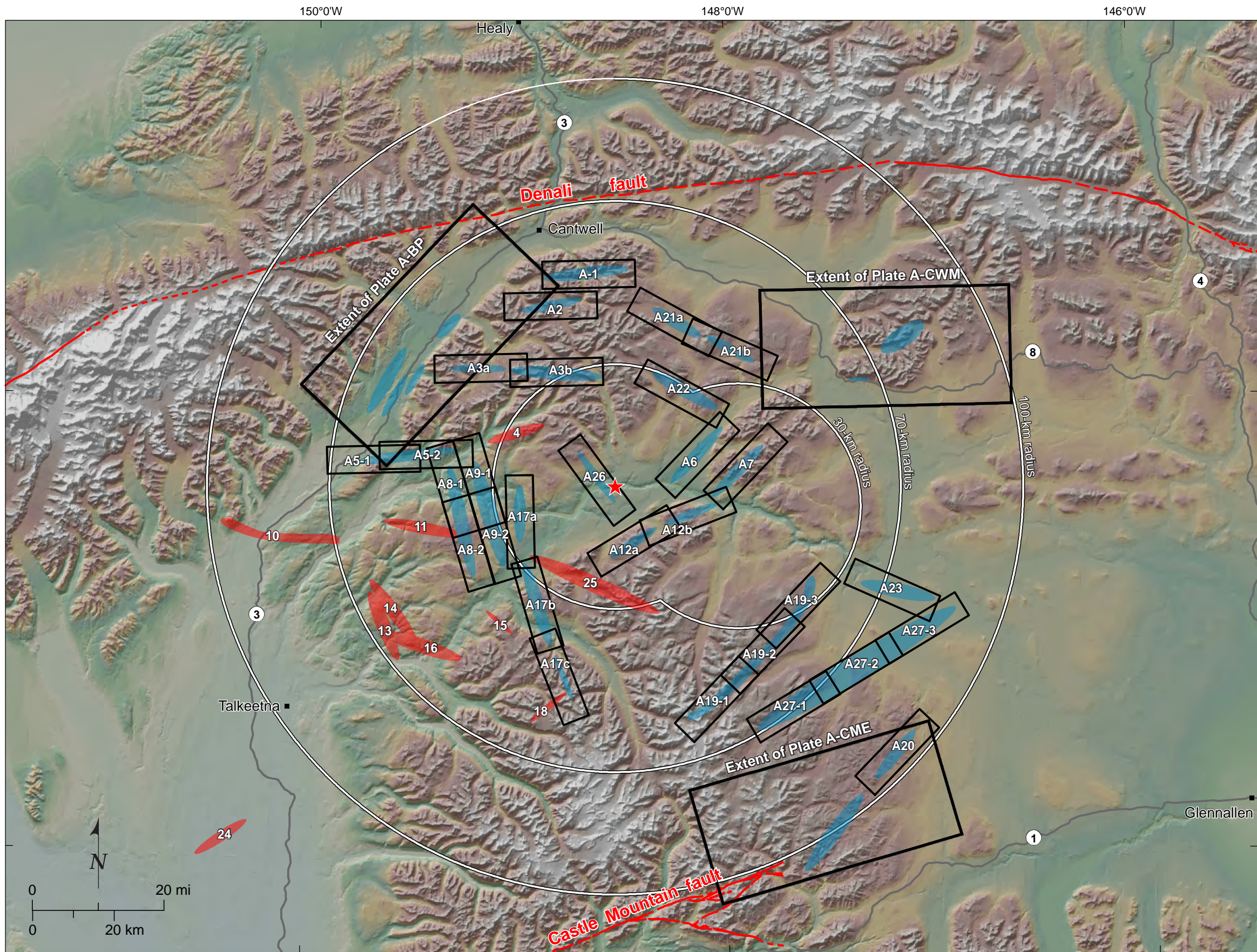


**Appendix A:  
Strip Maps and Photographic Documentation  
of Lineament Data Presented in FCL (2013)**



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



















Explanation	
	Quaternary fault, solid where well constrained, long dash where moderately constrained, short dash where inferred (Koehler et al., 2012)
	Extent of stripmap tile; figure number indicated
	Field work planned in 2013 based on results of TM-8 (FCL, 2013)
	No field work planned in 2013 based on results of TM-8 (FCL, 2013)
	Proposed Watana site
Lineament Groups and Corresponding Figures	
Lineament Group	Appendix A Figure Number
1	A1.1, A1.2
2	A2.1, A2.2
3a	A3a.1, A3a.2
3b	A3b.1, A3b.2
4	None, see TM-8 (FCL, 2013)
5	A5-1.1, A5-2.1, A5-2.2
6	A6.1, A6.2, A6.3, A6.4
7	A7.1, A7.2
8	A8-1.1, A8-2.1, A8-2.2, A8-2.3
9	A9-1.1, A9-2.1, A9-2.2, A9-2.3, A9-2.4
10	None, see TM-8 (FCL, 2013)
11	None, see TM-8 (FCL, 2013)
12a	A12a.1, 12a.2
12b	A12b.1, 12b.2
13	None, see TM-8 (FCL, 2013)
14	None, see TM-8 (FCL, 2013)
15	None, see TM-8 (FCL, 2013)
16	None, see TM-8 (FCL, 2013)
17a	A17a.1, A17a.2
17b	A17b.1, A17b.2, A17b.3
17c	A17c.1, A17c.2
18	None, see TM-8 (FCL, 2013)
19	A19-1.1, A19-1.2, A19-1.3, A19-2.1, A19-2.2, A19-3.1, A19-3.2
20	A20.1, A20.2, A20.3, A20.4, A20.5, A20.6
21a	A21a.1, A21a.2
21b	A21b.1, A21b.2, A21b.3
22	A22.1, A22.2
23	A23.1
24	None, see TM-8 (FCL, 2013)
25	None, see TM-8 (FCL, 2013)
26	A26.1, A26.2
27	A27-1.1, A27-2.1, A27-3.1, A27-3.2
Broad Pass area	Plate A-BP, A-BP.1, A-BP.2, A-BP.3
Castle Mtn. fault extension	Plate A-CME, A-CME.1, A-CME.2
Clearwater Mtns. area	Plate A-CWM, A-CWM.1, A-CWM.2, A-CWM.3



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
























This explanation applies to all figures and plates in Appendix A.

Geologic Units from OFR 09-1108 (Wilson et al., 2009)













	Water, ice field, or glacier
<b>Unconsolidated Deposits</b>	
	Surficial deposits, undivided
	Alluvium along major rivers and in terraces
	Landslide and colluvial deposits
	Glacial deposits, undivided
	Young moraine deposits
	Major moraine and kame deposits
	Glacioalluvium
	Outwash in plains, valley train, and fans
	Glacioestuarine deposits
<b>Sedimentary Rocks</b>	
	Sedimentary rocks, undivided
	Kenai Group, undivided
	Tsadaka Formation
	Chickaloon formation
	Matanuska formation
	Turbiditic sedimentary rocks of the Kahiltna flysch sequence
	Undivided Chinitna and Tuxedni formations
	Naknek Formation, undivided
	Talkeetna Formation, undivided
	Limestone and Marble
	Eagle Creek Formation, marine argillite and limestone

Note: For full explanation of geologic units see USGS OFR 09-1108 and USGS OFR 98-133.



**Igneous Rocks**

Volcanic and Hypabyssal Rocks	
	Tertiary volcanic rocks, undivided
	Felsic volcanic and sub-volcanic rocks
	Mafic volcanic rocks
	Dikes and sills
	Nikolai Greenstone and related rocks
	Slana Spur Formation, volcanoclastic rocks
	Station Creek Formation andesitic volcanic rocks
Plutonic Rocks	
	Intrusive rocks, undivided
	Granitic rocks
	Granitic rocks of Paleocene age
	Biotite-hornblende-granodiorite
	Granitic rocks, undivided
	Granodioritic rocks
	Granodiorite
	Trondhjemite
	Diorite, gabbro, picrite, and pyroxenite sill and dike swarm complex
	Quartz diorite, tonalite, and diorite
	Granodiorite and quartz monzonite
<b>Melange and Metamorphic Rocks</b>	
	Gneiss
	Plutonic and metamorphic rocks, undifferentiated
	Amphibolite
	Marble
	Metabasalt and slate
	Basaltic to andesitic metavolcanic rocks
	Metamorphosed Skolai Group


Geologic Units from OFR 98-133 (Wilson et al., 1998)

	Ice fields or glaciers
	Water
	Surficial deposits, undifferentiated
	Tertiary volcanic rocks, undivided
	Hypoabyssal felsic and intermediate intrusions
	Granitic and volcanic rocks, undivided
	Granite and granodiorite
	Phyllite, pelitic schist, calc-schist, and amphibolite of the MacLaren metamorphic belt
	Granitic rocks
	Kahiltna flysch sequence
	Calcareous sedimentary rocks
	Metavolcanic and associated metasedimentary rocks













Tectonic Features from WCC report (WCC, 1982)

	Detailed feature, from site-specific maps
	Regional feature, from small-scale maps




For completeness, features from both regional and detailed scale figures have been included. The location of regional features may not always be accurate and the detailed features may be limited to the extent shown on original figures.

 Location of trench T-2 (shown on Figures A14 and A16)






Faults Compiled by FCL (Wilson et al., 1998; Wilson et al., 2009; Williams and Galloway, 1986; Clautice, 1990; Clautice, 2001; Csejtey, 1978; Kachadoorian, 1979; Smith, 1988)

	Fault, approximate
	Fault, inferred or queried
	Fault, certain
	Fault, concealed
	High-angle reverse fault, approximate
	High-angle reverse fault, certain
	High-angle reverse fault, concealed
	High-angle reverse fault, inferred or queried
	Thrust fault, approximate
	Thrust fault, certain
	Thrust fault, concealed
	Lineament

Hydrographic Features from National Hydrography Dataset, 2000, 1:24,000 scale

	Stream
	Ice mass
	Lake or pond

Other Items

	Location of photograph taken during 2013 and 2014 field reconnaissance, labeled with photo ID and showing view direction
	GPS waypoint
	GPS track line, July and September 2013
	GPS track line, July and September 2014
	Proposed Watana site



\\twb-wc-filer\project\Projects\79\_2000\79\_218900\_Alaska\_Rail\05\_Graphics\79\_218900\_TM14 January 2014 Lineament Report 79\_218900 Appendix A

Attributes of lineaments mapped by FCL (2013) that apply to all figures and plates in Appendix A

Reconnaissance (INSAR)

- 1 - 5
- 10
- 77
- 88

Detail (LiDAR)

- 1 - 5
- 10
- 77
- 88

Lineament Groups

17a

Lineament group mapped for this study coinciding with previously mapped fault or lineament

25

No previously mapped fault or lineament coincides with lineament group

Attribute	Cross Section Morphology*	Description	Examples
1		Linear break-in-slope bisecting a planar surface	Uphill- or downhill-facing scarps, lateral moraines or kame deposits along lateral margins of valley glaciers
2		Abrupt changes in slope adjacent to otherwise relatively horizontal (and planar) surfaces	Linear range fronts, faceted ridges, terrace risers, steep downstream faces of roushe mountonees
3		Linear U-shaped trough	Glacial valleys, ice-scoured flutes, flood-scoured flutes,
4		Linear V-shaped trough	Active stream channels
5		Linear ridges	Drumlins, water-scoured terrain, eskers
6 (also 77)	n/a	A series of aligned features	Could include attributes #1 -5 above and/or aligned saddles, tonal lineaments, etc.
66	n/a	Data artifacts	Linear seams between data sets collected on different dates
88	n/a	A series of aligned features, which are too small to individually map at the given scale	Could include features with attributes #1-5 above and/or aligned saddles, tonal lineaments, etc.
99	n/a	A line which encloses a broad expanse of features all having the same orientation	An area of jointing or of glacial striae all having the same, parallel orientation
10	n/a	Anthropogenic lineaments	Roads, rail roads, power lines and other linear clearings, etc.

Notes: \*Arrow points to location of the mapped feature.

Explanation for relevant geologic units of Williams and Galloway (1986) shown on Figure A20.5 and A23.1

Geologic Units



Bottom deposits of 914 - 975 m lake

Overprint denoting glacial drift that is mantled by bottom sediments of glacial lake that extended to 914 - 975 m above modern sea level, largely confined to middle Susitna valley, above ice dam below Fog Lake (off map) and apparently bounded on east and south side by glacier ice. Does not cover late(st) Wisconsin (last major) morainial systems. No shoreline features are mapped.



Bottom deposits intermediate (777 - 747) lake

Overprint denoting bottom deposits of a local lake that covered melting glacier ice between Tyone Lake and Lake Louise, apparently behind Tyone Spillway, and drained as the elevation of the spillway was cut down from 777 m to 747 m above sea level while stagnant ice was still in valley bottom.



Bottom deposits of last regional lake

Overprint denoting drape of bottom deposits over drift and thick lake sediments that persisted in Copper River drainage basin from just before deposition of Old Man moraines to a time when glaciers had retreated to within 16 to 24 km of present glaciers: older than 13,000 years.

Symbols



Location and letter designation of radiocarbon-dated stratigraphic section in accompanying text.



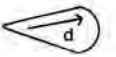
Ice boundary, morainial ridge, kame terrace, delta, or other ice contact feature marking edge of glacier: hachures toward glacier.



Shoreline of regional lake: mapped for the lake in Copper River basin where at 747 m (maximum elevation); the elevation to which Tyone Spillway was eroded, and successively lower levels in the northern part of area between 747 m and 701 m above sea level. Lesser recessional shorelines mapped by Nichols and Yehle (1969) not shown.



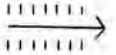
Upper limit of post-glacial (Holocene, in part) shoreline of Tazlina Lake from elevation 564 m down to present lake level 544 m caused by lowering of lake as Tazlina River has deepened its canyon.



Delta of glacial lake, including those of modern glacial lakes such as Tazlina Lake.



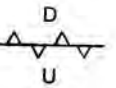
Linear or drumlinoid feature, due to ice scour, direction of ice movement indicated by arrow.



Spillway for glacial meltwater, including that stored in large glacial lakes.



Contact between map units where not glacial boundary, most commonly between different levels of lake deposits.



Active (?) fault, lower Sonoma Creek, offsetting unconsolidated deposits.



Location of selected erratic boulders, mountain top erratic stones transported by glaciers, e.g. Sheep Mountain; many occurrences on mountains lower than 1829 m not shown.



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Explanation for relevant geologic units of Smith et al. (1988) shown on Figure A21b.1

UNCONSOLIDATED DEPOSITS

Alluvial deposits

**Qa** FLOODPLAIN ALLUVIUM - Unconsolidated deposits in modern stream drainages. Material ranges from coarse, unsorted gravel in highland valleys to finely bedded silt in large river drainages.

Glacial deposits

**Qdt<sub>3</sub>** TILL OF LATE WISCONSIN AGE - 11,800 to 25,000 yr B.P.


**Qdt<sub>2</sub>** TILL OF EARLY WISCONSIN AGE - 40,000 to 75,000 yr B.P.

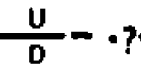
**Rs** SCHIST - Medium- to coarse-grained biotite-plagioclase-quartz schist with local garnet and feldspar porphyroblasts to 0.5 mm. Dominantly gray or brown weathering. Includes local horizons that contain randomly oriented hornblende on foliation surfaces. Stippled pattern near intrusive contacts indicates hornfelsed zone in schist. K-Ar age of 57.2 m.y. was obtained from biotite in this unit in the adjacent Healy A-1 Quadrangle (Smith, 1981).


**Kp** PHYLLITE - Silver-gray, biotite-bearing phyllite with biotite porphyroblasts to 2mm long; locally calcareous. Minor compositional banding with more quartzose layers parallel to foliation. Biotite yielded K-Ar age of 53 ± 1.6 m.y. (loc. 3 on map; Turner and Smith, 1974). Grades into amphibole-bearing phyllite (Khp) unit.


**Khp** AMPHIBOLE-BEARING PHYLLITE - Medium to dark gray spotted phyllite with planar laminations. Spotted with porphyroblastic biotite. Interlayered with beds that contain randomly oriented amphibole on foliation surfaces. Amphibole prisms commonly 0.5 to 3 mm long. K-Ar age of actinolitic hornblende from this unit in Healy A-I Quadrangle is 64.1 m.y. (Smith, 1981).

MAP SYMBOLS

 Contact - dashed where approximately located ; dotted where concealed; queried where inferred

 High-angle fault - dashed where approximately located; dotted where concealed; queried where inferred. D, downthrown side; U, upthrown side


 Thrust fault - dashed where approximately located. Sawteeth on upper plate. Arrow indicates dip of fault


 Lineament - inferred from aerial photographs, may represent fault


Modified from selected portion of Smith et al. (1988) explanation


Explanation for relevant geologic units of Reger (1990) shown on Figure A21a.2

GLACIAL LIMITS


 Glaciation of unassigned age, dashed where discontinuously mapped


 Glaciation of Illinoian age, dashed where discontinuously mapped

 Glaciation of late Wisconsin age, dashed where discontinuously mapped


 Glaciation of Holocene age, dashed where discontinuously mapped


OTHER FEATURES


 Prominent meltwater drainage channel

 Radiocarbon sample locality


PROMINENT WAVE-CUT SCARPS


 3,700-ft (1,120-m) lake, dashed where discontinuously mapped, dots on descending scarp


 3,650-ft (1,110-m) lake, dashed where discontinuously mapped, open triangles point down descending scarp

 3,400-ft (1,030-m) lake, dashed where discontinuously mapped, solid triangles point down descending scarp


AREAS INUNDATED BY GLACIER-DAMMED LAKES


 3,700-ft (1,120-m) lake


 3,650-ft (1,110-m) lake

 3,400-ft (1,030-m) lake

Explanation for relevant geologic units and features from Acres, 1982 shown on Figure A6.1

 Contact

 Thrust fault

 Shear

QUATERNARY

**Qa** Alluvium, alluvial terraces and fans

**Qid** Ice disintegration deposits

**Qt** Till

**Qo** Outwash

TERTIARY

**Tsu** Conglomerate, sandstone and claystone

MESOZOIC

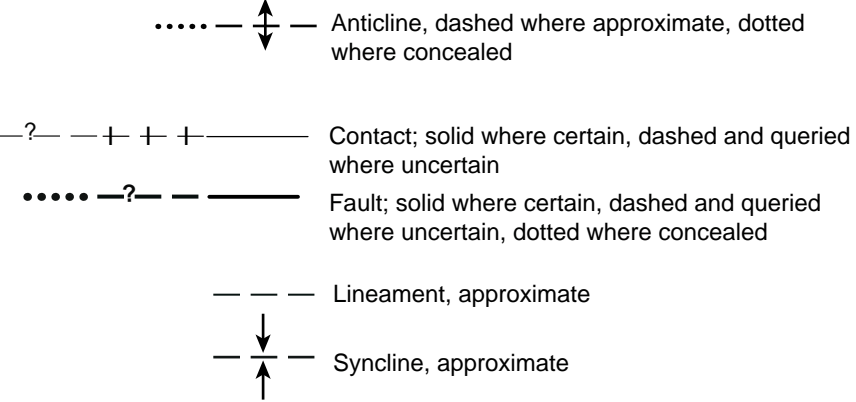
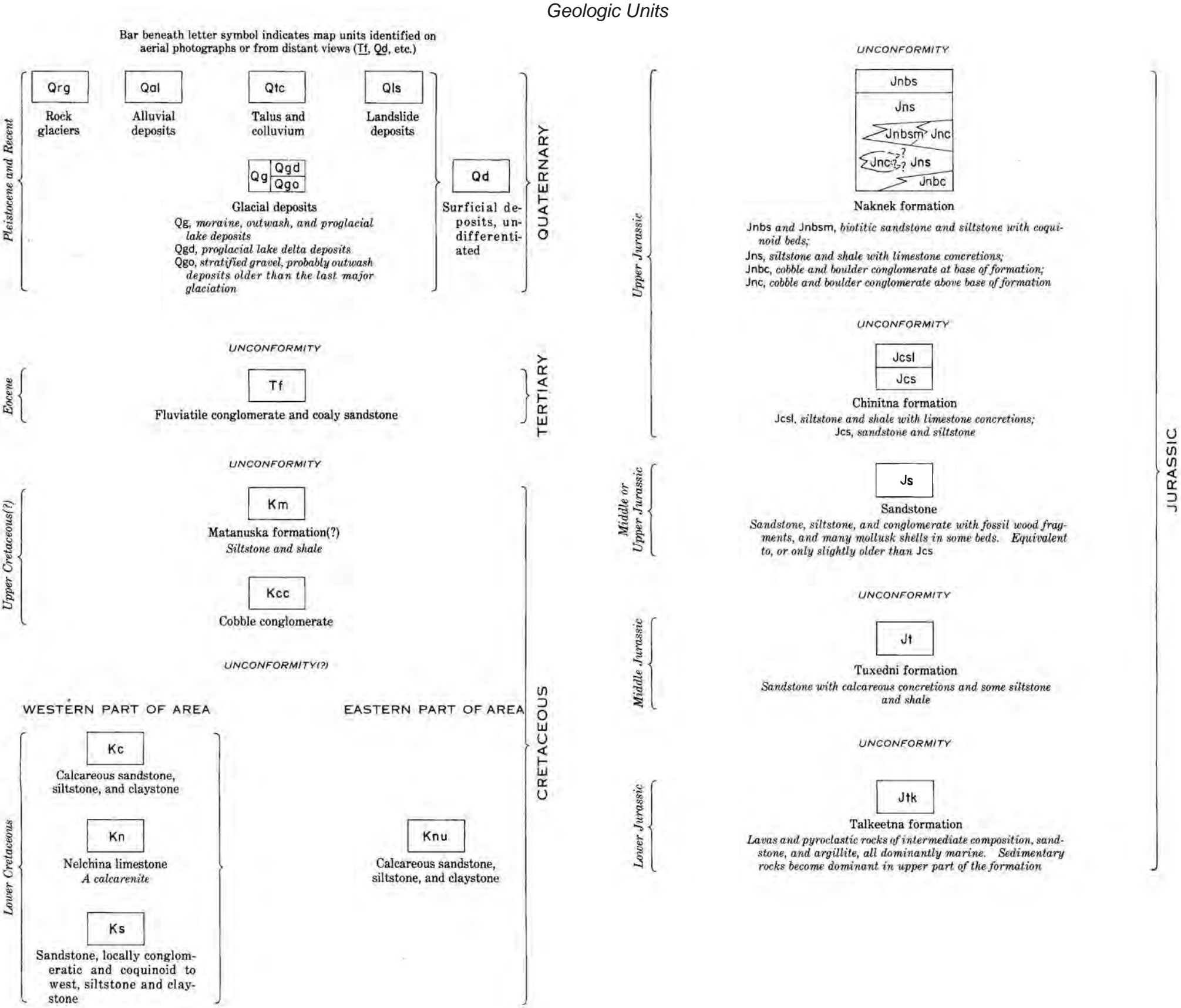
TRIASSIC

**TRvs** Basaltic metavolcanic rocks, metabasalt and slate

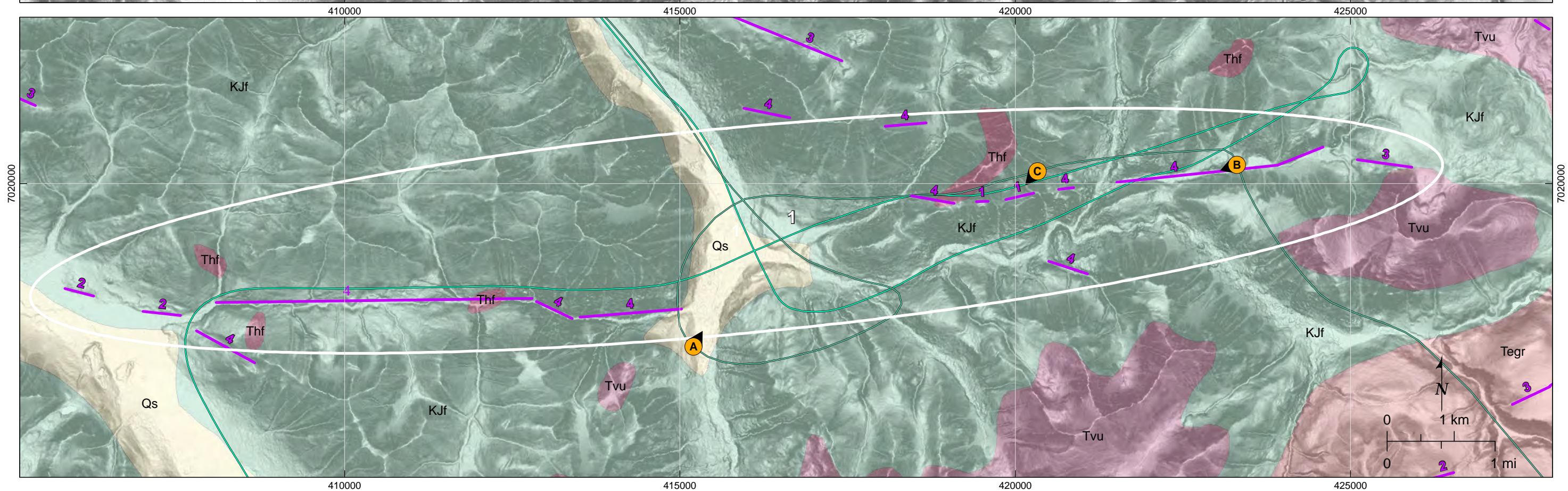
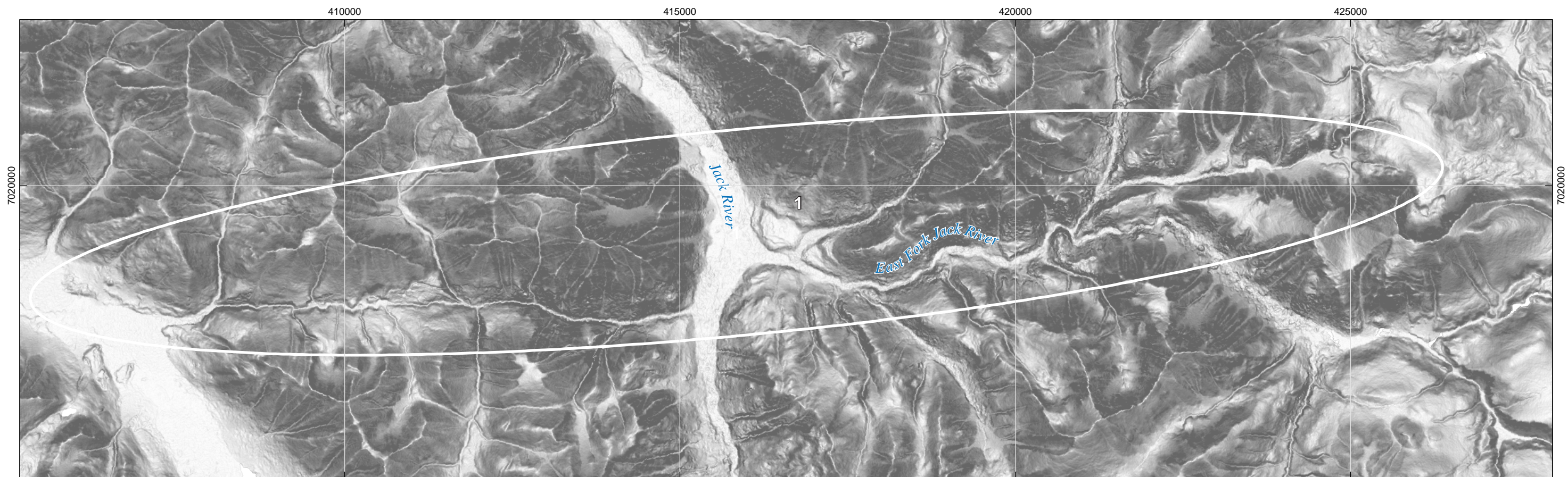


Explanation

Lineaments, Faults, Contacts,  
Synclines, and Anticlines

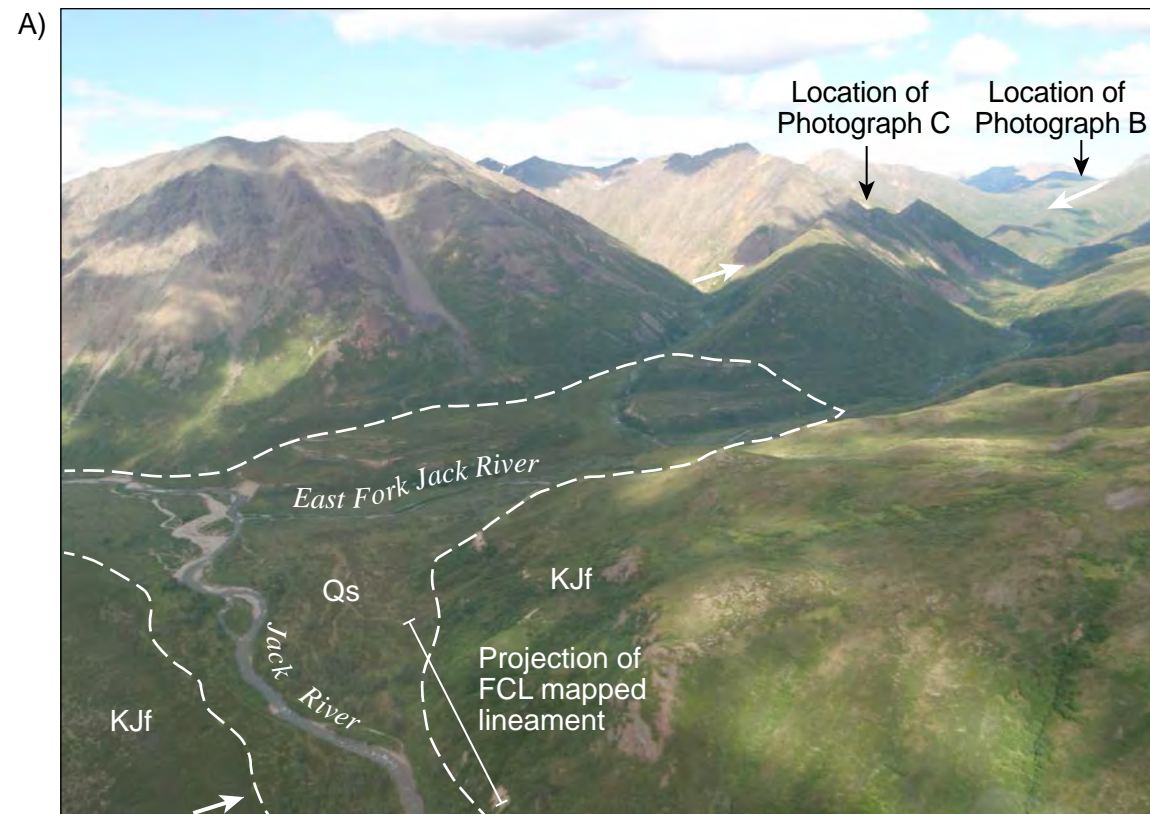




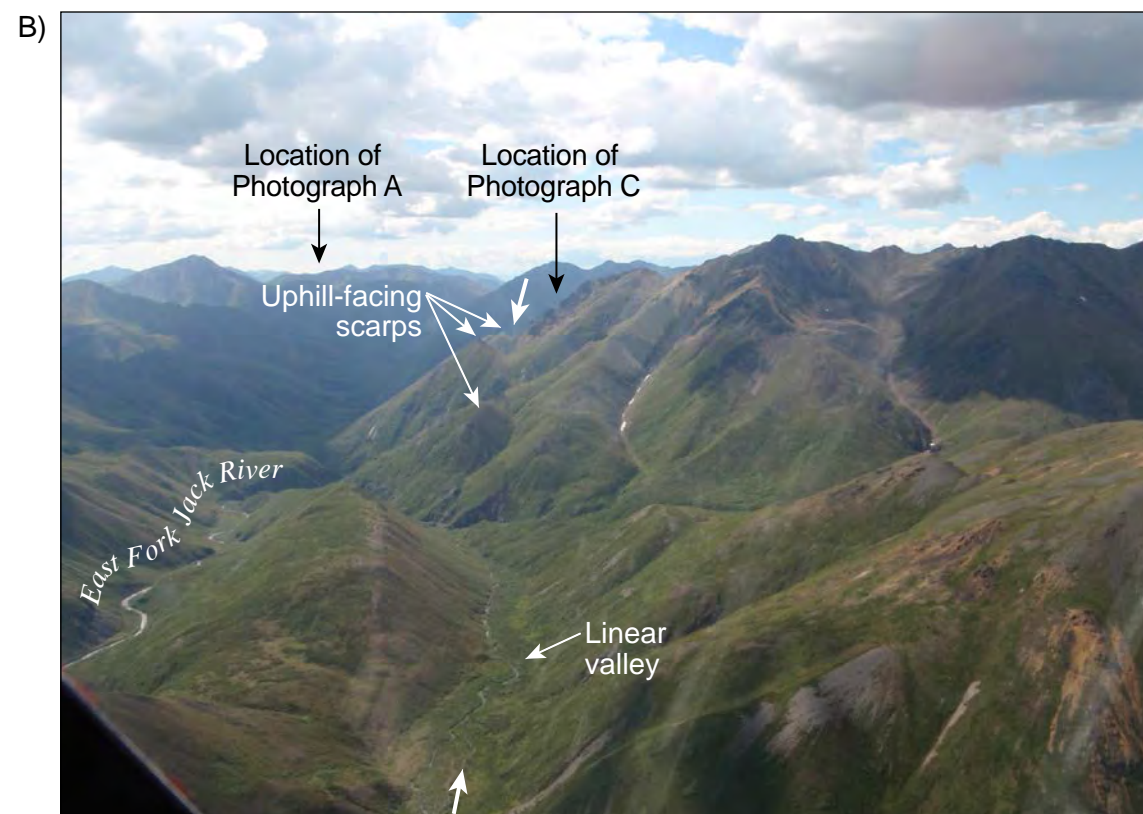


Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Geology by Wilson et al., 1998

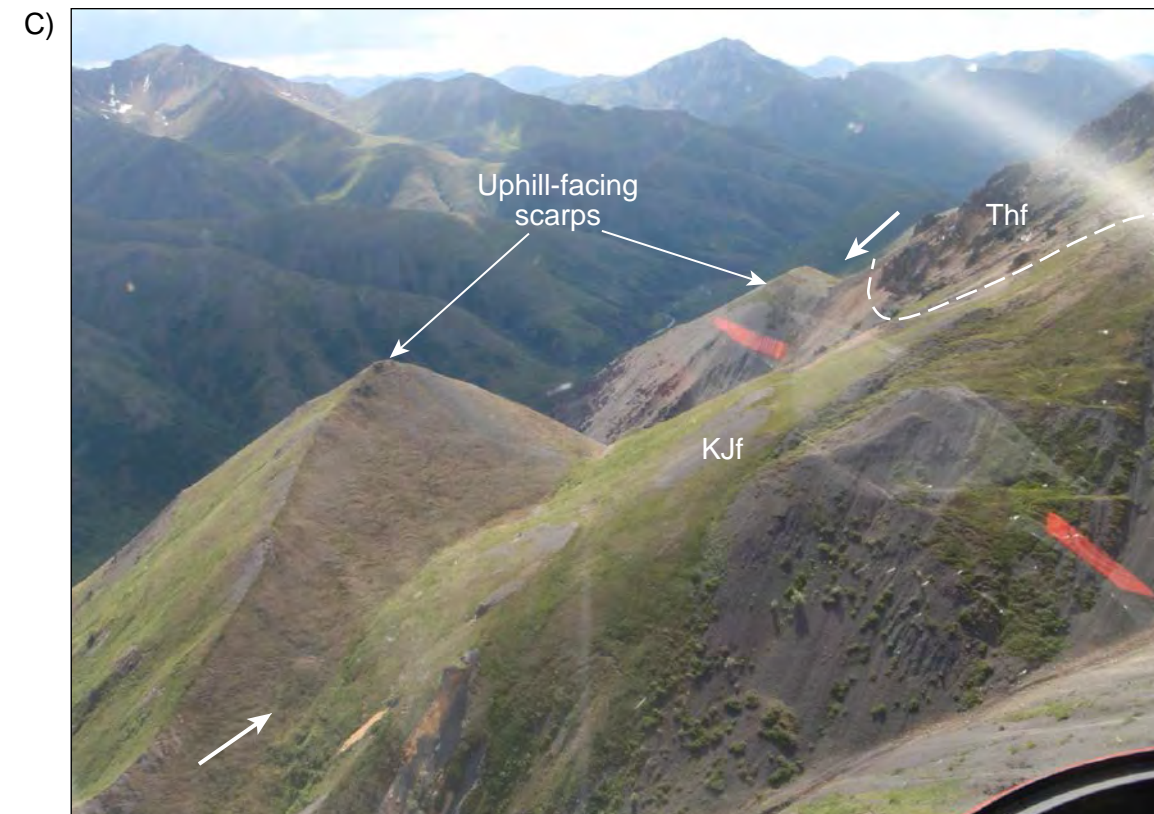




View looking northeast from location A towards the confluence of the Jack River and the East Fork Jack River. Arrows point along the alignment of mapped lineaments. Note absence of linear expression in Quaternary deposits.

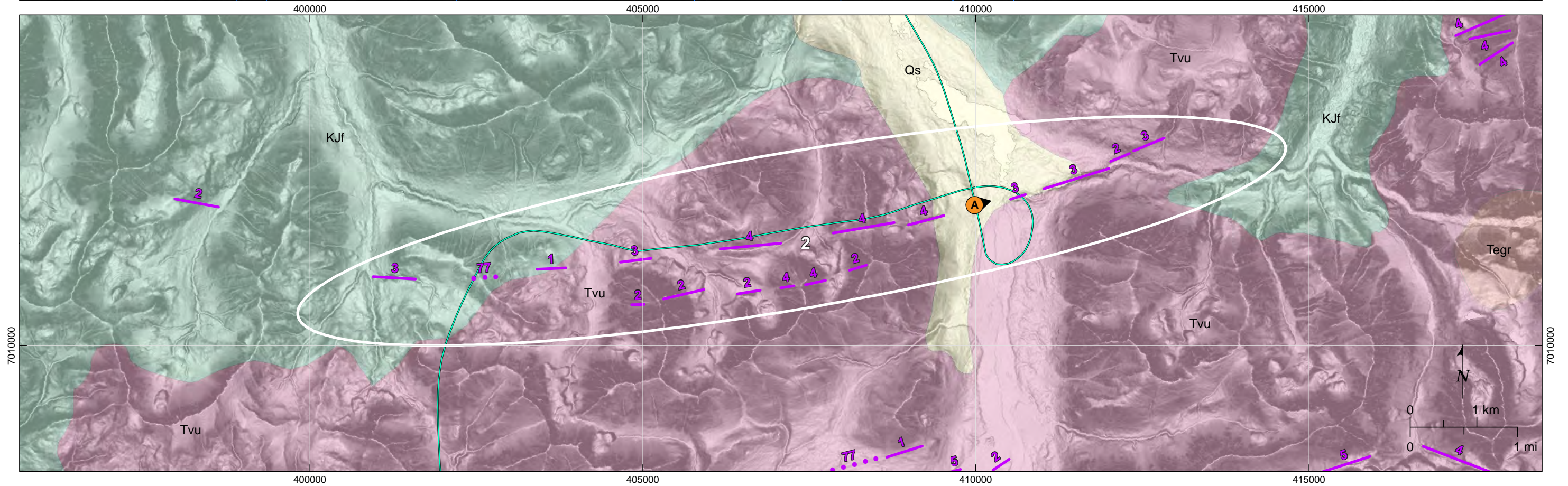
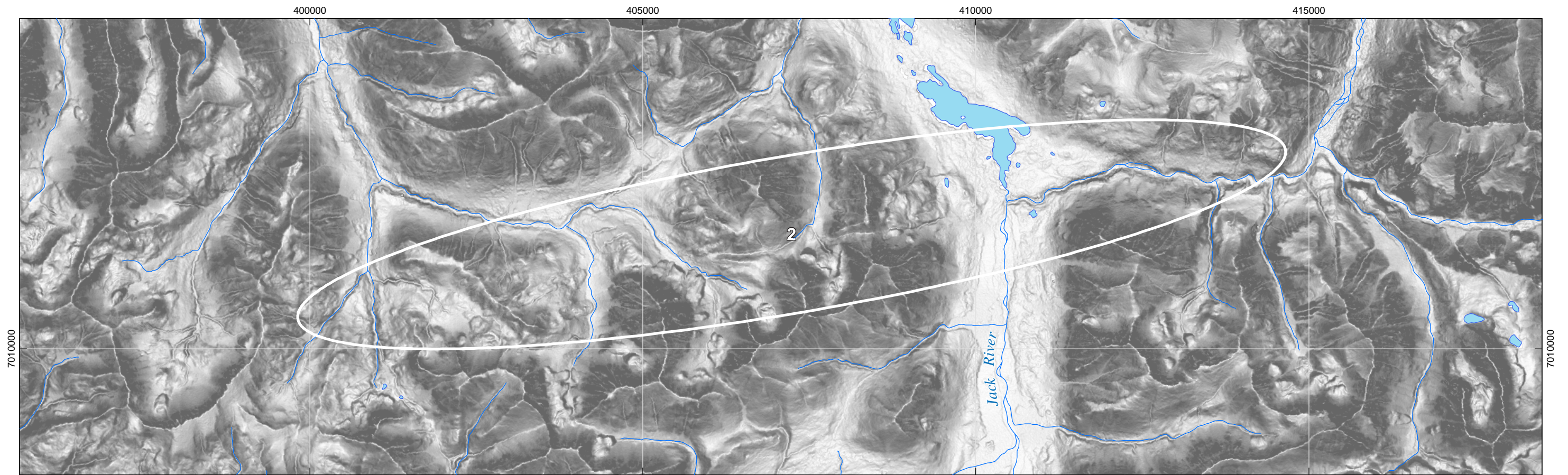


View looking southwest from location B along alignment of linear features. Arrows indicate the alignment of the mapped lineaments.



View looking southwest from location C at a detailed view of aligned uphill-facing scarps. Note Thf contact is up-slope from the scarp in the distance.



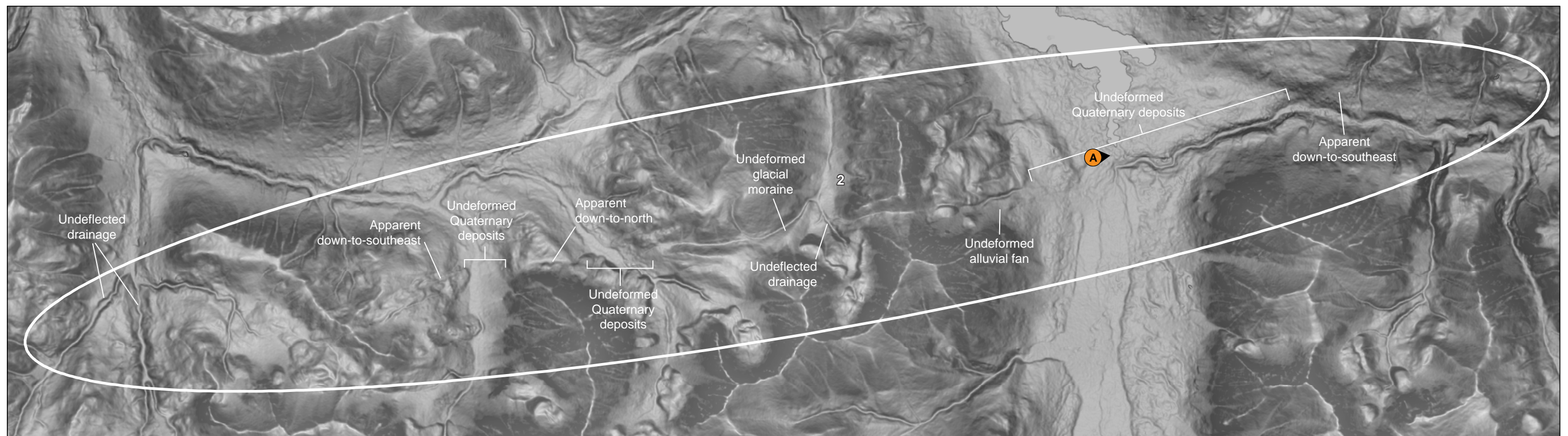


Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Geology by Wilson et al., 1998.

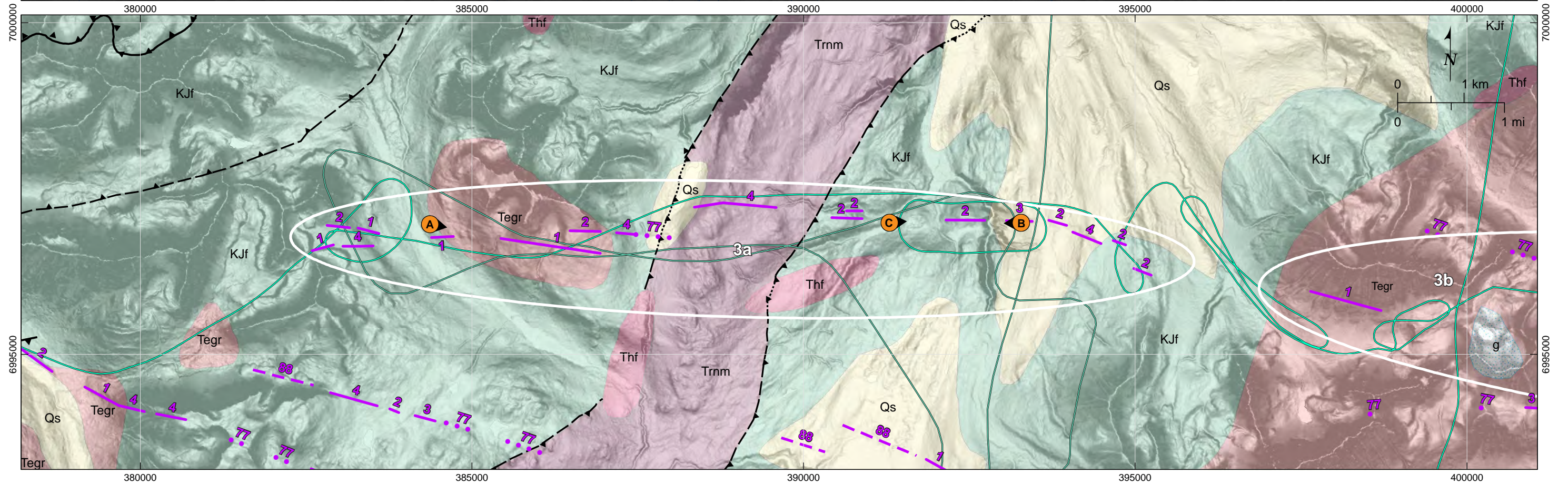
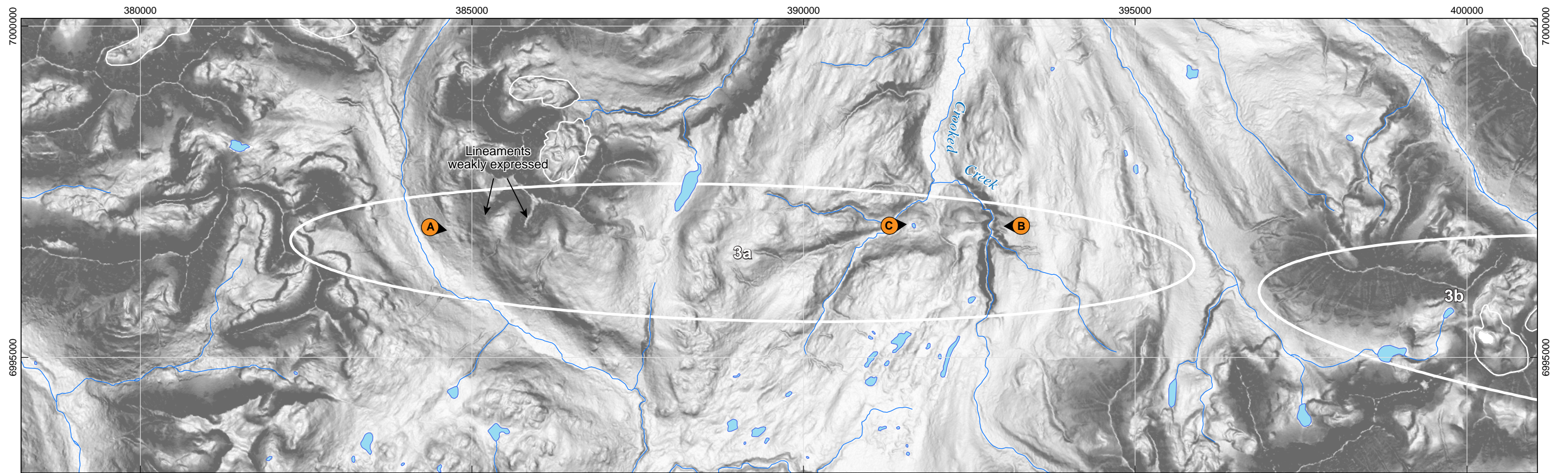




Photograph taken from location A looking east-northeast. Arrows show the alignment of FCL-mapped lineament. Note lack of apparent deformation in bedrock exposure along Jack River.







Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
2. Geology by Wilson et al., 1998.



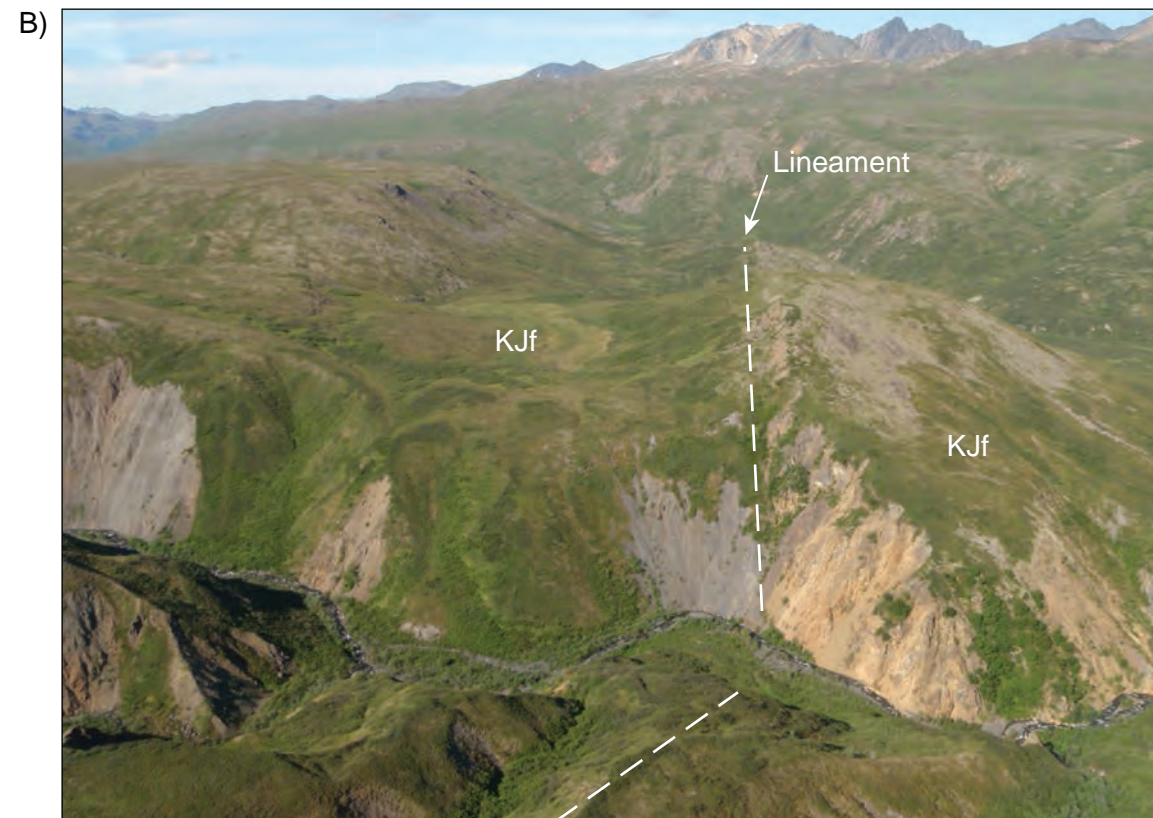
SUSITNA-WATANA HYDROELECTRIC PROJECT  
LINEAMENT GROUP 3a  
MAP DATA

FIGURE  
A3a.1

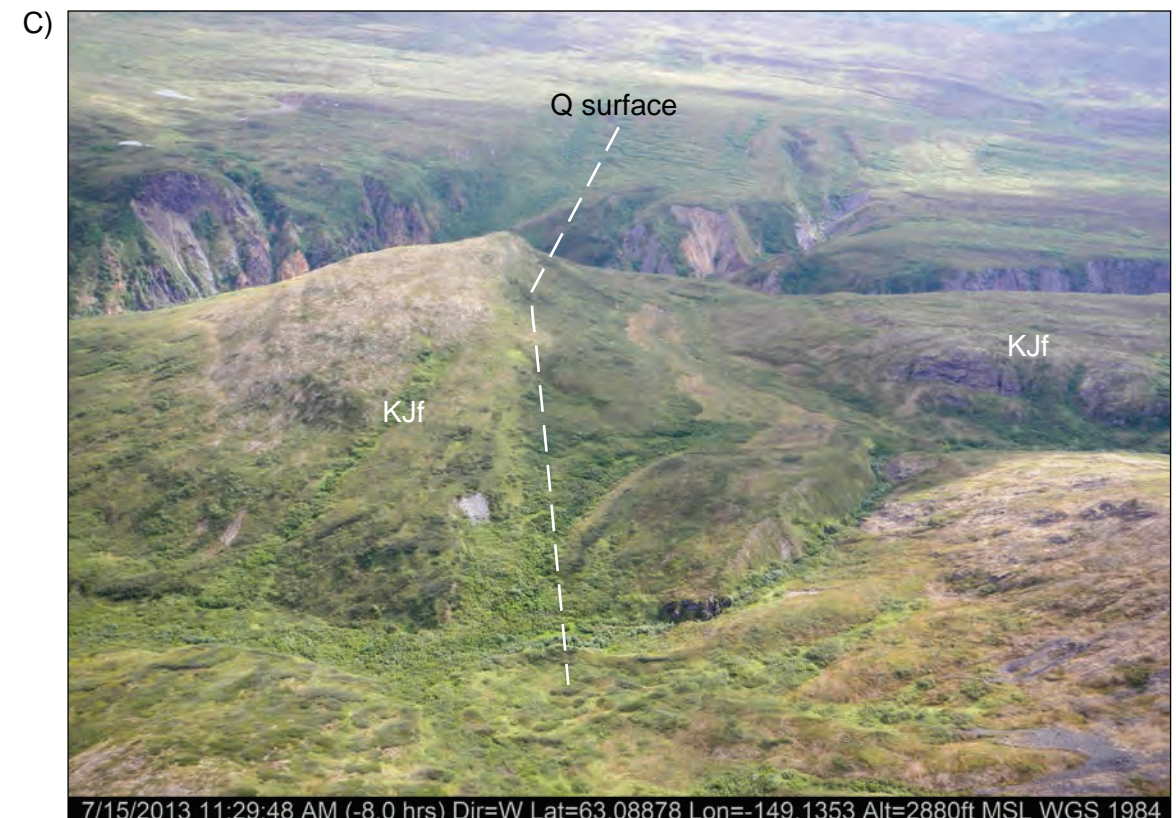




View looking east at likely solifluction-related scarps on hillside that correspond with mapped lineaments. Large arrows point along lineaments.

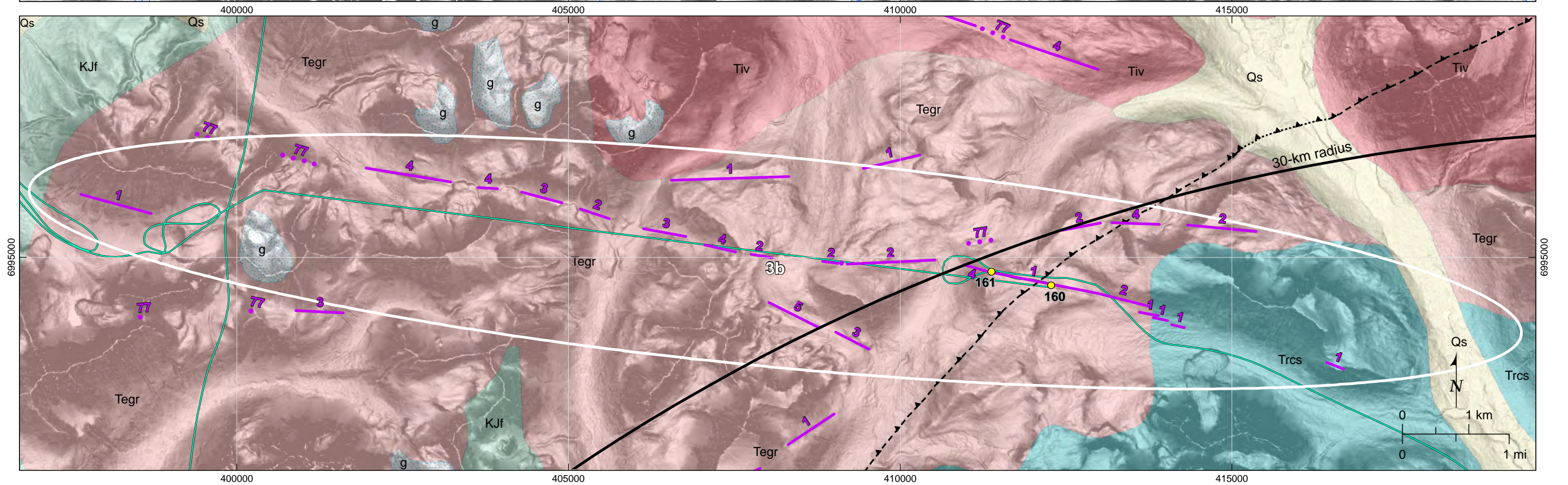
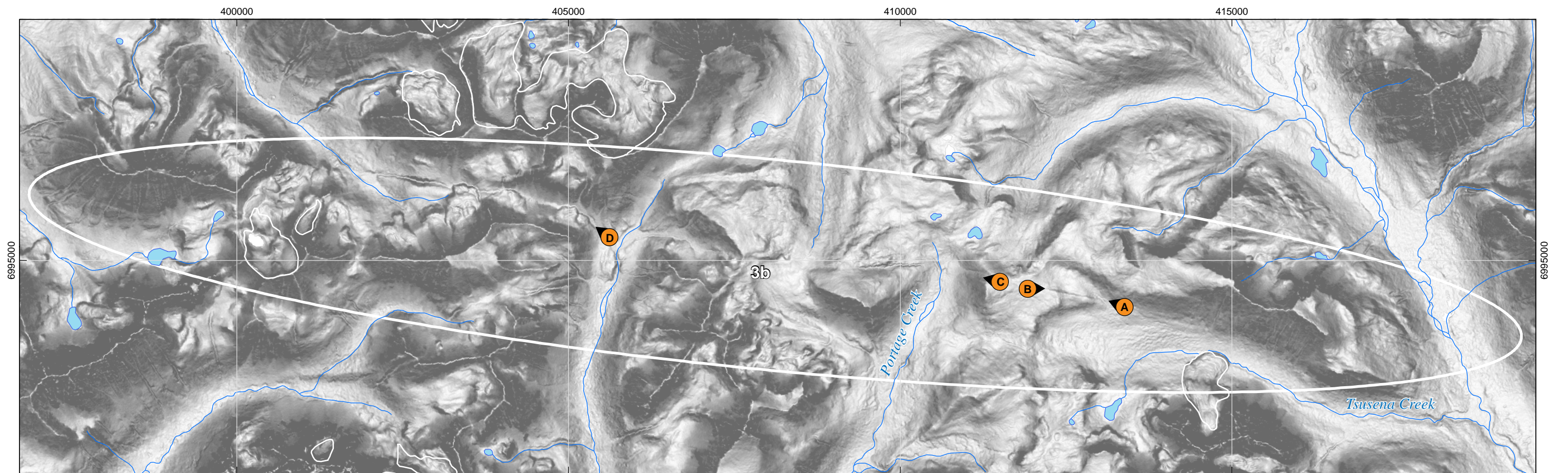


View looking west along 3a lineament expressed as sharp ridge within Kahlitna flysch (KJf). Apparent color change and topographic expression may suggest a geologic structure, however, none were previously mapped. The feature may be a result of weathering because of lithologic change within the flysch.



View looking east past ridge, with unfaulted Quaternary sediments in the foreground and far distances.





Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
2. Geology by Wilson et al., 1998.



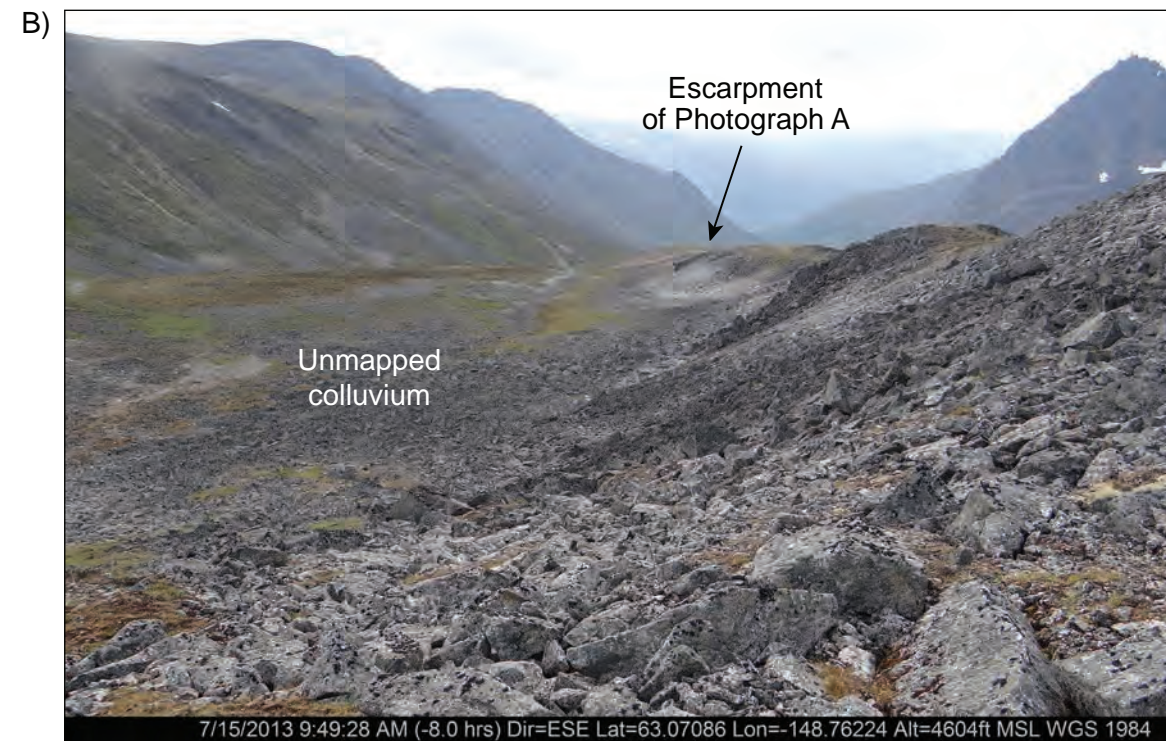
SUSITNA-WATANA HYDROELECTRIC PROJECT  
LINEAMENT GROUP 3b  
MAP DATA

FIGURE  
A3b.1





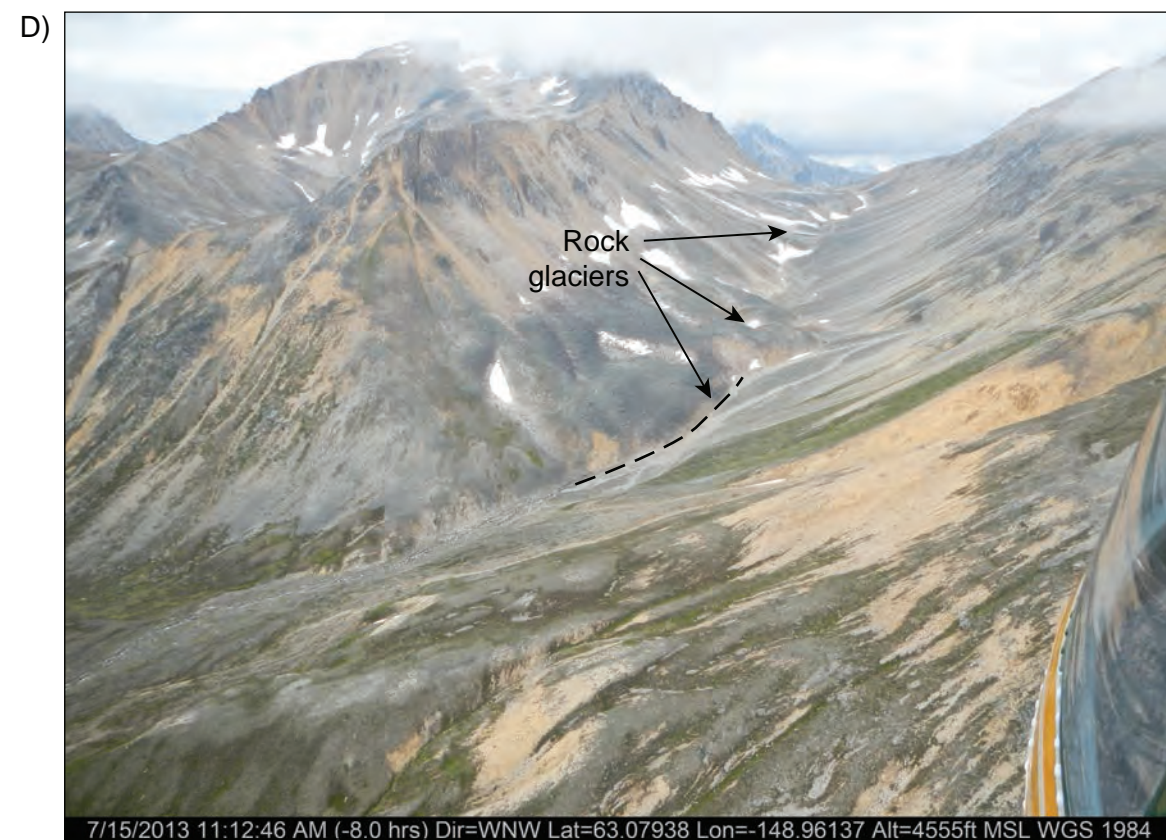
View looking west along north-facing escarpment in Eocene granitics.



View looking east along lower talus scree field that shows decreasing relief at west end of lineament 3b.

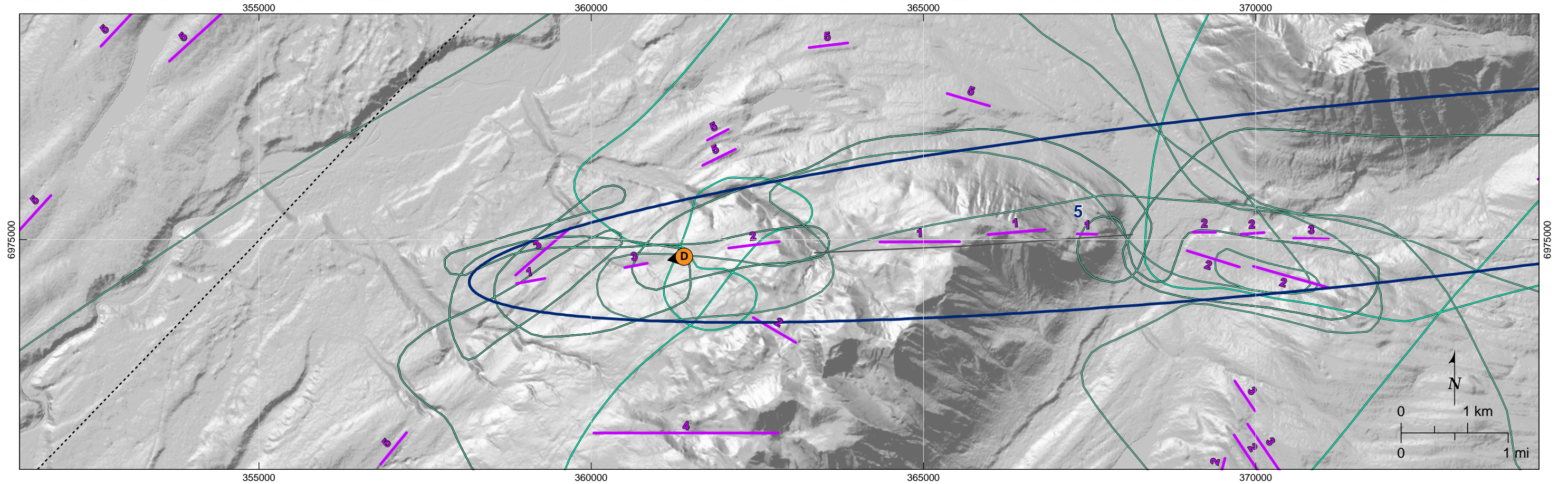
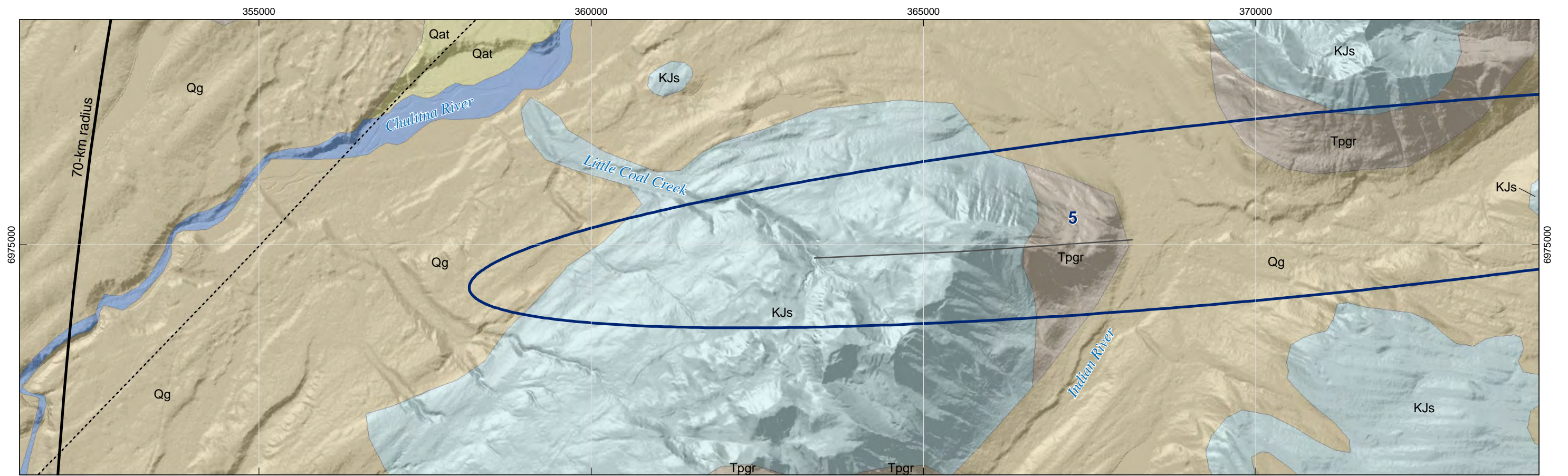


View looking west along lineament 3b projection. South-facing escarpment indicates a reversal in kinematic morphology.



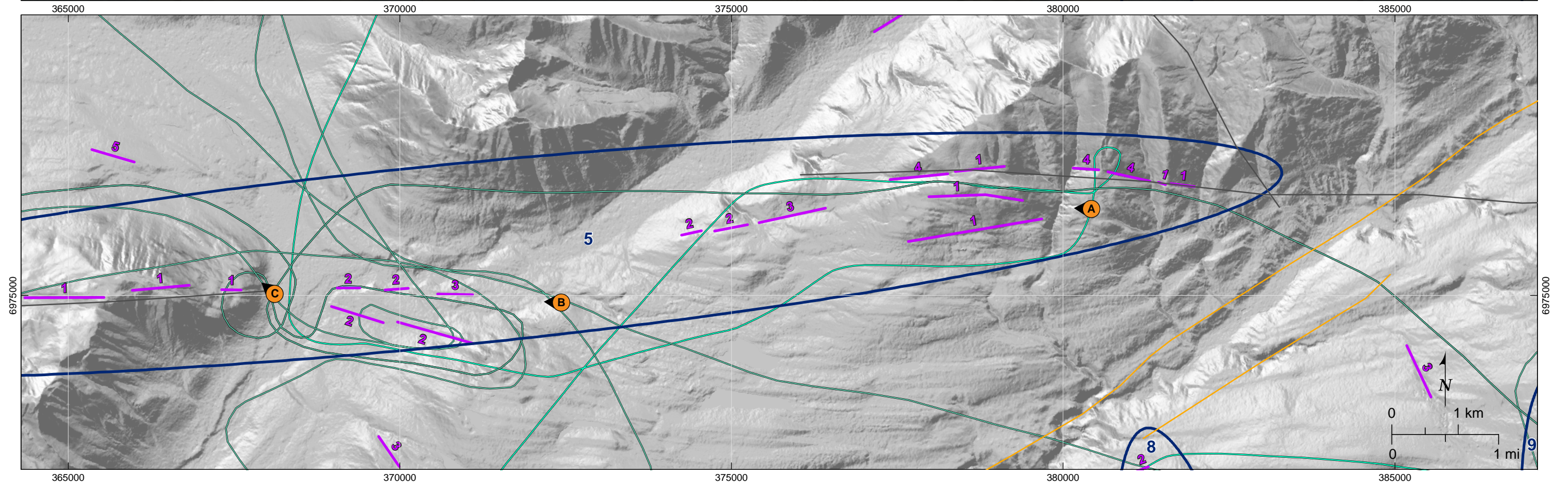
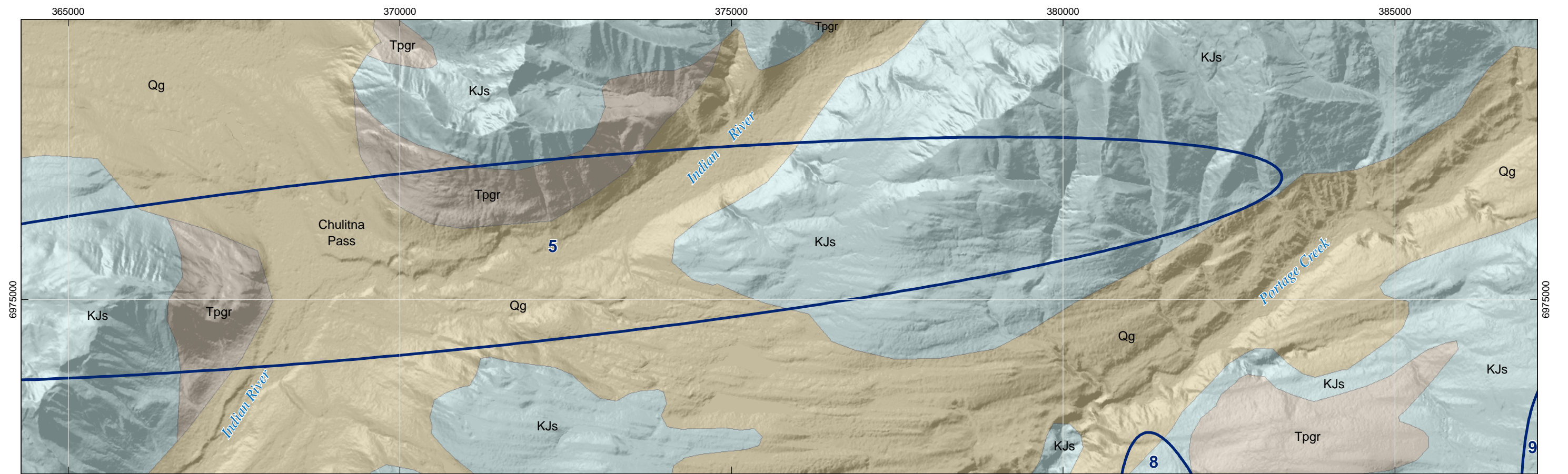
View looking west along lineament 3b projection. Holocene rock glaciers are not offset, and lineament is expressed as a linear valley.





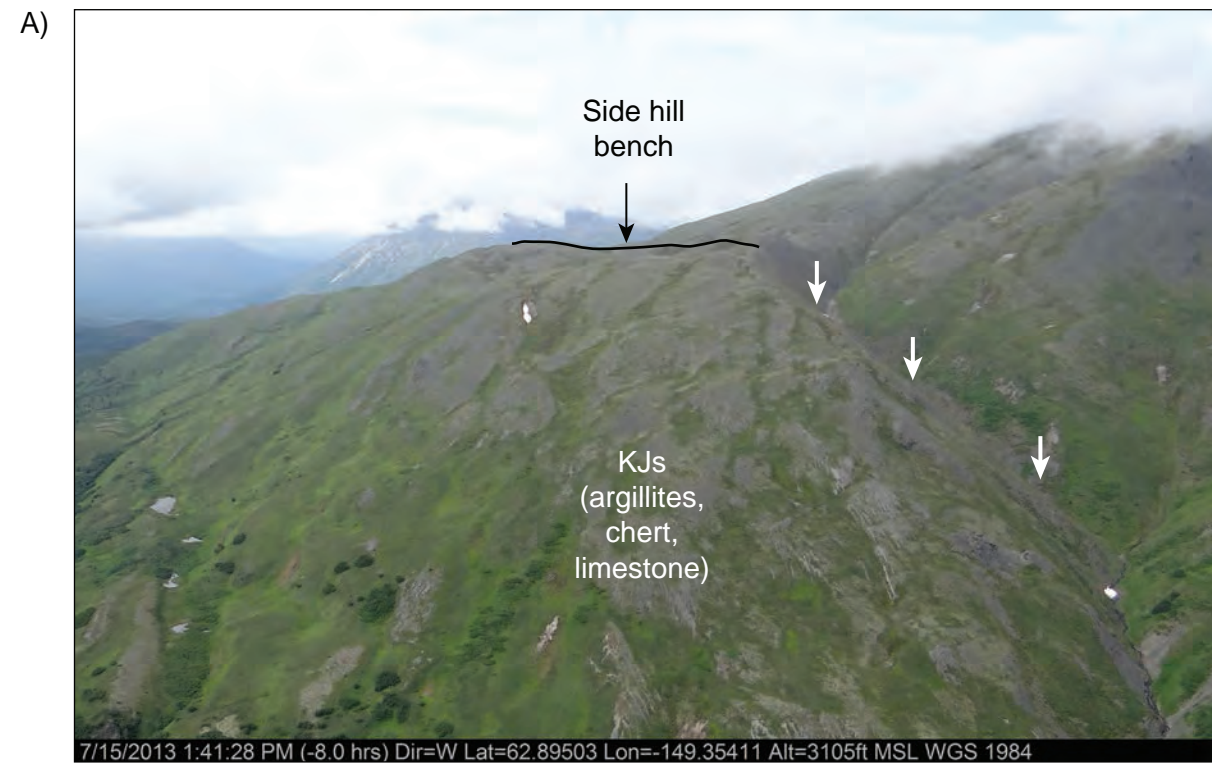
Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
2. Geology by Wilson et al., 2009.



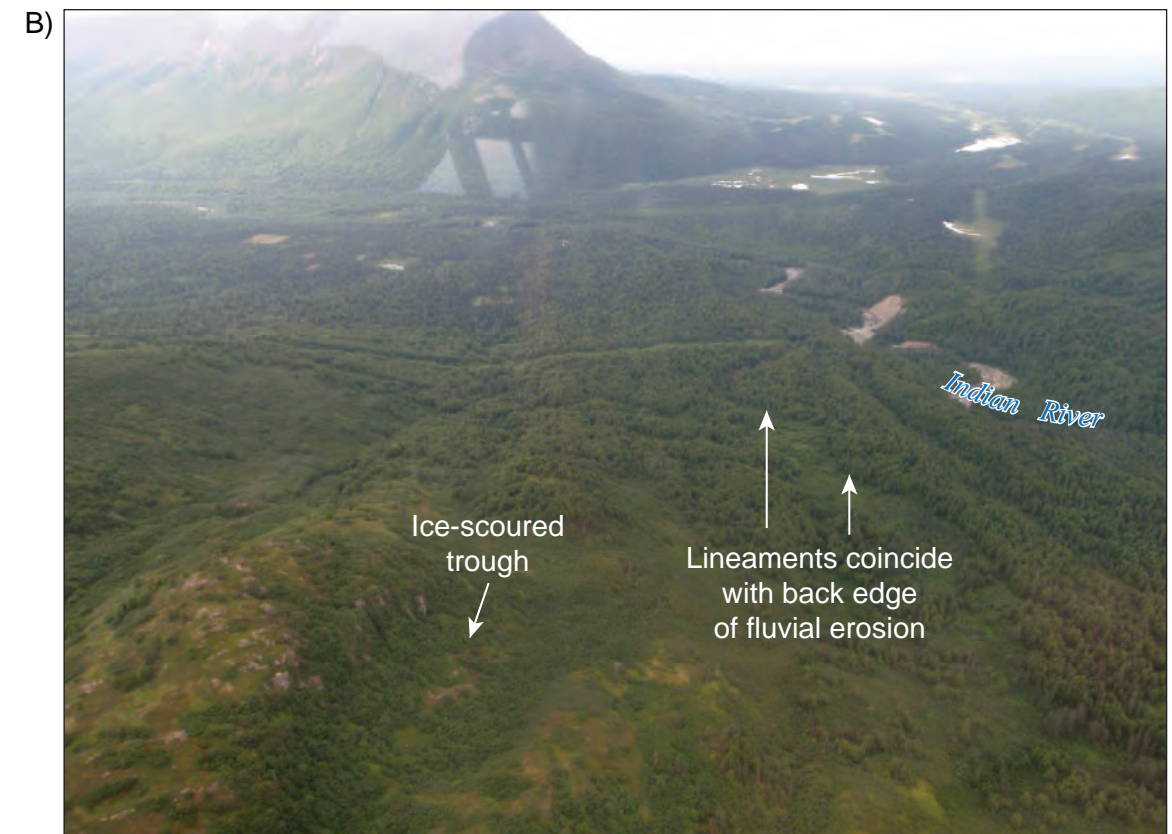


Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
2. Geology by Wilson et al., 2009.

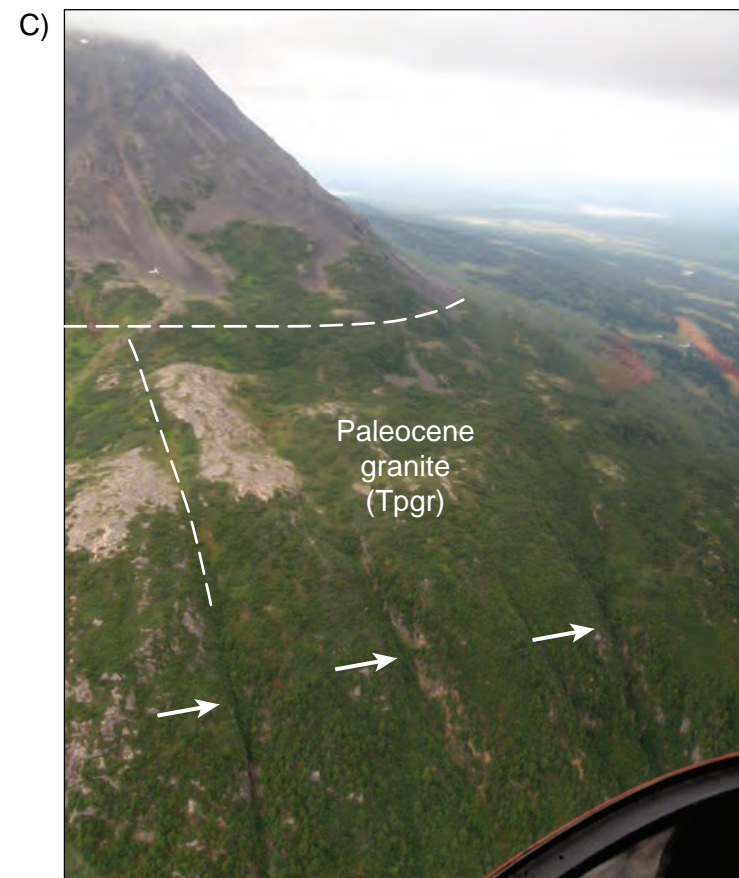




View looking west at eastern part of apparent side hill bench.



View looking west along ice-scoured terrain, with the Indian River flowing from right to left.

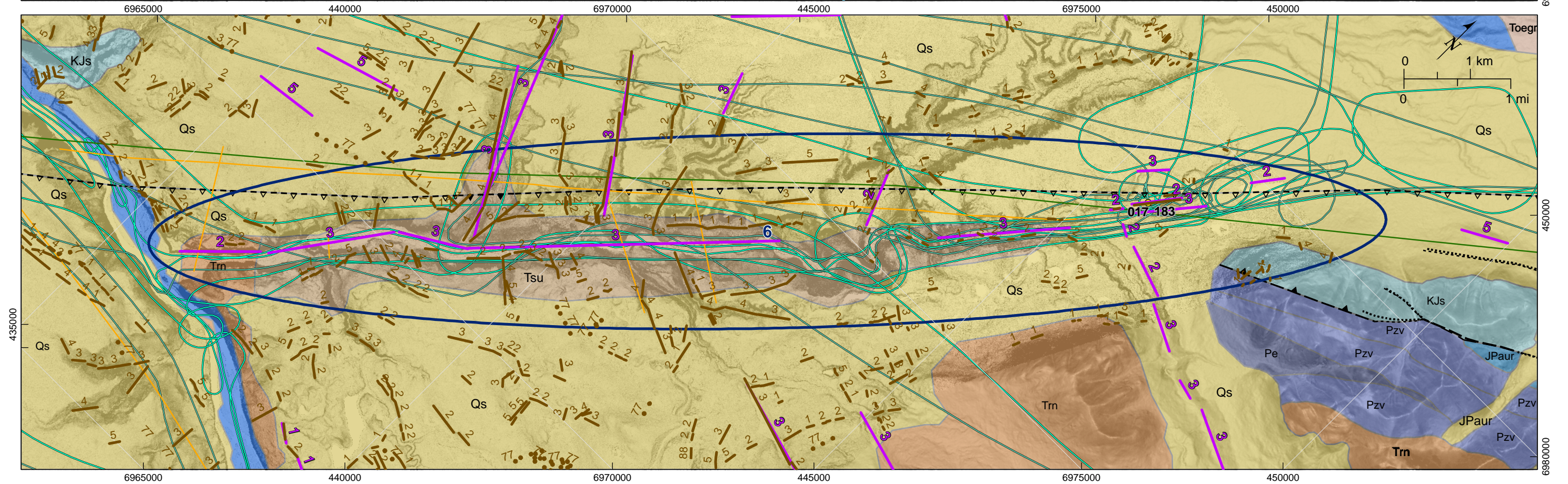
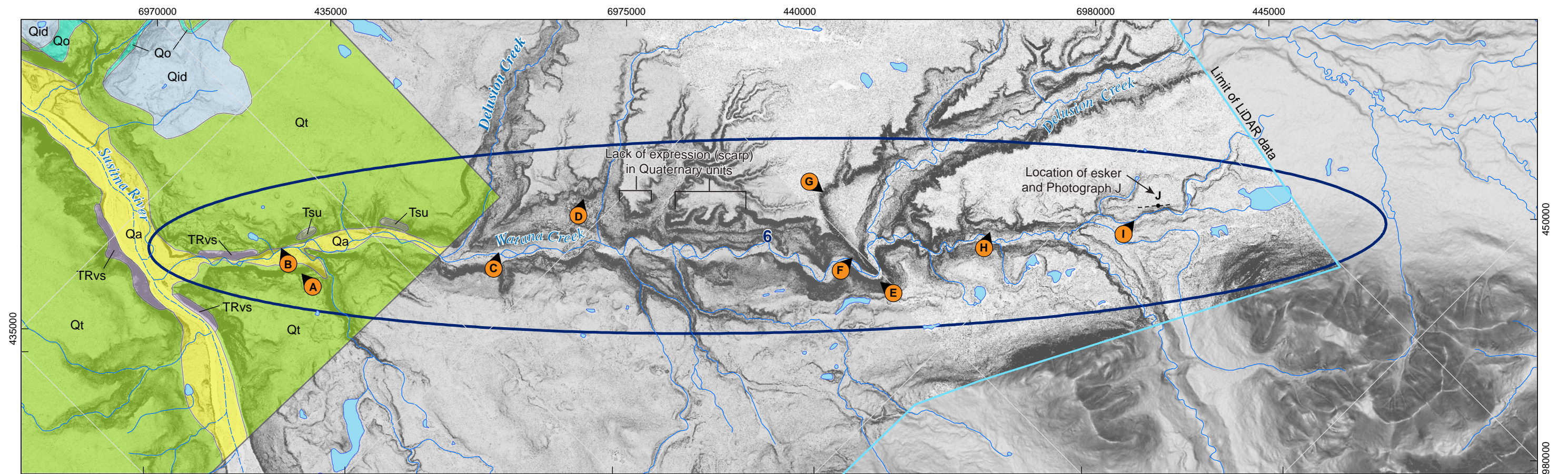


View of linear gullies developed on bedrock slope. Mapped lineament approximately shown.



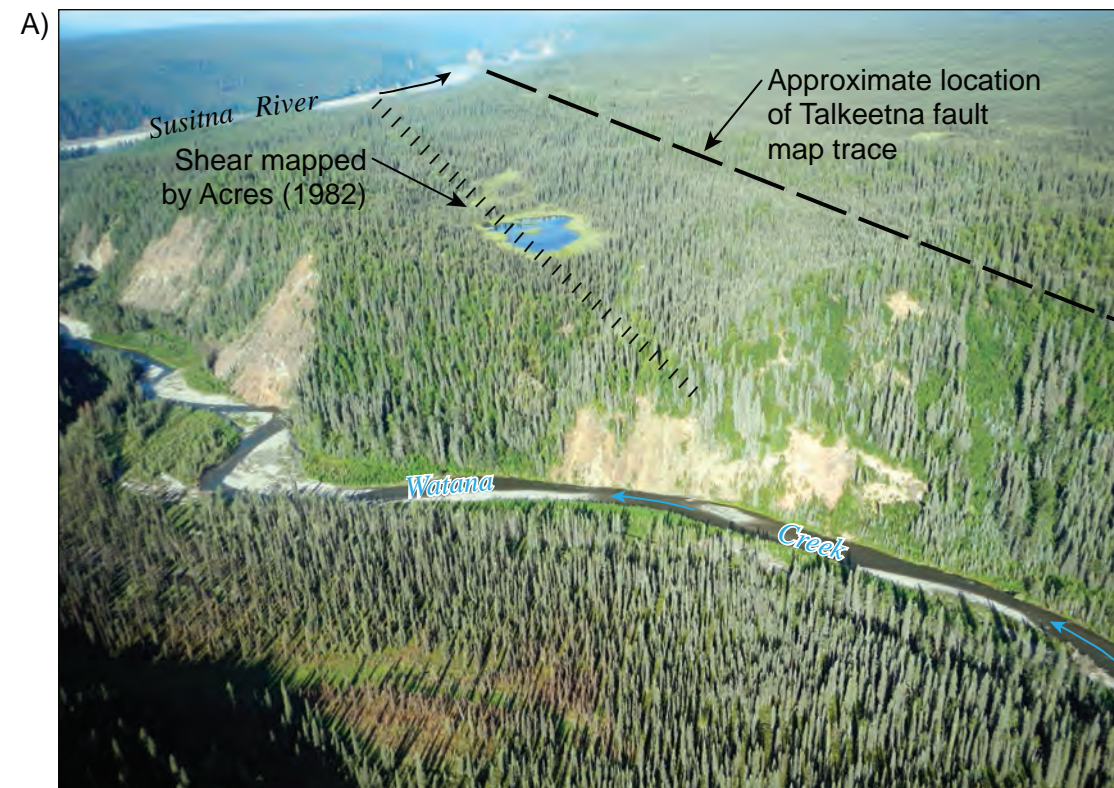
View of drainage with mapped lineament approximately shown.



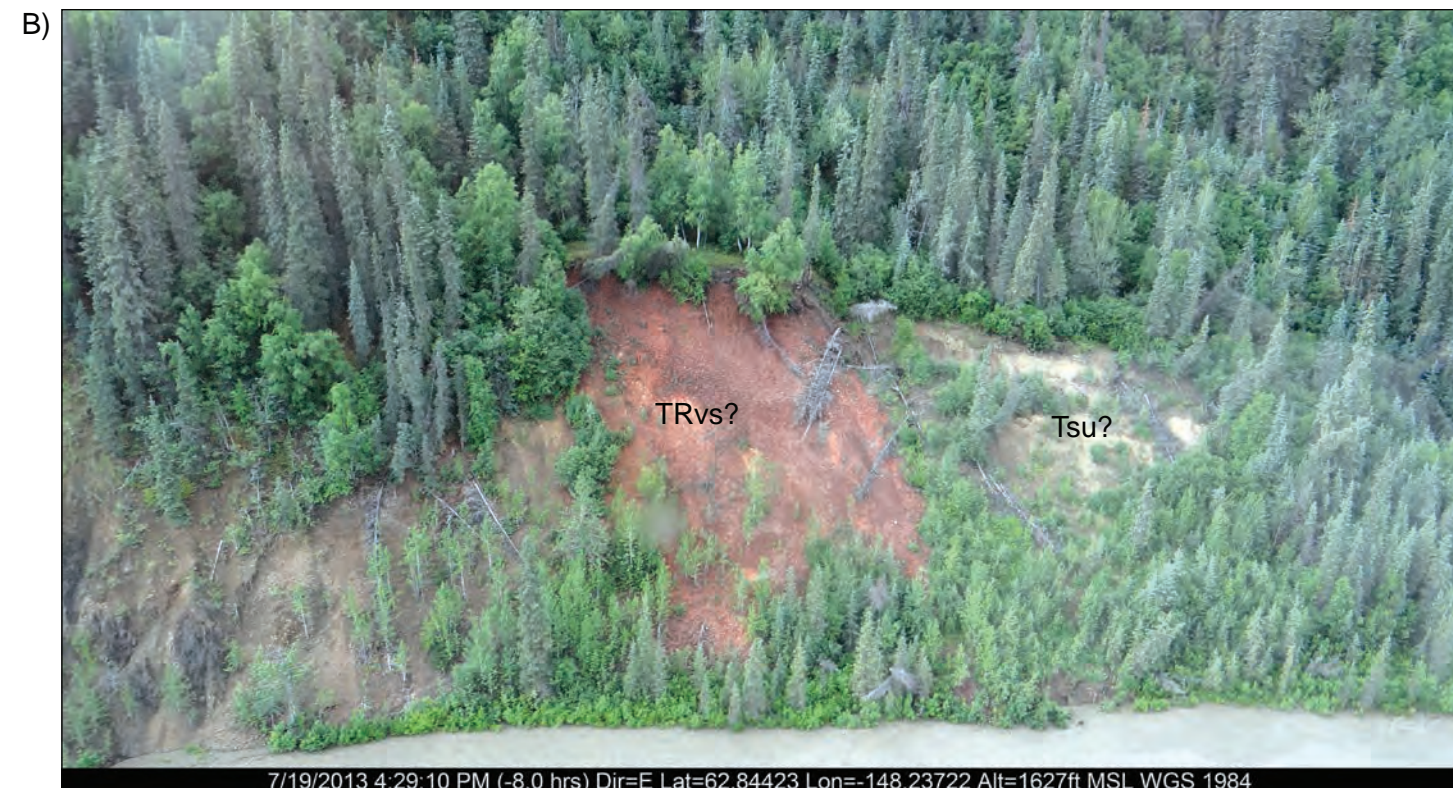


Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 45° east of north.  
 3. Geology from Acres, 1982 (top) and by Wilson et al., 2009 (bottom)





View looking west along oblique to projection of Talkeetna fault



View looking east along lower river bank at apparent alternation zone distinguished by color contrast, possible juxtaposition of Triassic metabasalts and undifferentiated Tertiary sediments. This location is east of the mapped projections of the Talkeetna fault.

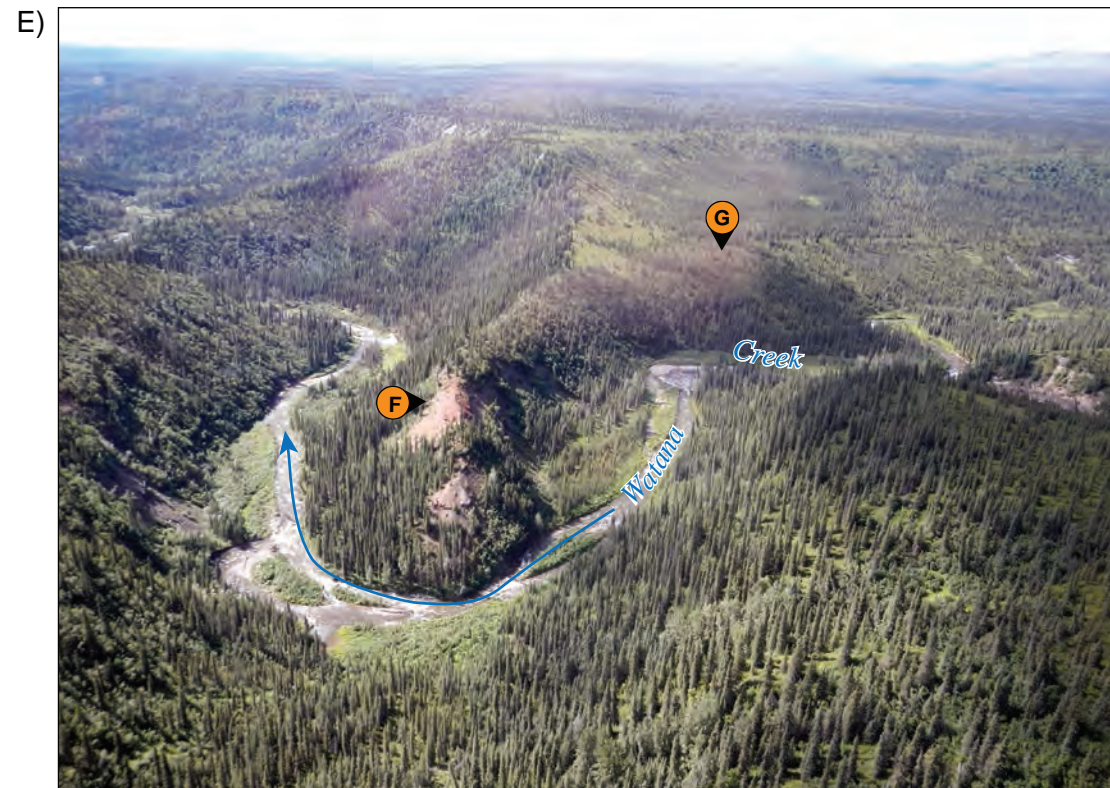


View looking east at apparent flat-lying contact between Quaternary lake sediments (above) and Quaternary till (below). Arrows point to contact.



View looking west at projected trace of Talkeetna fault whose ground expression is absent in Quaternary surface.

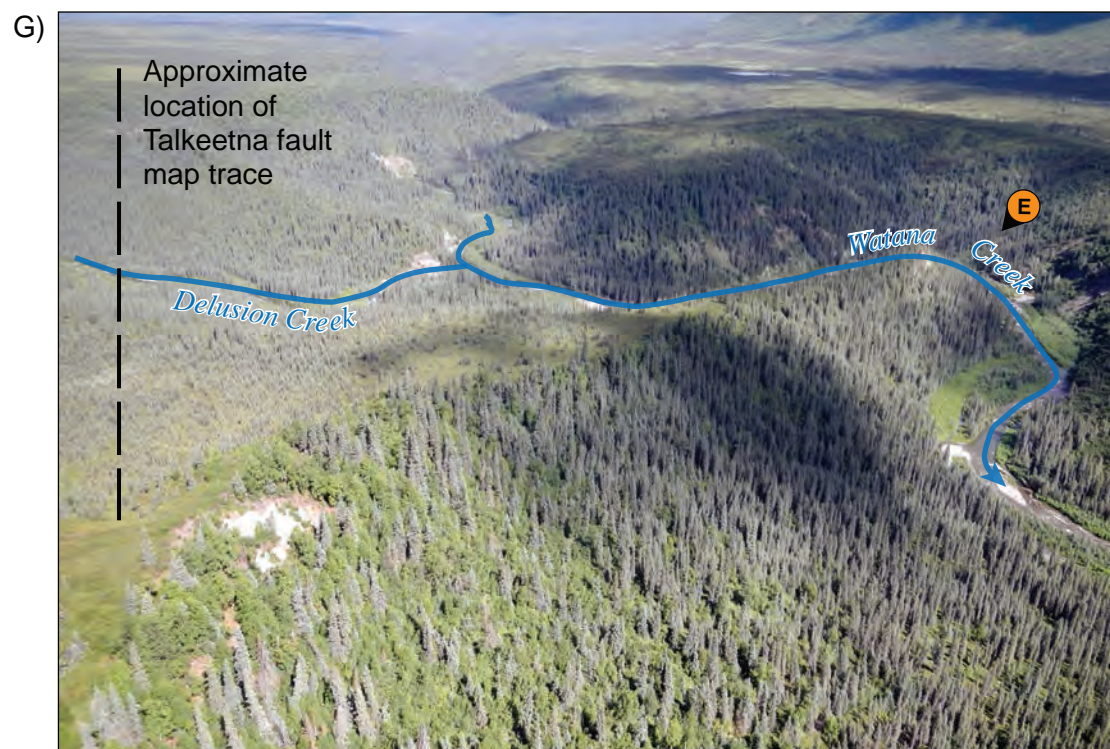




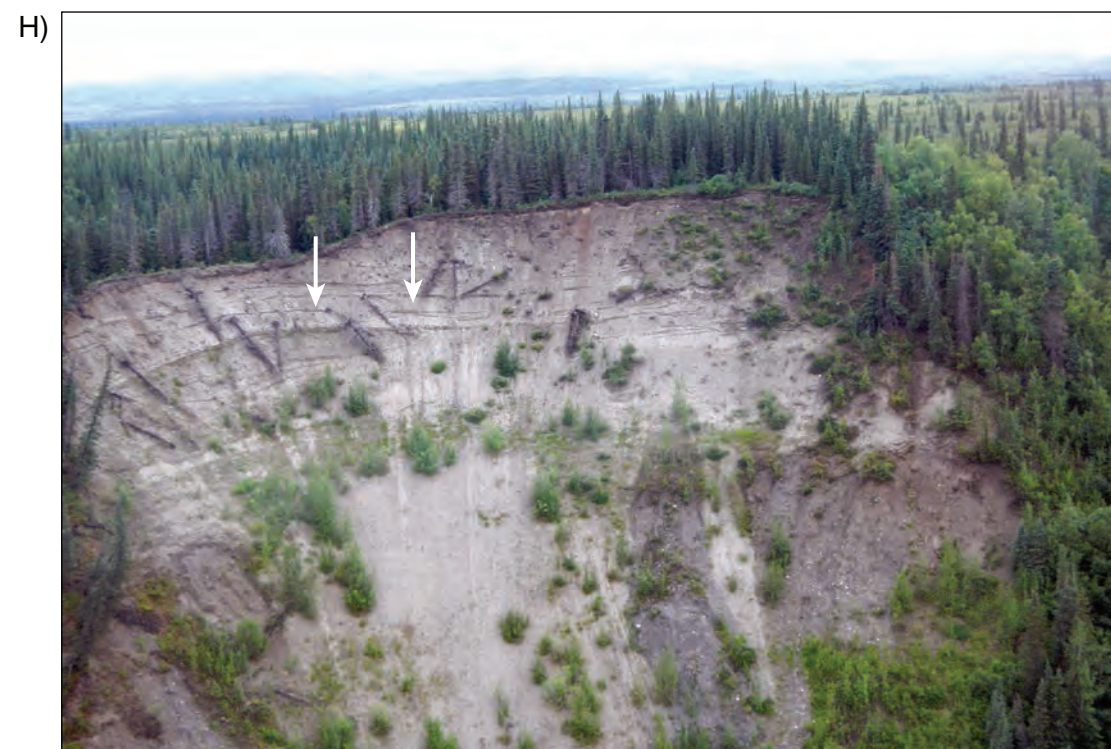
View looking south at erosion-resistant ridge of Tertiary sediments whose beds dip gently to the northwest but appear undisrupted.



View looking west at apparently northwest-dipping beds in Tertiary sediments, relatively consistent with northwest dips measured by WCC (1982) in Tertiary sediments along west bank Watana Creek.



View looking north-northeast past ridge, with flat and apparently undisturbed Quaternary sediments in the background.

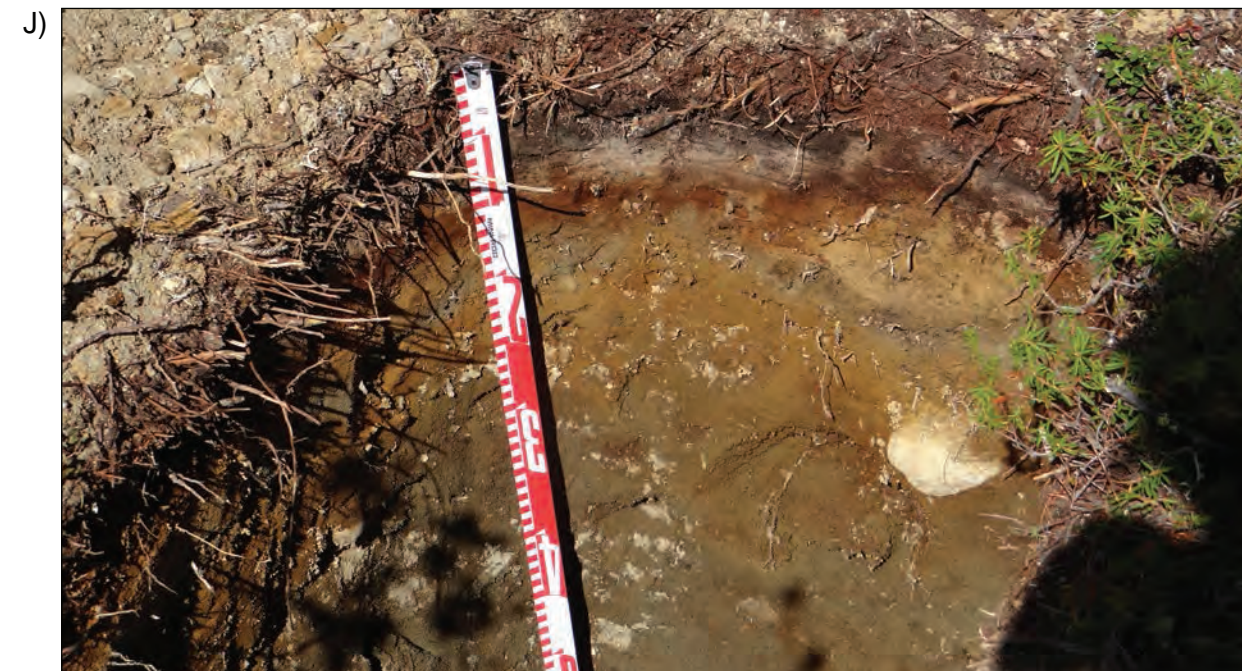


View looking west at bedded (lake?) stratigraphy exposed in eroding bluff. Beds appear relatively horizontal, but may have a sense of non-planar geometry because of semi-circular outcrop. Note fallen trees that indicate erosion/slope movement.





View looking north at linear esker nearly coincident with map projection of Talkeetna fault. See Figure A6.1 for location. Arrows point to esker crest.



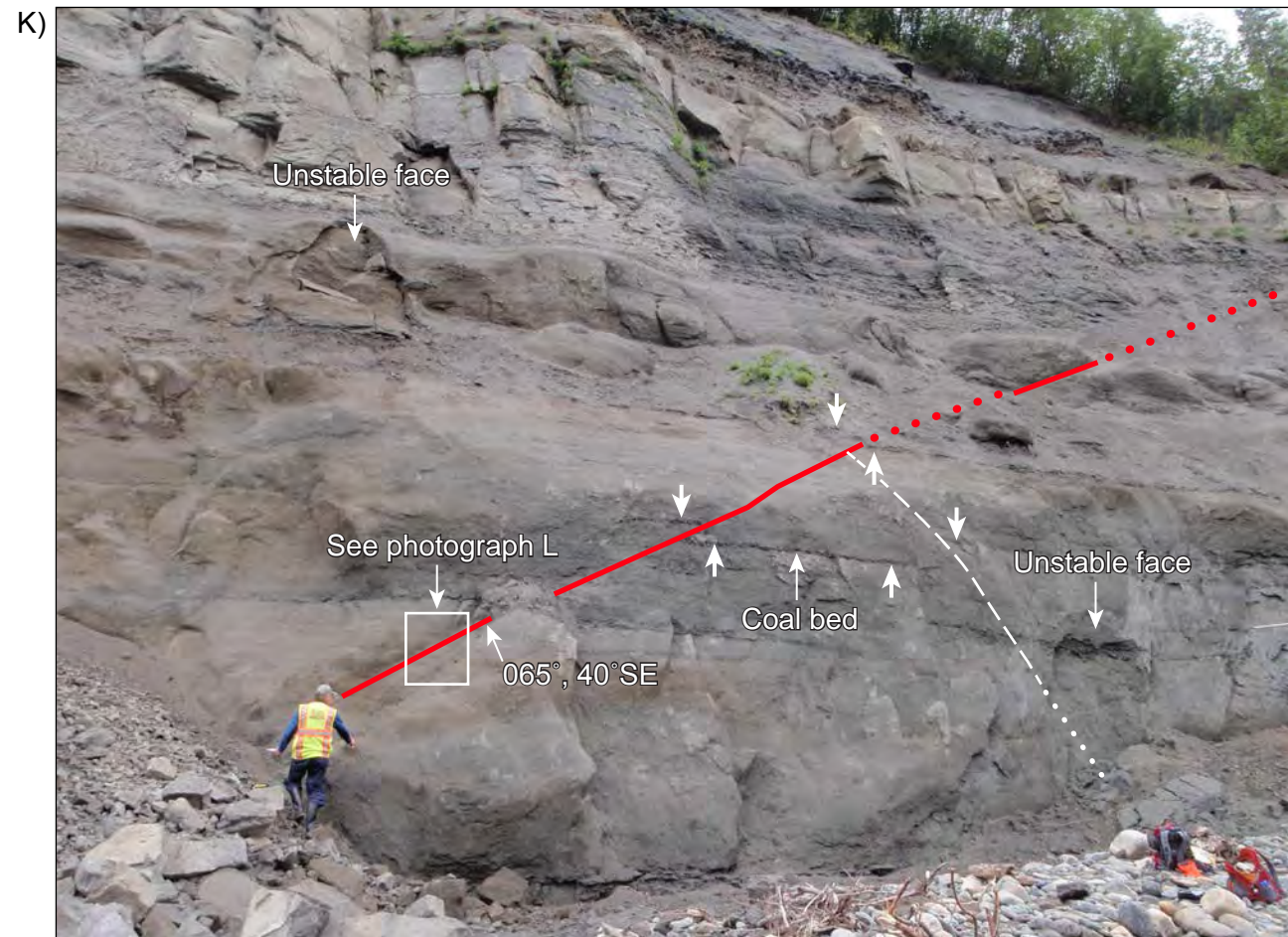
View looking at shallow soil pit dug in esker crest. Upper black, gray, and reddish soil layers are Holocene tephras. Scale is in centimeters; the upper 45 centimeters of the pit are in view.







twla-wc-file/project/Projects/79\_2000/79\_218900\_Alaska\_Railbelt/05\_Graphics/2189\_TM14\_January 2014 Lineament Report /



Photograph of faulted outcrop with coal bed. Visually estimated 60-80 cm of separation along the fault plane. Second fault appears to terminate against primary fault (065, 40° SE) extends across the outcrop.



Detail of fault plane. Placard is 6 inches (15 cm) in length; fault plane is approximately 1 cm wide.

REV	DESCRIPTION	BY	DATE

Project No.	
Date	10/27/14
Designed	
Drawn	
Approved	

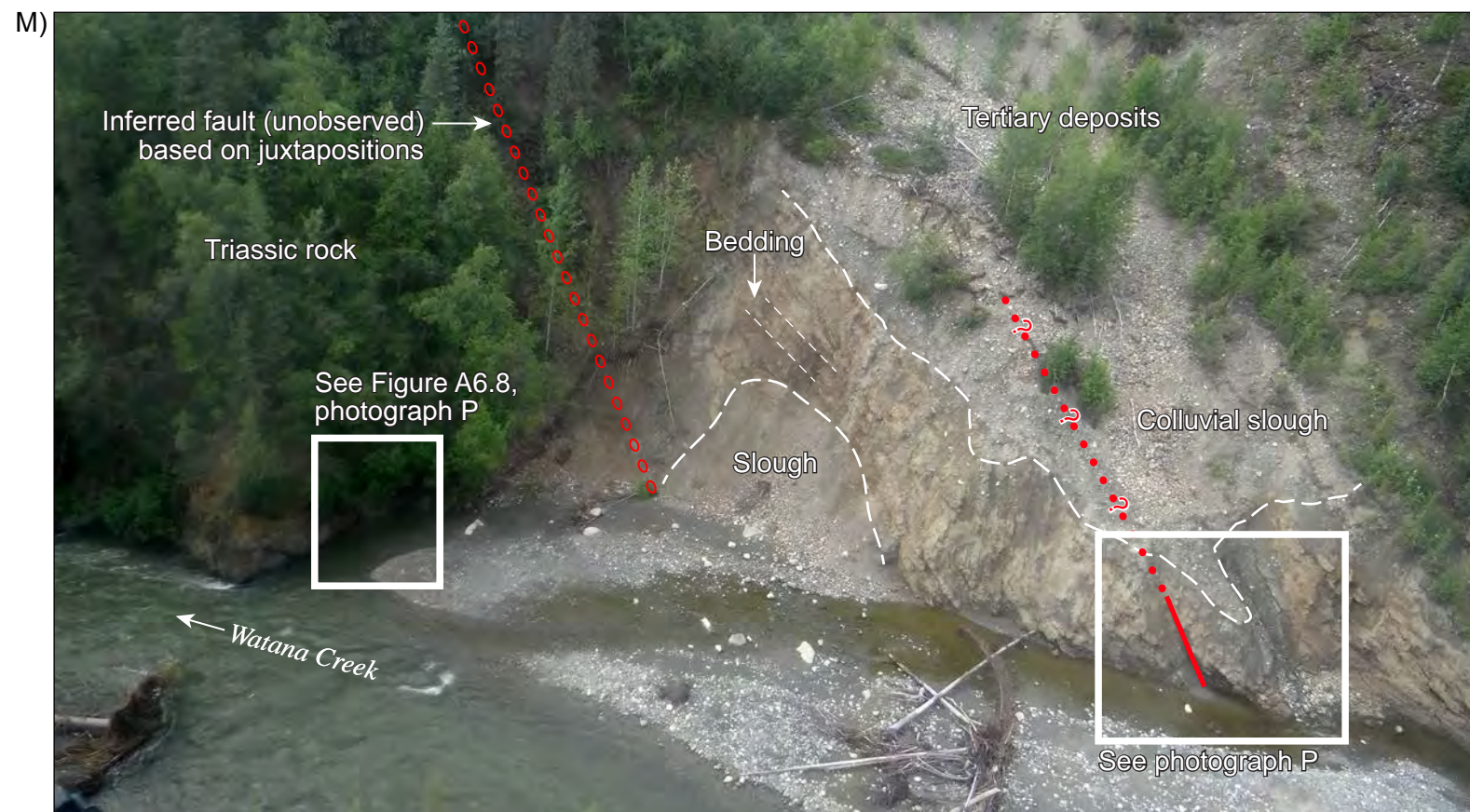


SUSITNA-WATANA HYDROELECTRIC PROJECT  
PHOTOGRAPHS SHOWING FAULTED  
OUTCROP AND FAULT PLANE

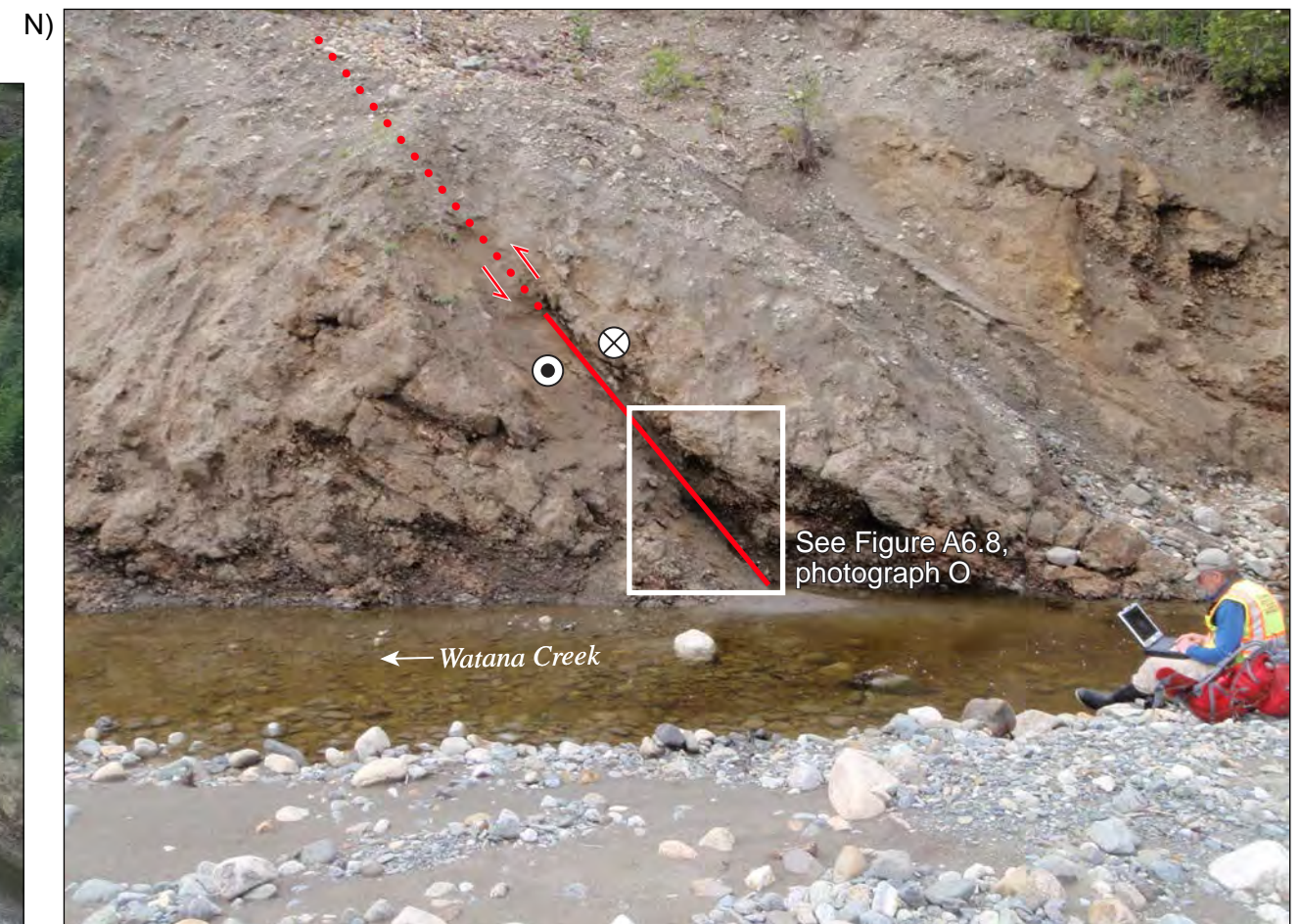
FIGURE  
FIGURE A6.6



\\wla-wc-file\project\Projects\79\_2000\79\_218900\_Alaska\_Railbelt\05\_Graphics\2189\_TM14\_January 2014\_Lineament Report /



Aerial view looking approximately south-southwest. Triassic rocks are densely vegetated.



View looking west at lower part of Tertiary deposit toward uncleaned exposure of fault (065-080° strike; 65°N dip). Left-lateral oblique relative movement.

REV	DESCRIPTION	BY	DATE

Project No.	
Date	10/27/14
Designed	
Drawn	
Approved	



SUSITNA-WATANA HYDROELECTRIC PROJECT  
PHOTOGRAPHS SHOWING  
AERIAL VIEW OF FAULT

FIGURE  
FIGURE A6.7



\\wla-wc-file\project\Projects\79\_2000\79\_218900\_Alaska\_Railbelt\05\_Graphics\2189\_TMI4\_January 2014\_Lineament Report /



Close up of fault in cobble-rich Tertiary deposit.



View looking south at vertical fault in Triassic rocks; visually estimated apparent strike is northeast.

REV	DESCRIPTION	BY	DATE

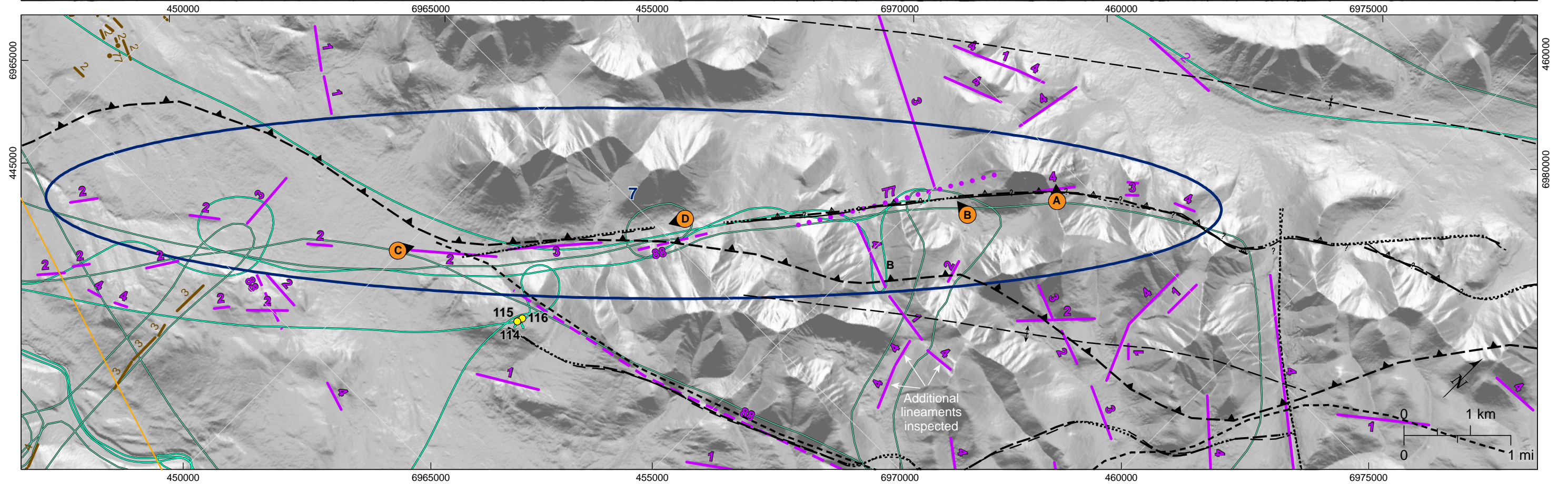
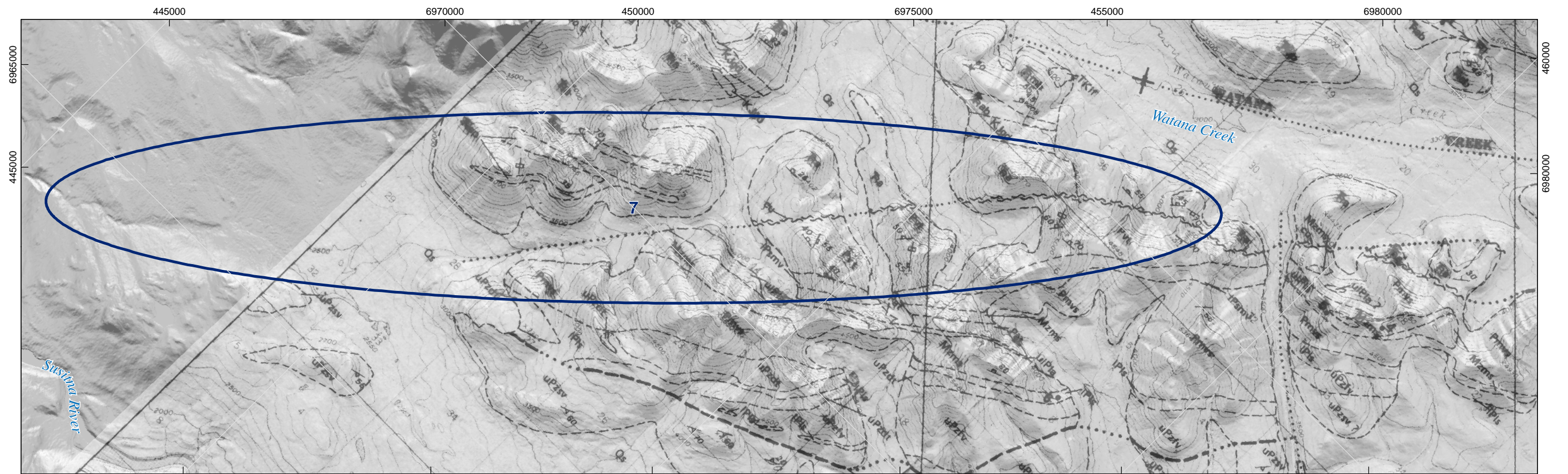
Project No.	
Date	10/27/14
Designed	
Drawn	
Approved	



SUSITNA-WATANA HYDROELECTRIC PROJECT  
PHOTOGRAPHS OF FAULTING  
AT WATANA CREEK

FIGURE  
FIGURE A6.8





Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 45° east of north.  
 3. Geologic map by Kline et al., 1990.



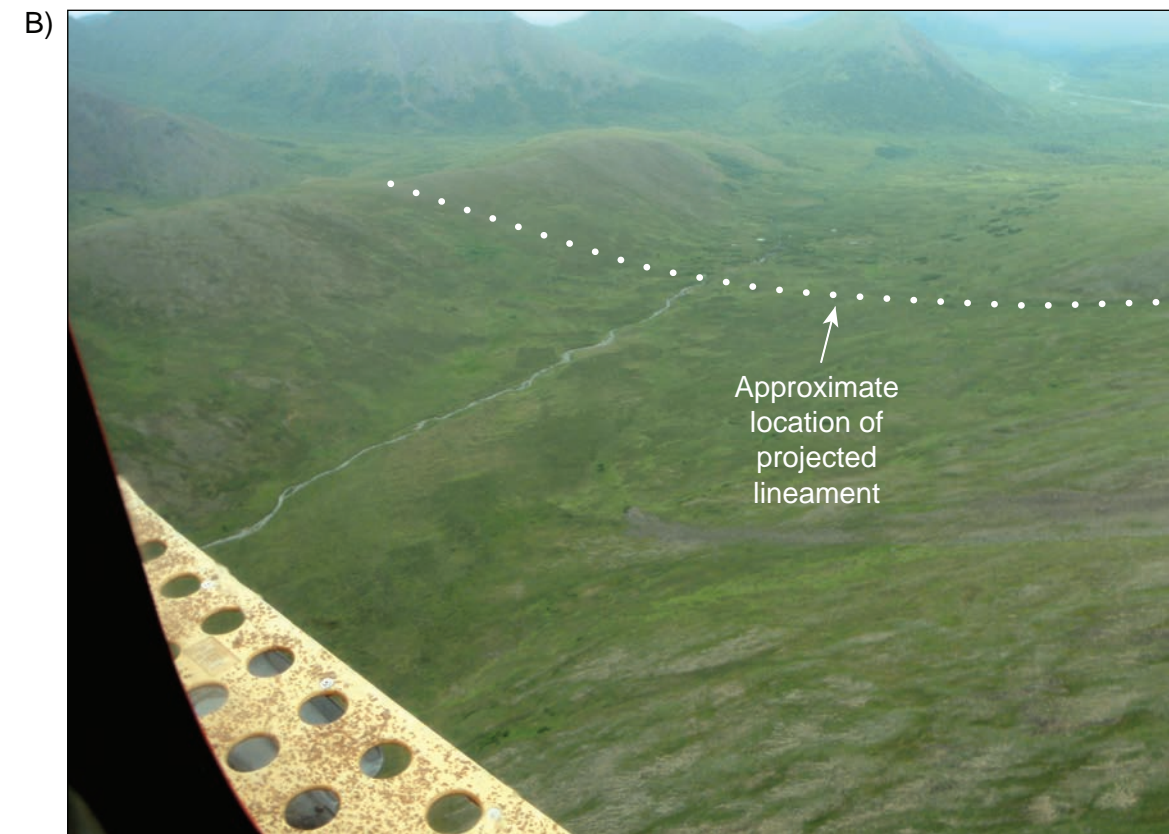
SUSITNA-WATANA HYDROELECTRIC PROJECT  
 LINEAMENT GROUP 7  
 MAP DATA

FIGURE  
 A7.1

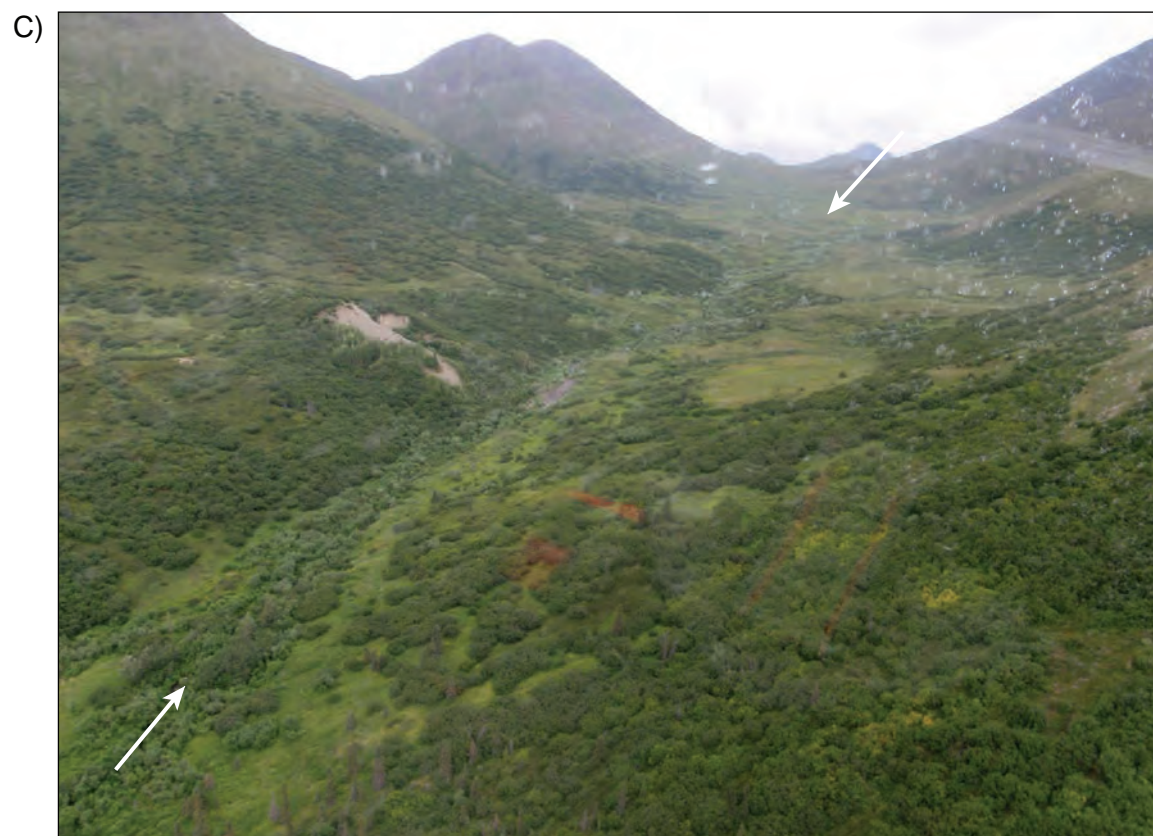




View looking at color contrast at previously mapped bedrock fault.



View looking west down-valley at apparent undeformed glacial sediments.

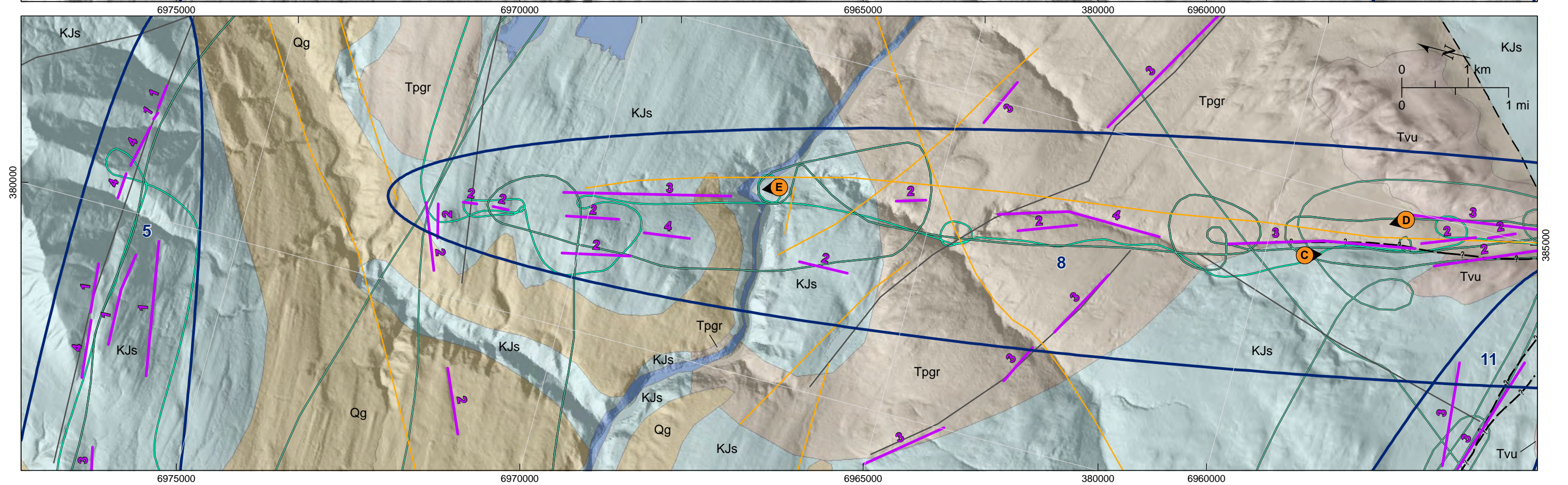
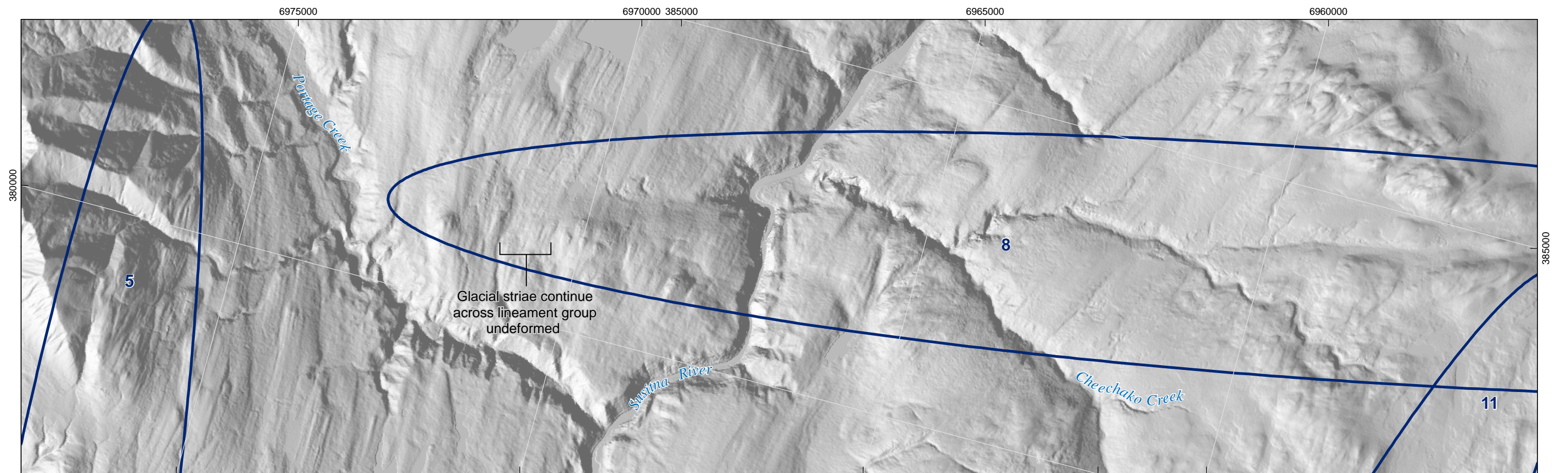


View looking up-valley at incised drainage that coincides with mapped lineament and previously mapped fault.



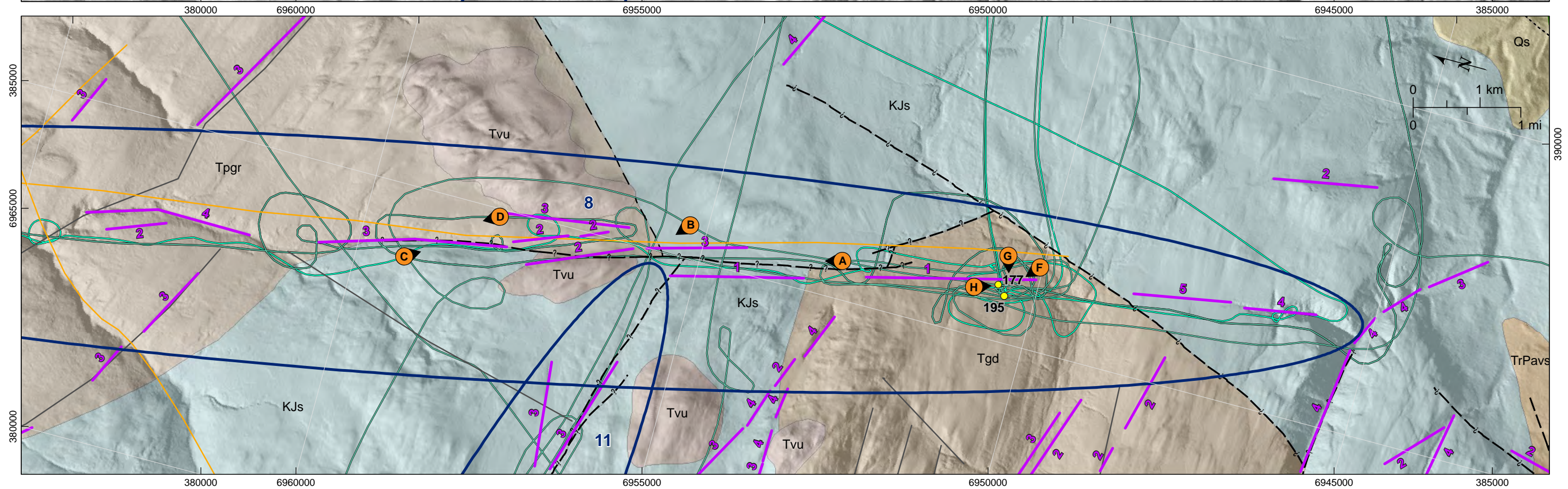
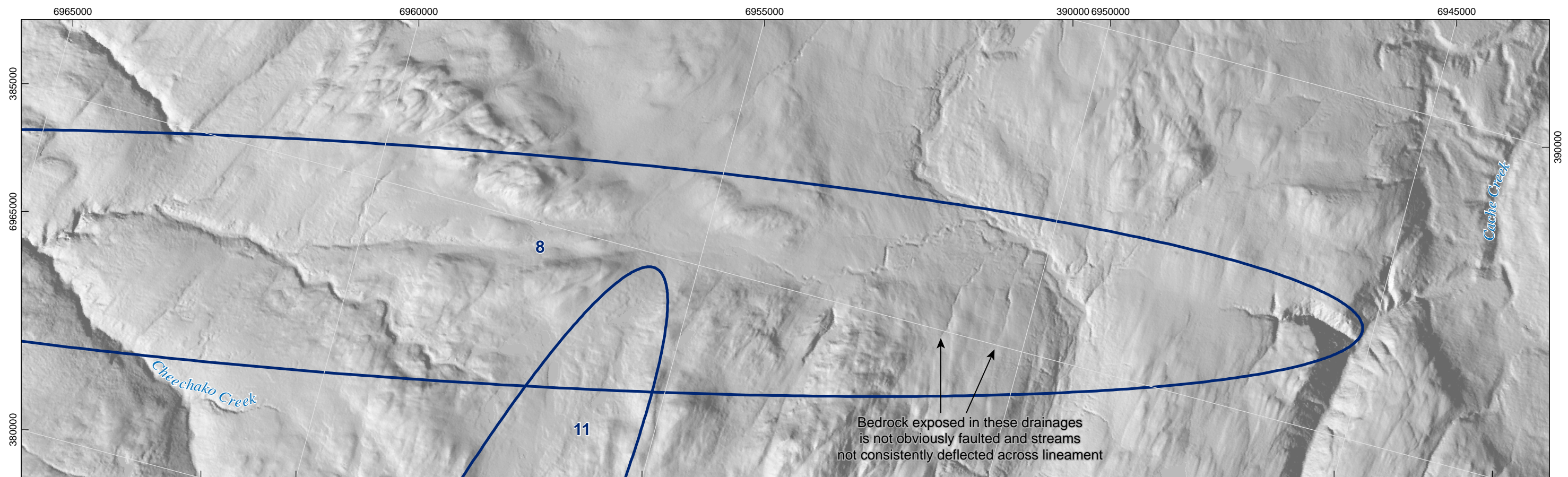
View looking down-valley from the top of the drainage seen in Photograph C.





Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 75° west of north.  
 3. Geology by Wilson et al., 2009.





Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 75° west of north.  
 3. Geology by Wilson et al., 2009.





View looking north at middle portion of lineament group 8 along mapped inferred fault. Brackets show position of fault but note that no geomorphic expression of faulting is readily apparent.



Close up view of saddle area shown in Photograph A. Brackets, again, show position of fault but note that no geomorphic expression of faulting is readily apparent.



View looking south opposite that shown in Photograph B above. Mapped fault runs between large arrows. Note presence of many solifluction scarps in the landscape.

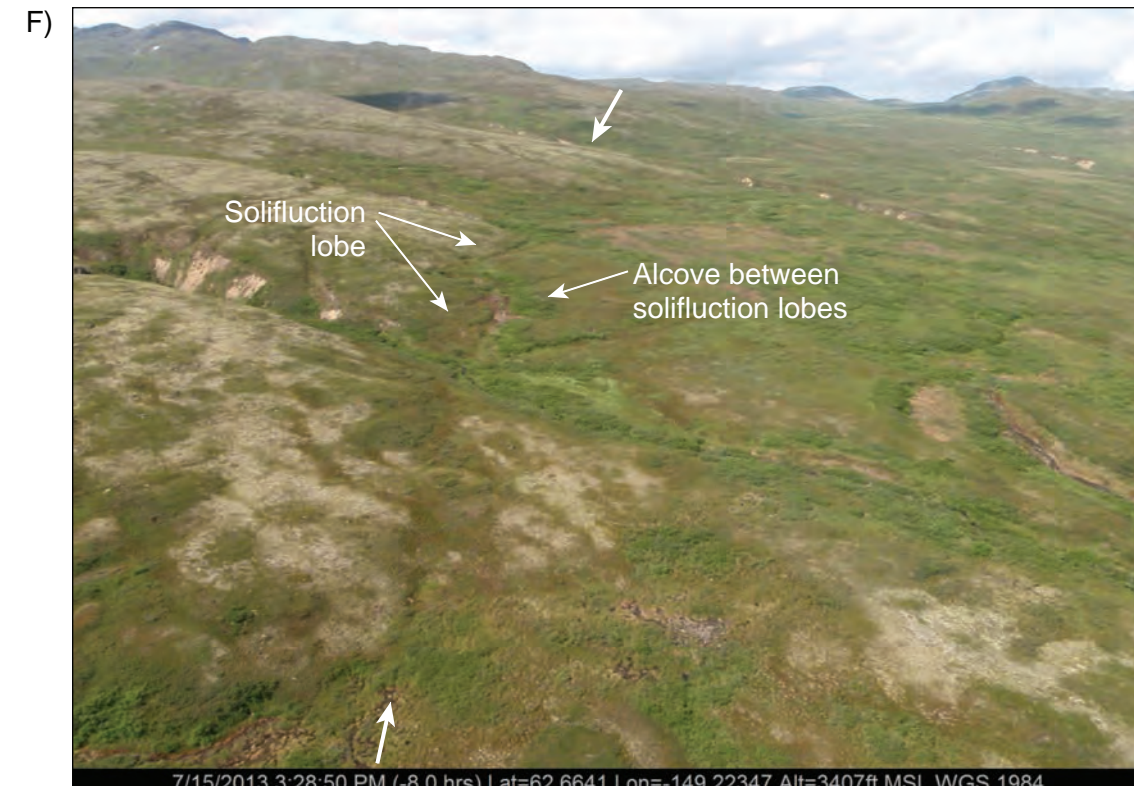


View looking north down the prominent, deeply incised linear drainage. Mapped fault runs between large arrows.

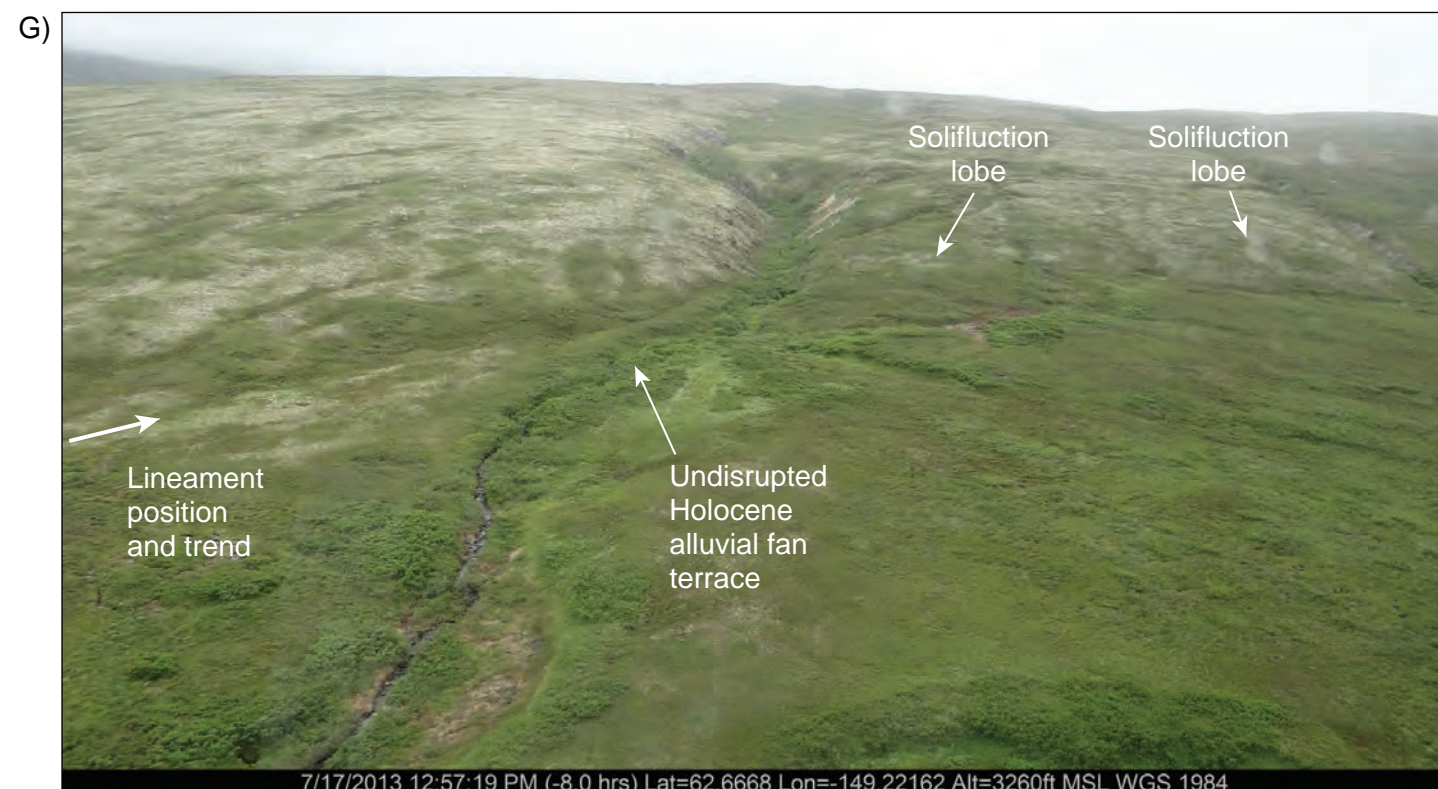




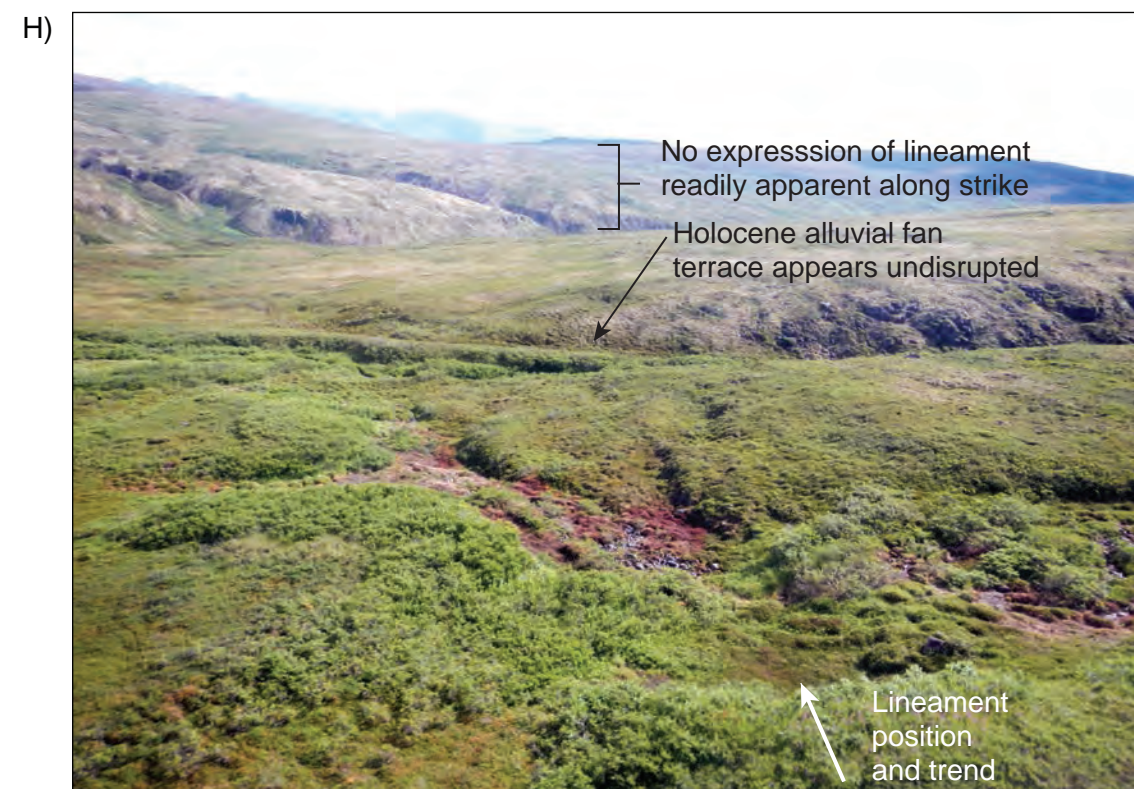
View looking north at north (right) bank of Susitna River showing oxidized mafic dike interpreted by WCC (1982) to not be truncated by the linear drainage.



View looking north along 1- to 2-m-high east-facing scarps along southern portion of lineament group 8. Large arrows point along mapped lineament. Note the presence of solifluction lobes with an alcove or recession in between them that create an irregular and curving topographic scarp.

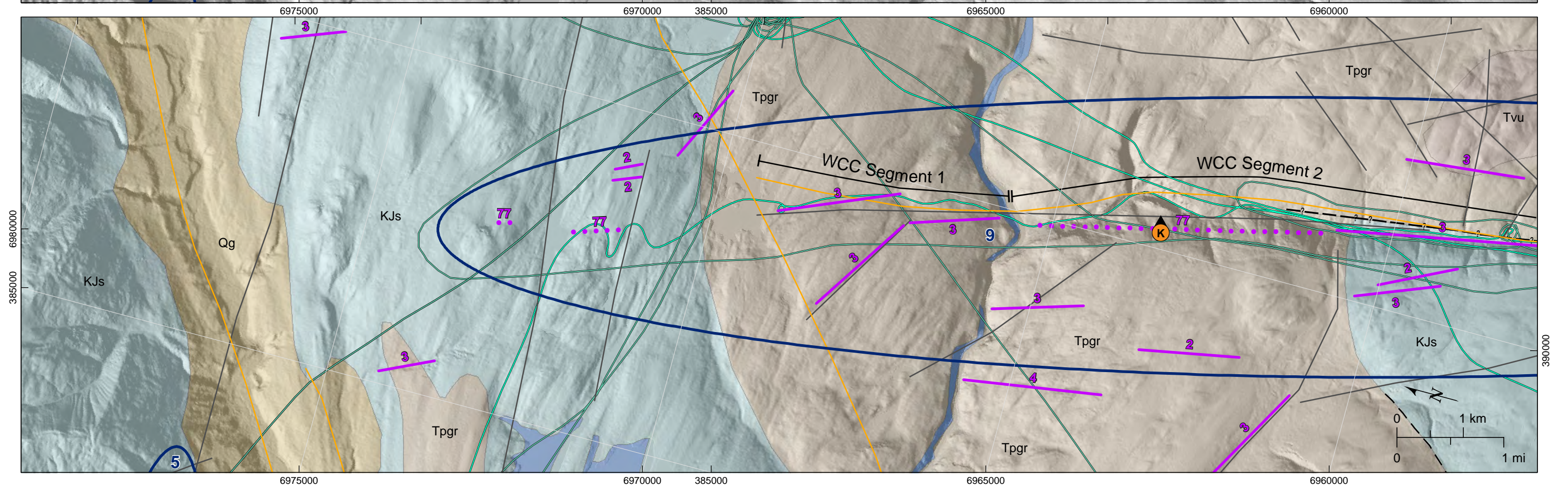
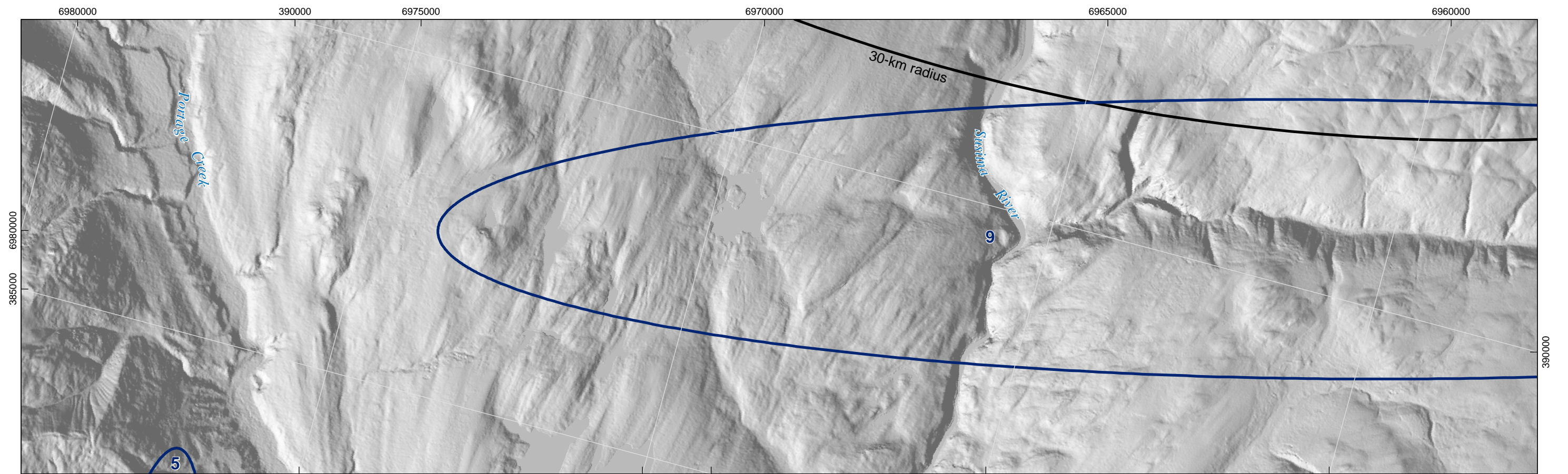


View looking west directly towards 1- to 2-m-high east-facing scarps shown in Photographs F and H. Large arrow points along mapped lineament.

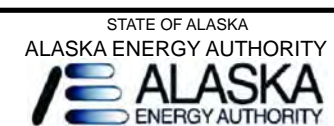


View looking south opposite that shown in Photograph F above. Large arrow points along lineament position and trend.





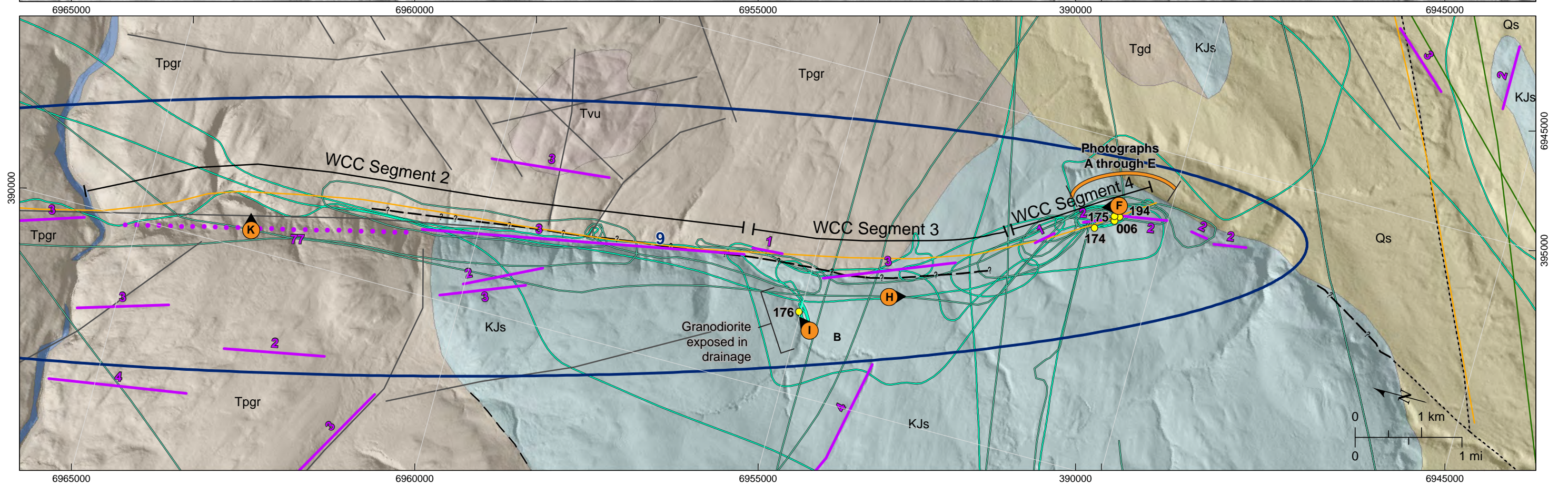
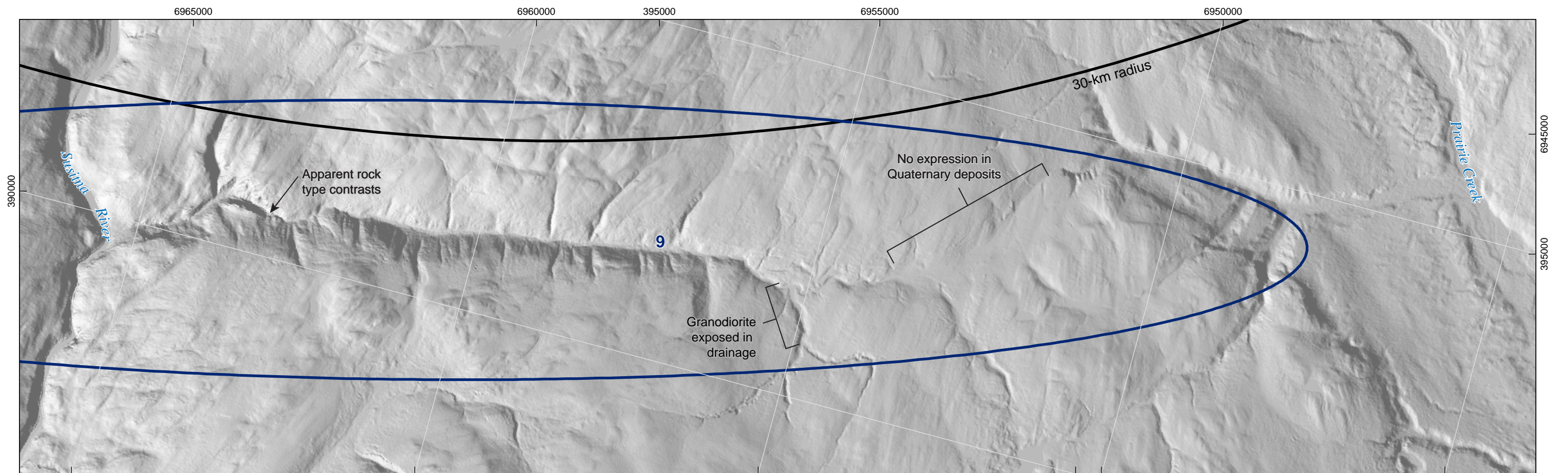
Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 75° west of north.  
 3. Geologic map by Wilson et al., 2009.



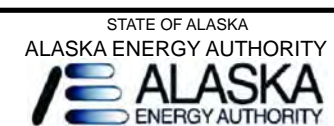
SUSITNA-WATANA HYDROELECTRIC PROJECT  
 LINEAMENT GROUP 9  
 MAP DATA

FIGURE  
 A9-1.1





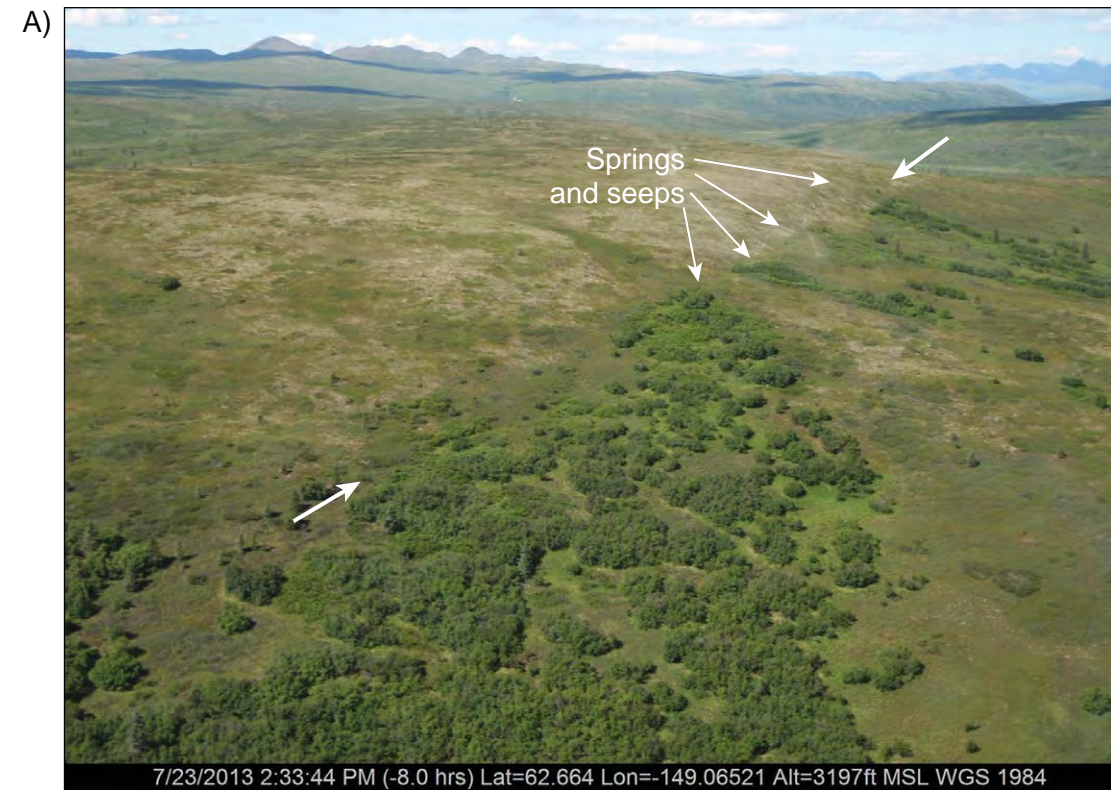
Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 75° west of north.  
 3. Geology by Wilson et al., 2009.



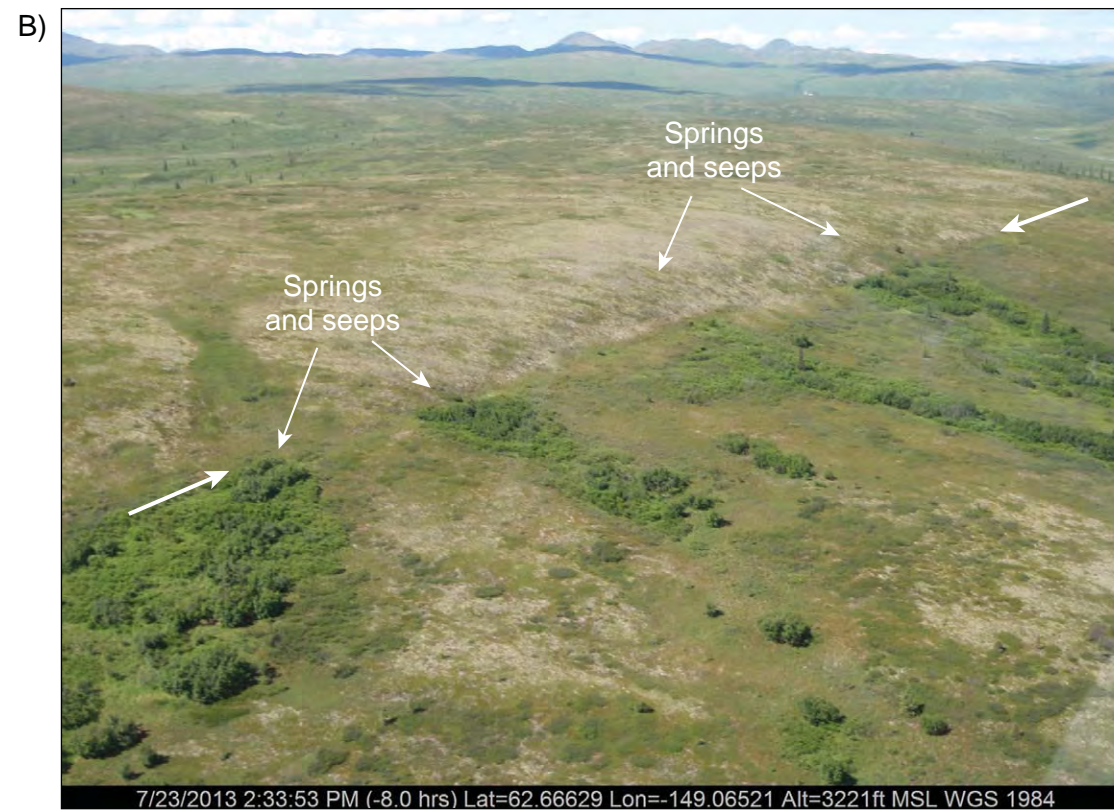
SUSITNA-WATANA HYDROELECTRIC PROJECT  
 LINEAMENT GROUP 9  
 MAP DATA

FIGURE  
 A9-2.1





The first in a sequence of 5 photographs looking northwest taken along a series of north-trending, east-facing aligned slope breaks in the southernmost portion of lineament group 9. Large arrows point along lineament.

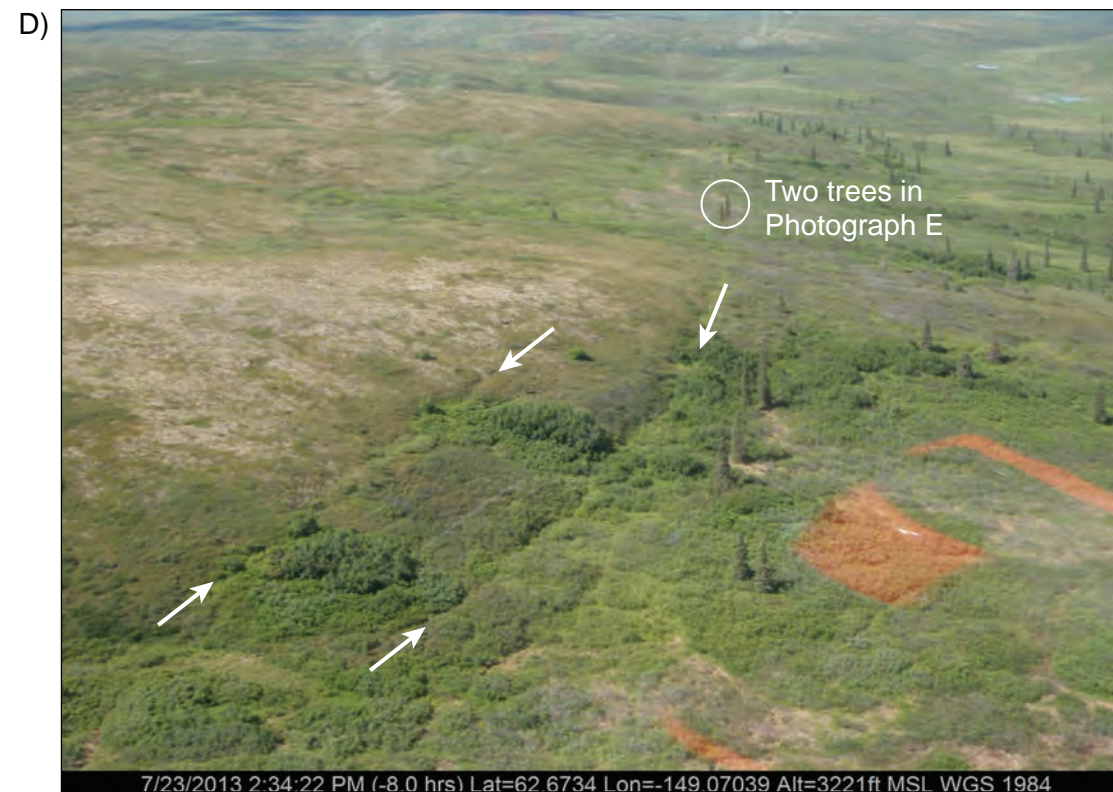


Photograph 2 of 5 looking northwest. Large arrows point along lineament.



Photograph 3 of 5 looking northwest. Large arrows point along lineament.





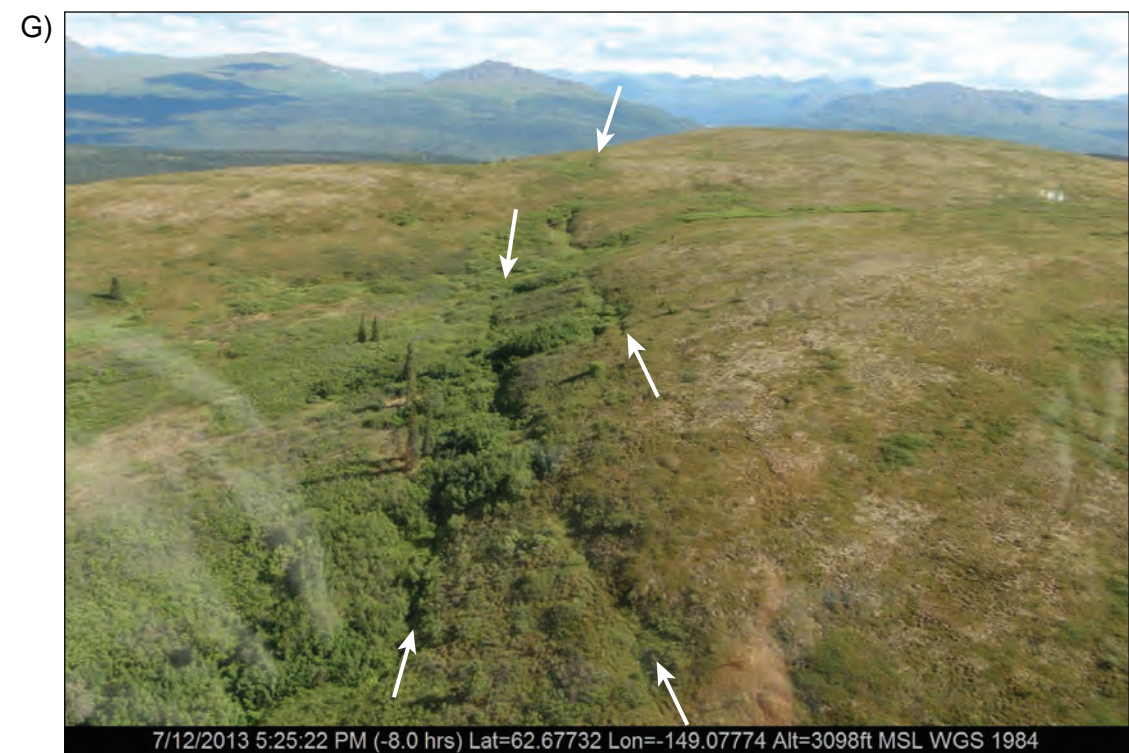
Photograph 4 of 5 with view looking northwest. Large arrows point along lineaments.



Photograph 5 of 5 with view looking northwest. Note that lineament expression has died out and brackets bound the location of its projection.



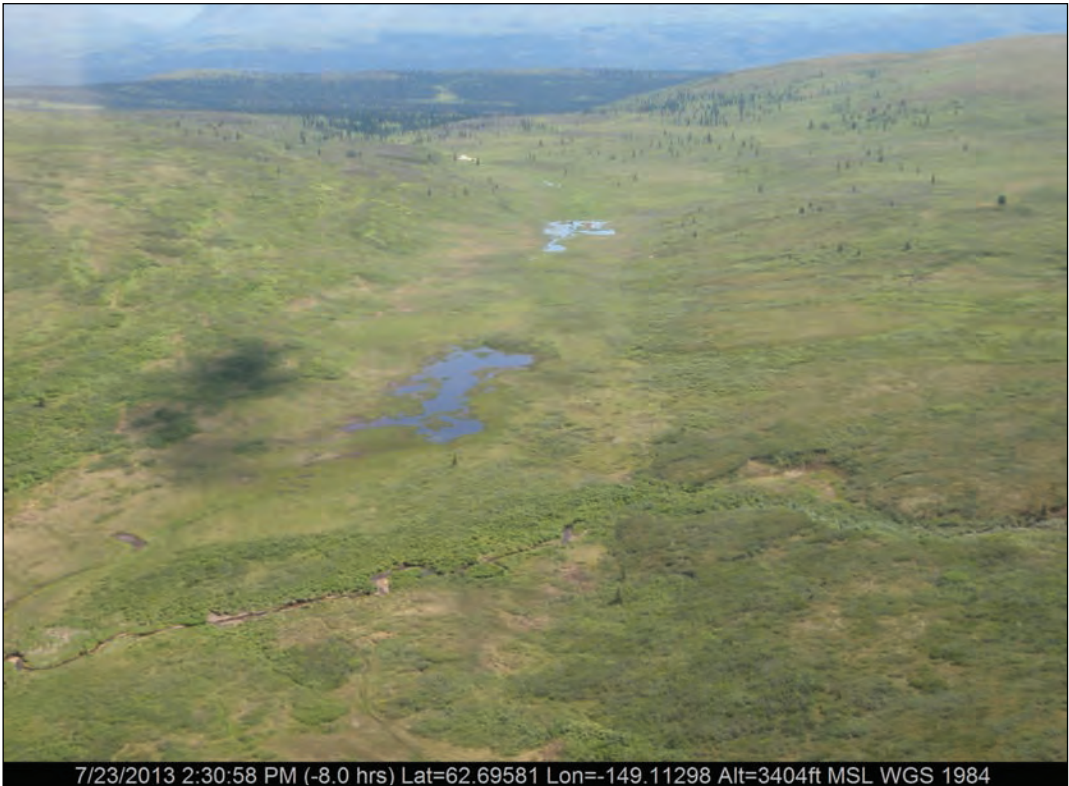
View looking north from location F. Geologist at base of east-facing break-in-slope is 170 cm tall.



View looking almost 180 degrees from that shown in Photograph D. Large arrows point along lineaments.



H)



View looking south from location I across area within WCC's segment 3. Note the lack of expression of any lineaments in the broad depression.

I)



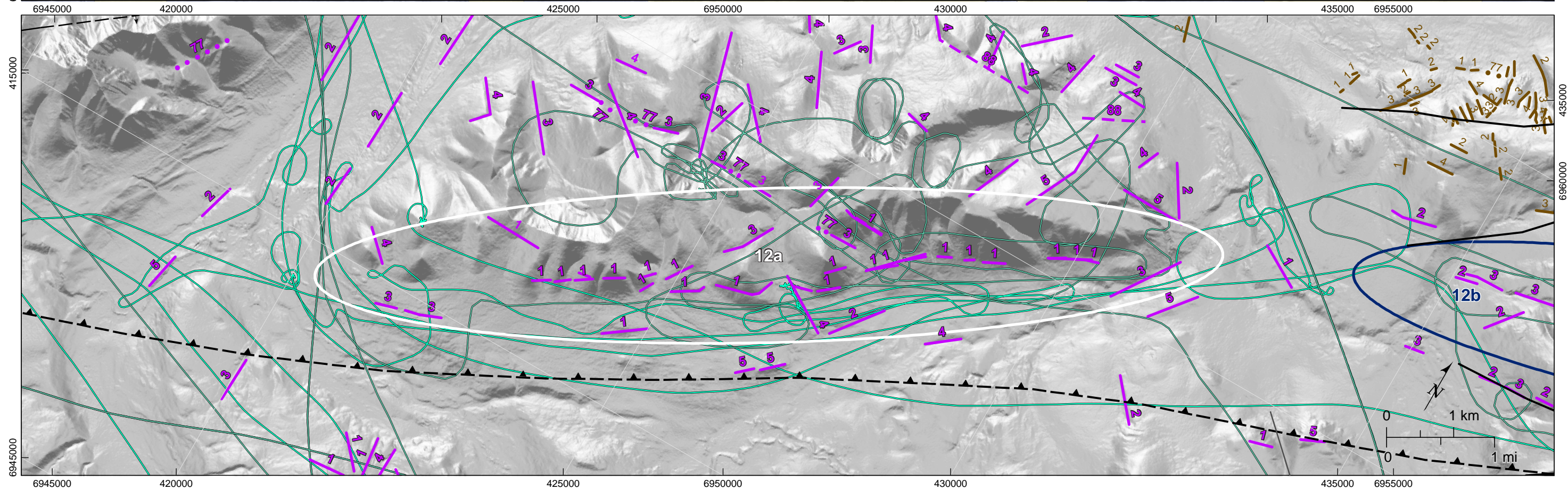
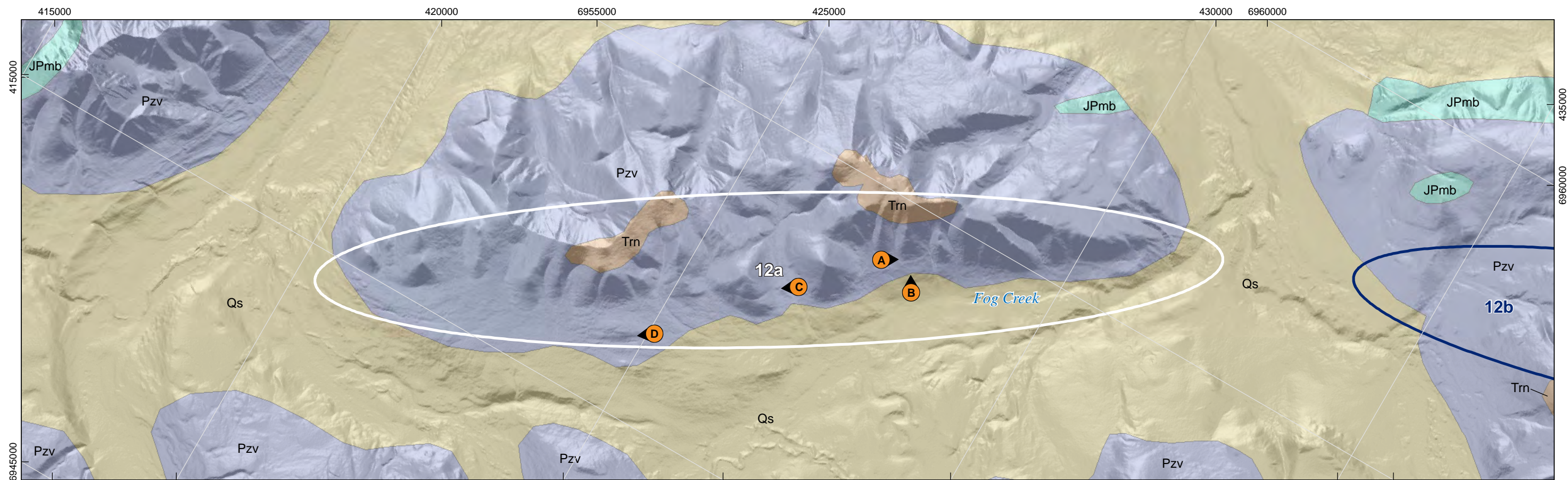
Exposures of widespread granodiorite in unnamed creek near GPS waypoint 176 in terrain mapped as flysch (map unit KJs) by Wilson et al. (2009). The geologist is approximately 175 cm tall.

J)



View looking northeast at right wall of linear v-shaped canyon. Large arrows point along apparent bedrock type contrast.





Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 30° east of north.  
 3. Geologic map by Wilson et al., 2009.



SUSITNA-WATANA HYDROELECTRIC PROJECT  
 LINEAMENT GROUP 12a  
 MAP DATA

FIGURE  
 A12a.1





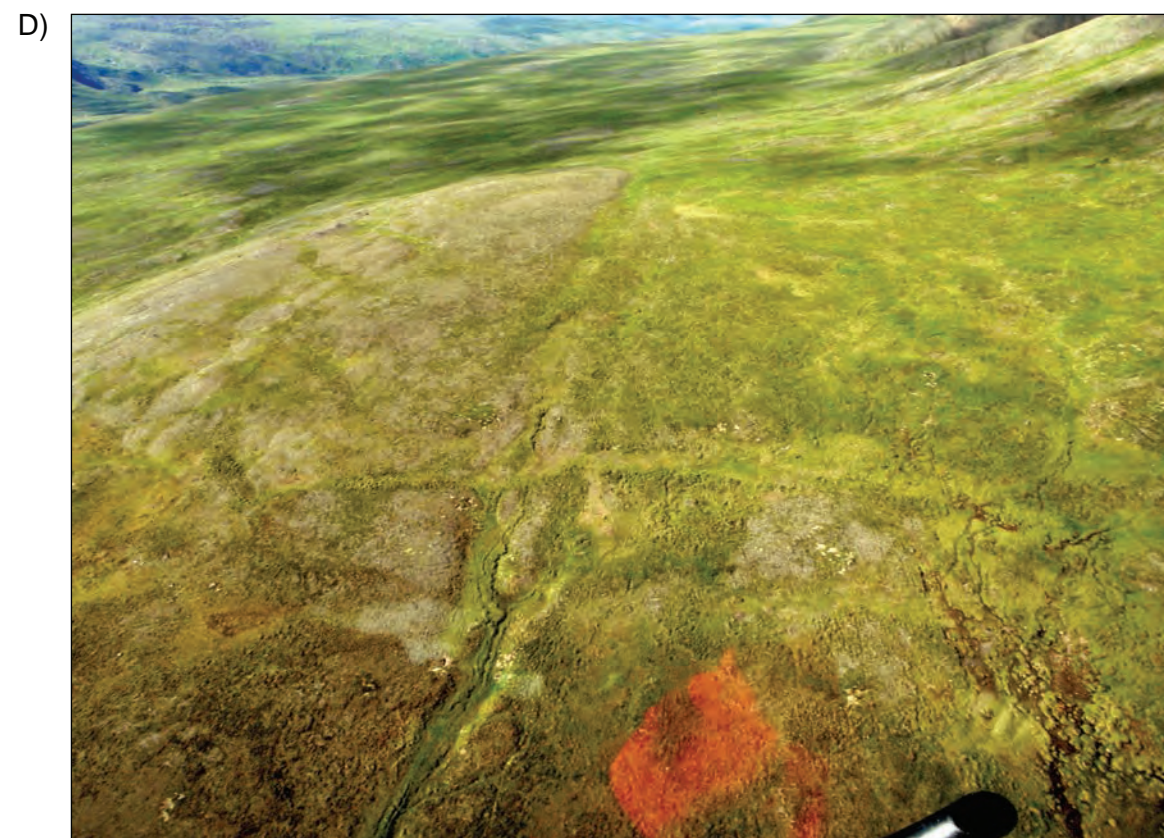
View looking northeasterly along lineaments. Arrows point along trend and position of lineaments.



View of lineaments expressed in Quaternary sediment.

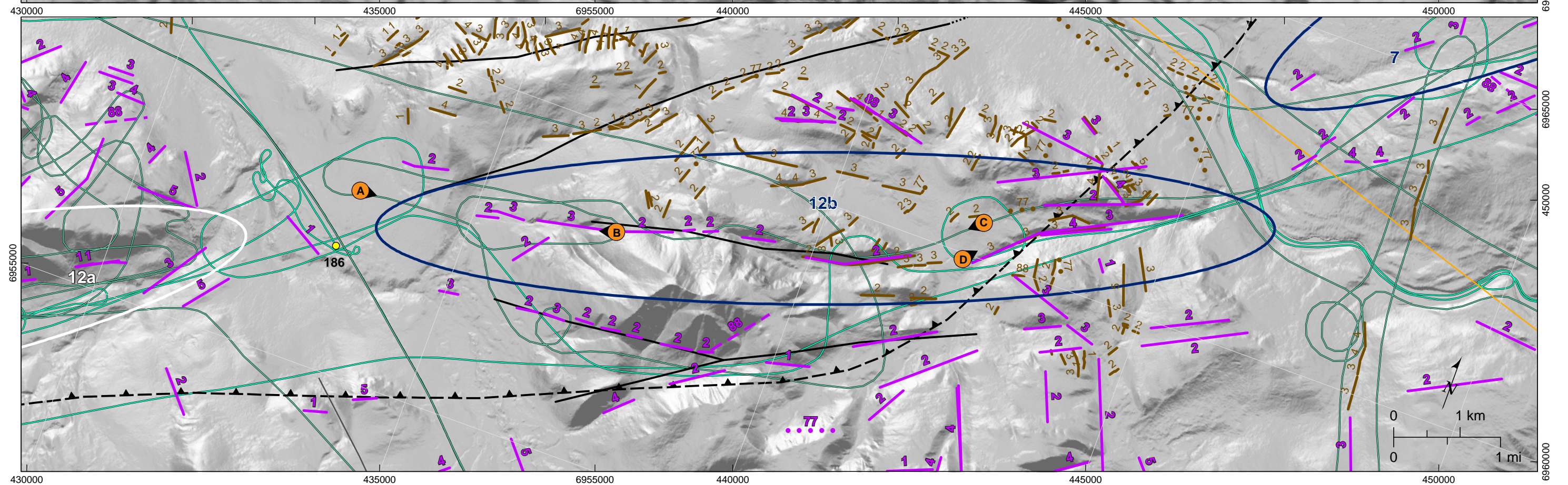
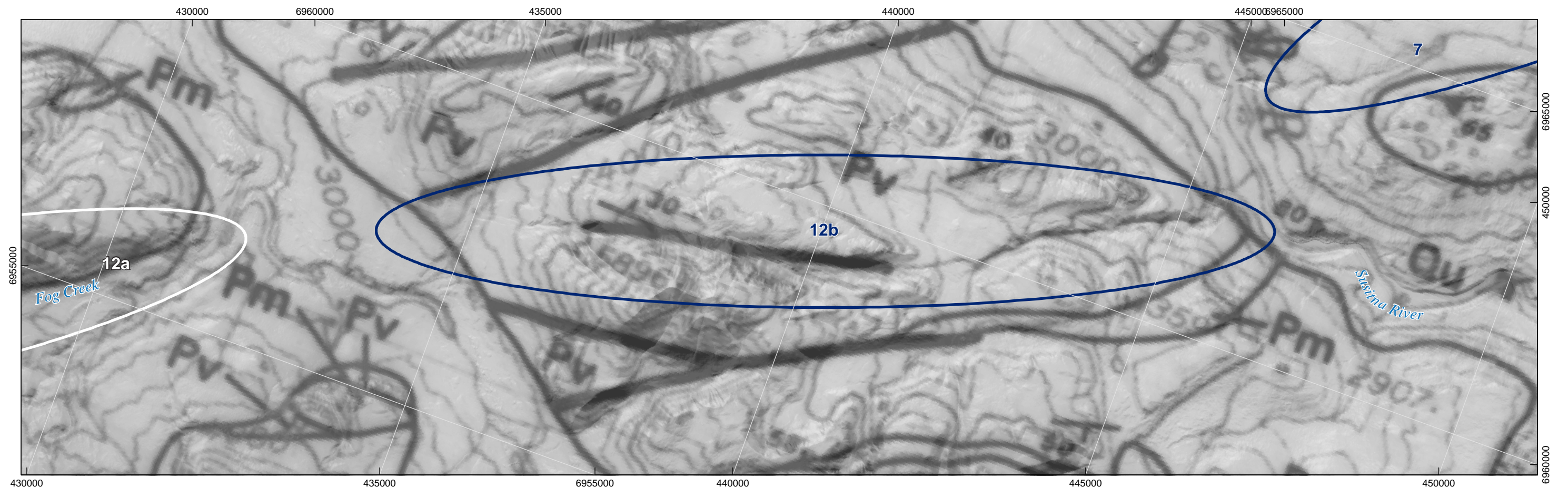


View looking at notch in bedrock with expression of apparent northwesterly dip.

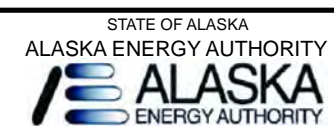


View looking southwesterly along glacially scoured surface.





Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 20° east of north.  
 3. Geologic map by Clautice et al., 2009.



SUSITNA-WATANA HYDROELECTRIC PROJECT  
 LINEAMENT GROUP 12b  
 MAP DATA

FIGURE  
 A12b.1

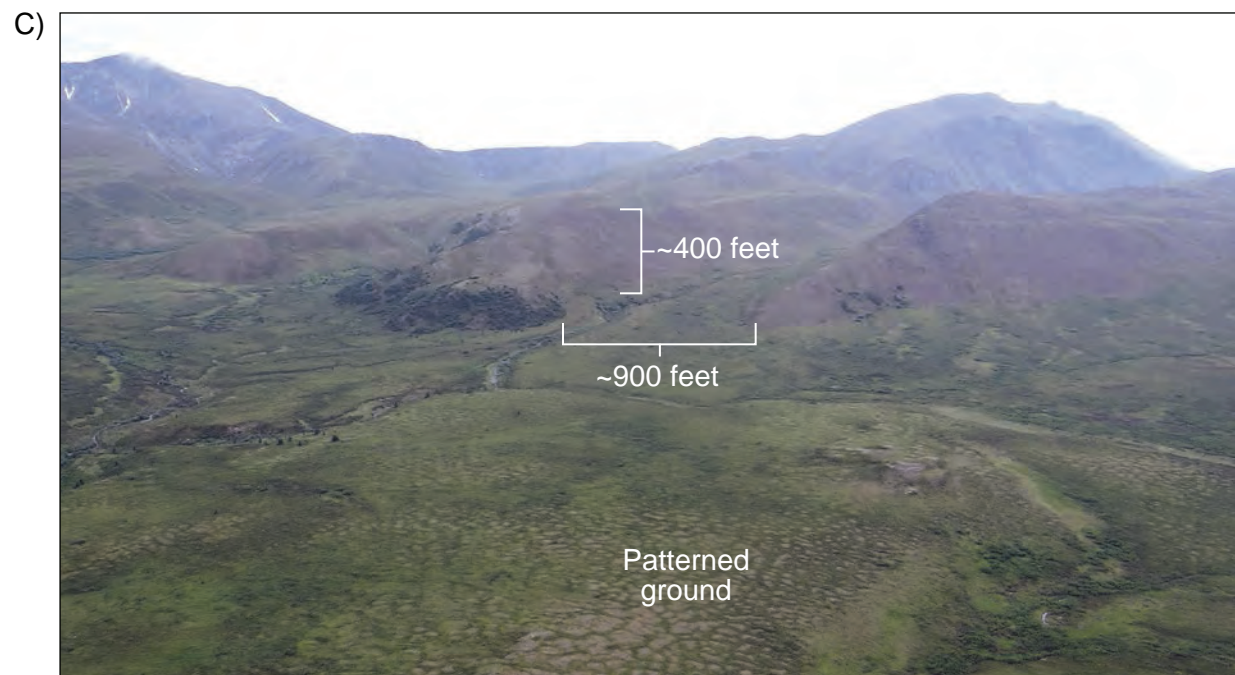




View looking northeast at erosional break-in-slope mapped as an individual lineament. Feature is absent in the background along projection of strike.



View looking southwest down-valley along lineament geomorphically expressed as linear valley. Very little alluvium has accumulated in the drainage, and glacially sculpted bedrock is shallow.

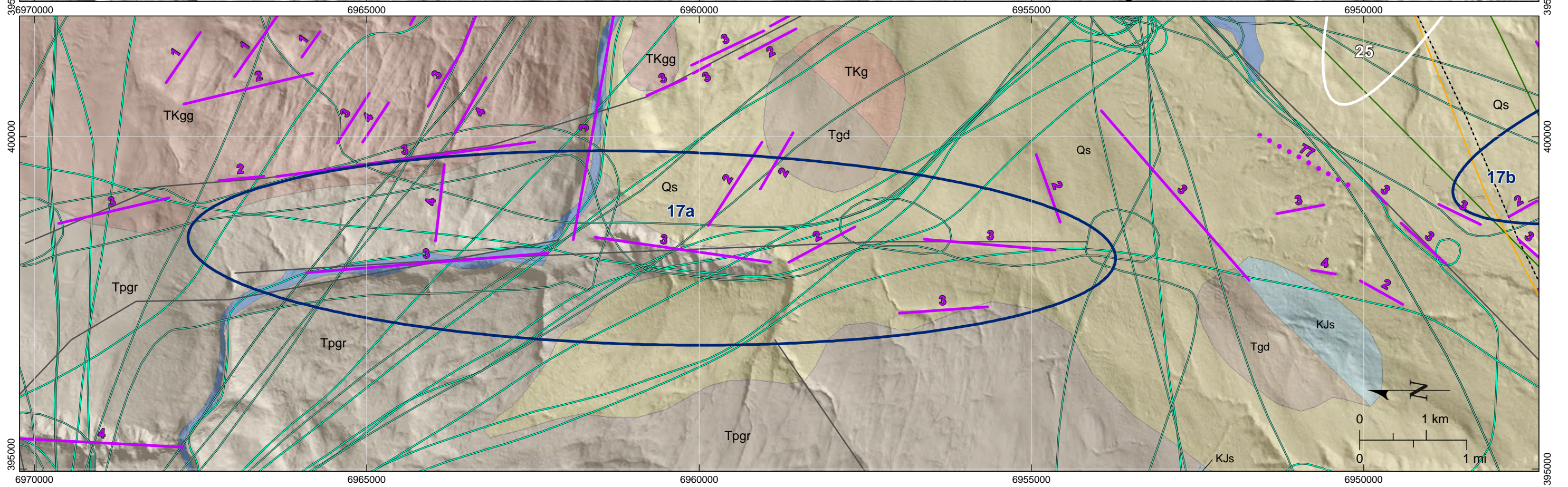
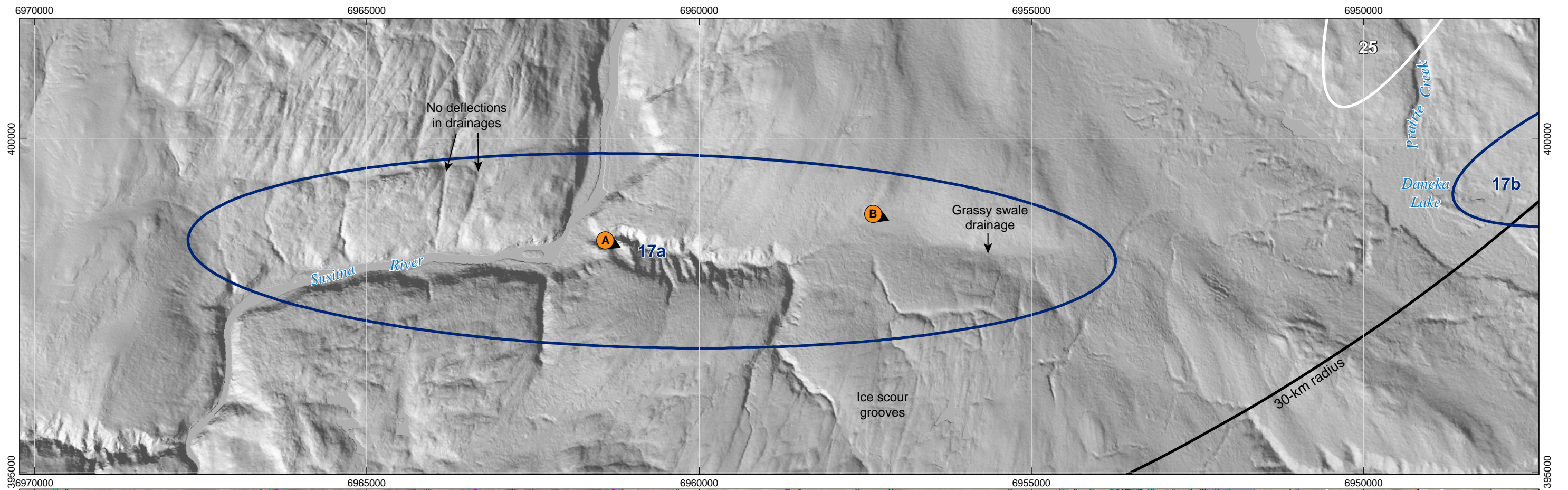


View southerly up-valley into glacial valley along lineaments geomorphically expressed as linear valley and drainage. Underfit creek in deep linear valley suggests landform created by sub-ice channel meltwater.

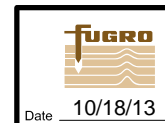


View northerly down-valley along lineaments geomorphically expressed as linear drainage. Thin cover of unconsolidated surficial sediment mantles the Paleozoic rocks.





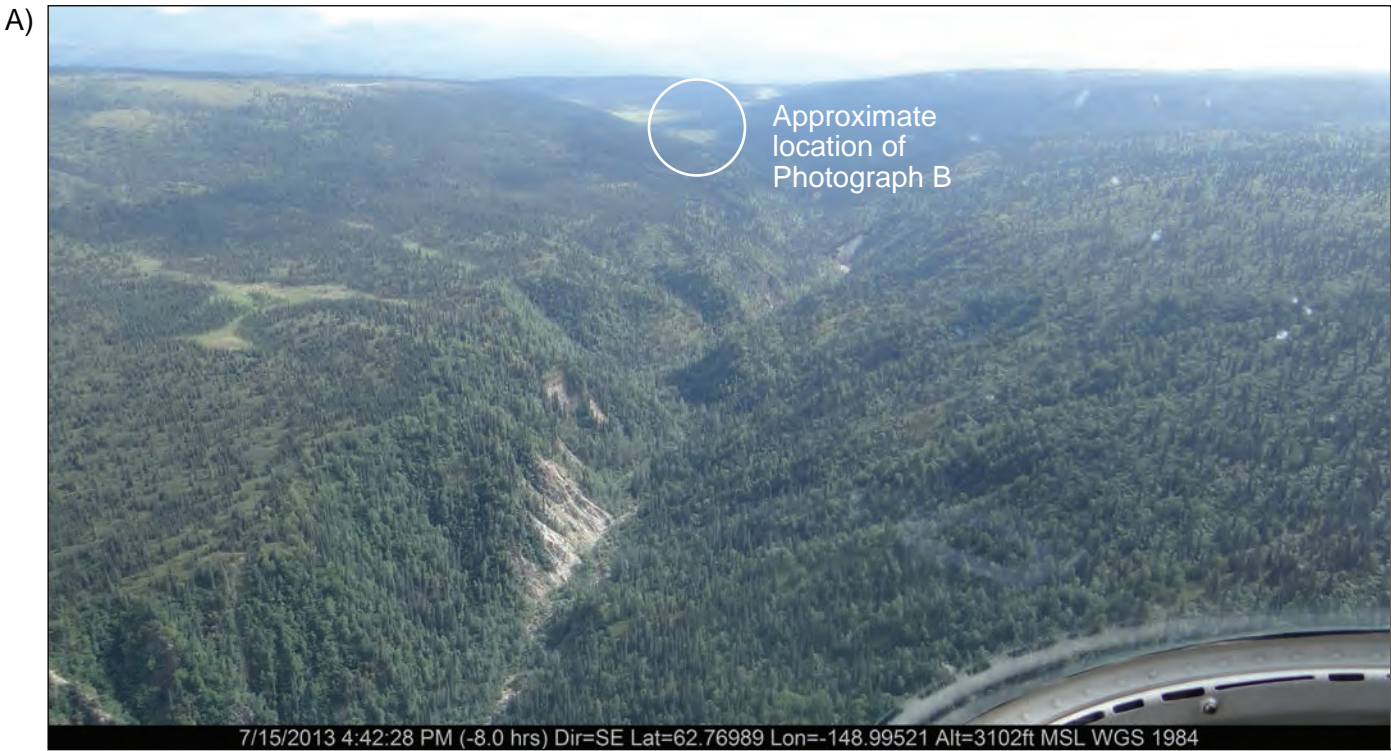
Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 90° west of north.  
 3. Geology by Wilson et al., 2009.



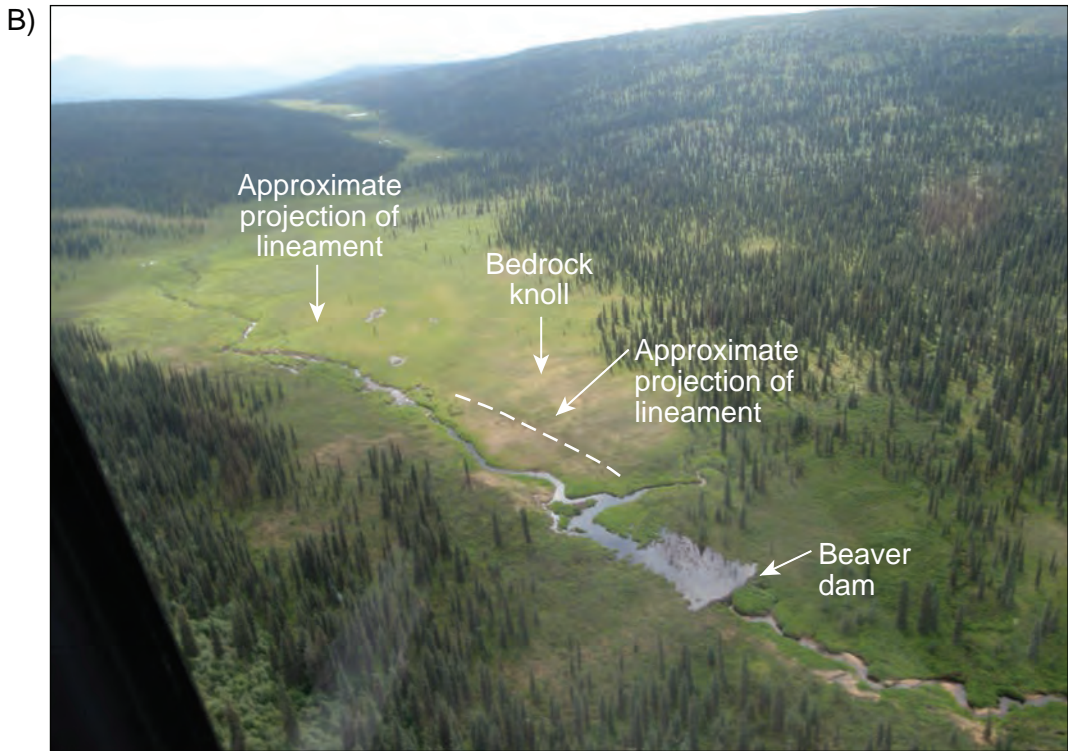
SUSITNA-WATANA HYDROELECTRIC PROJECT  
 LINEAMENT GROUP 17a  
 MAP DATA

FIGURE  
 A17a.1



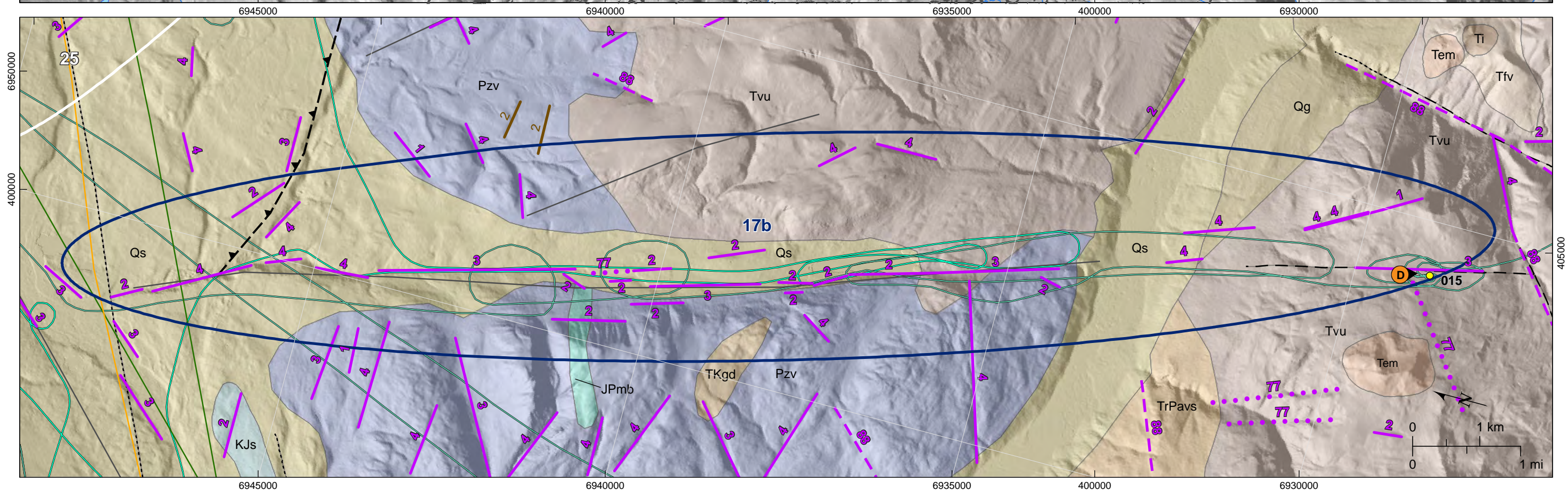
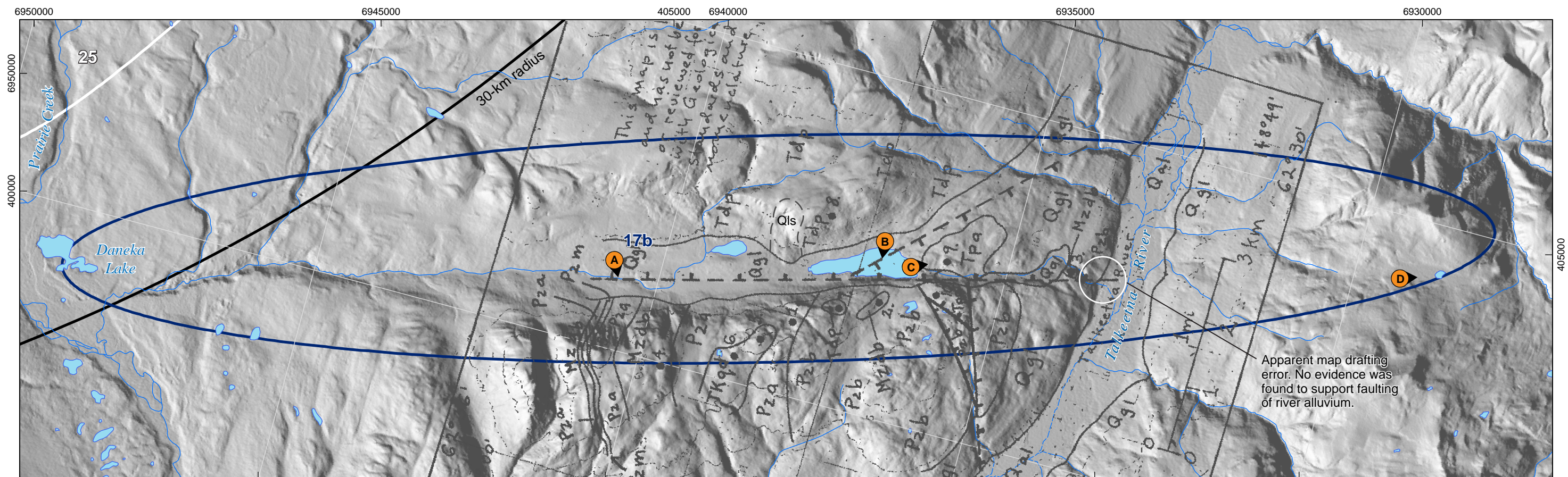


View looking south at linear canyon that is tributary to the Susitna River. Canyon bottom and creek drainage have sinuosity not apparent at smaller scales.



View looking north-northeast at creek in boggy (Holocene) drainage. Lineament is expressed as a depositional contact along the shallow bedrock knoll.

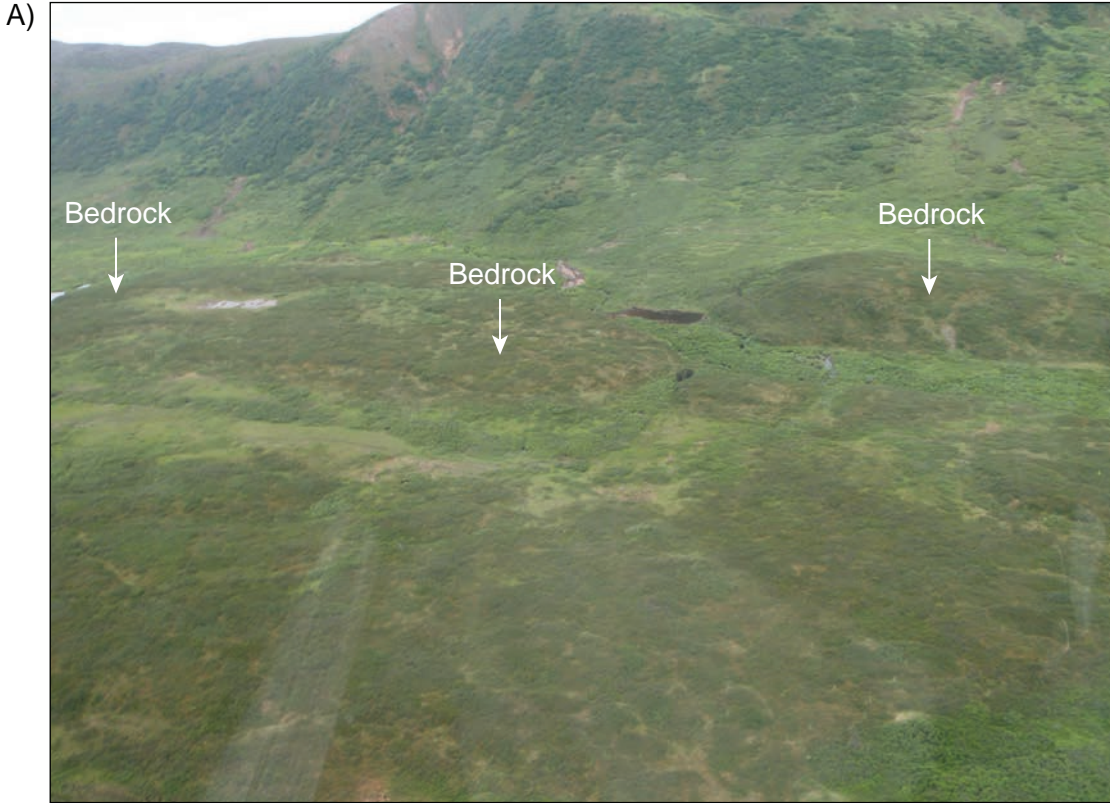




- Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 75° west of north.  
 3. Geology by Csejtey (1974), Talkeetna Mountains, Figure 4 (top) and Wilson et al., 2009 (bottom).



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View looking westerly at break-in-slope at base of hillside and undulating glacially-eroded bedrock knobs in foreground.

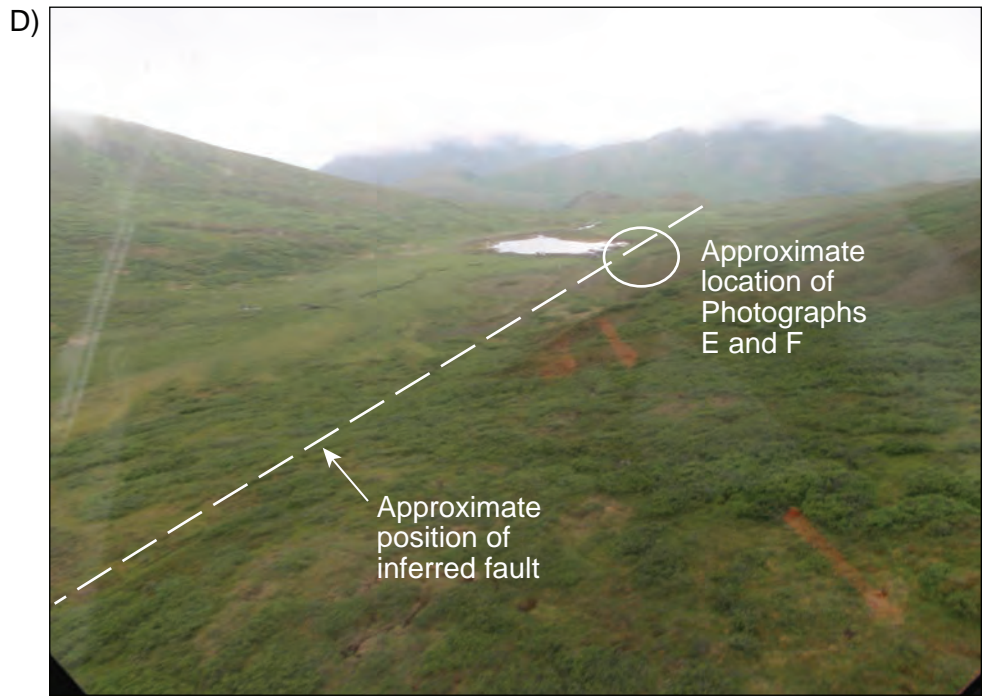


View looking south southwest at lake margin of glacial valley. Lineament was mapped at base of slope, and is not expressed as a scarp-type feature. Apparent colluvium along projection of lineament does not appear offset.



View looking south southeast along glacially-sculpted terrain along which Csejtey (1974) has inferred a fault within the glacial sediment that mantles the bedrock knolls (Figure A17b.1).

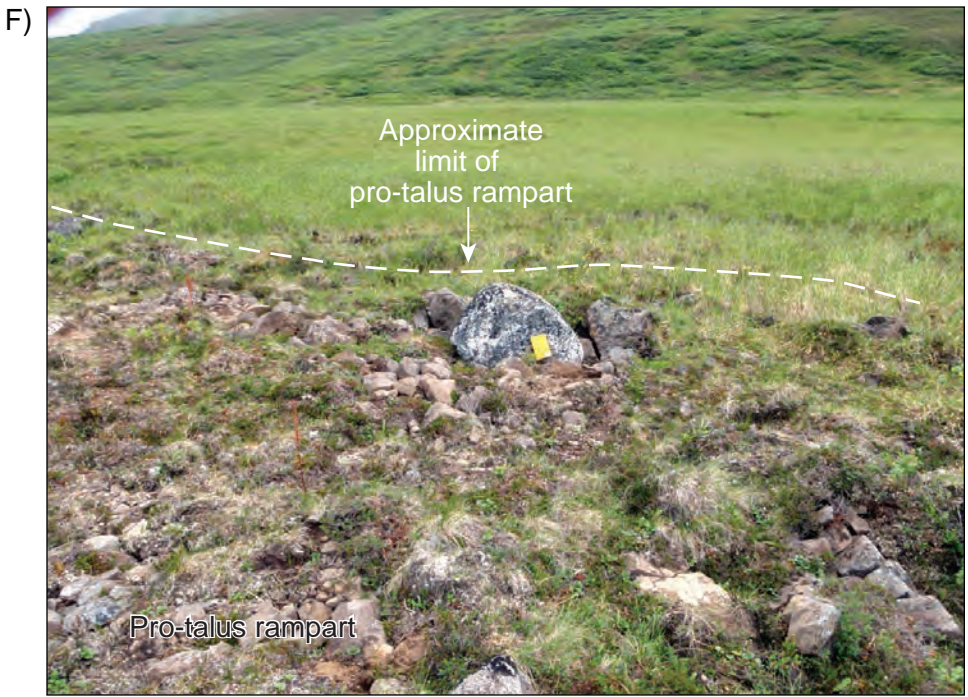




View looking south along southern extent of group 17b, along which an inferred bedrock fault is mapped by Wilson (2009). Photographs B and C are adjacent to lake.

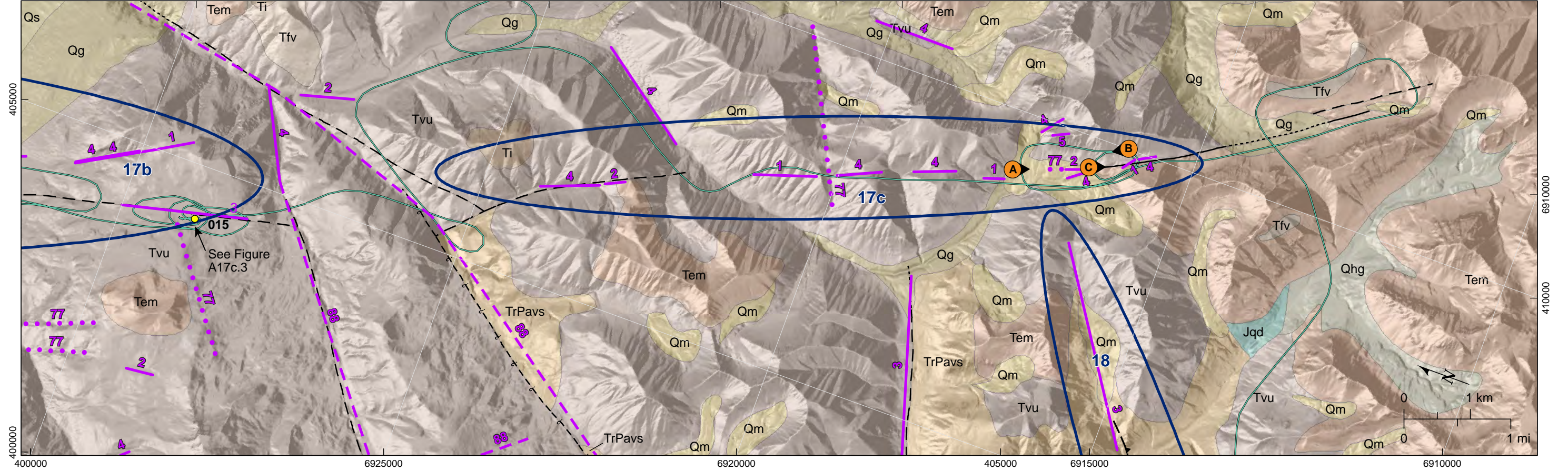
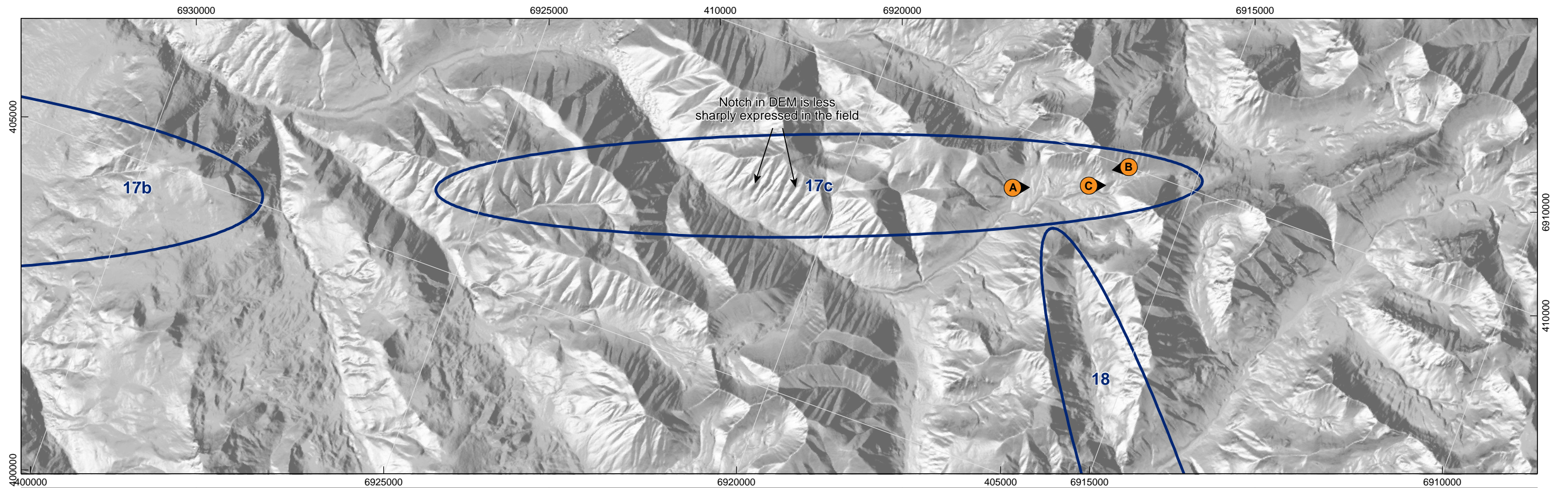


View looking south at pro-talus rampart and GPS waypoint 15. Note lateral distance between base of slope to crest of rampart. Geologist for scale is about 180 cm tall.

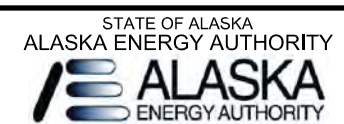
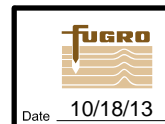


Pro-talus rampart constructed from blocky, frost-shattered volcanic rocks. Photograph is centered on more sub-rounded glacial erratic (granitic) that is not similar to any of the local hillside lithologies. Field notebook is 19 cm tall.





- Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 70° west of north.  
 3. Geology by Wilson et al., 2009.



SUSITNA-WATANA HYDROELECTRIC PROJECT  
 LINEAMENT GROUP 17c  
 MAP DATA

FIGURE  
 A17c.1

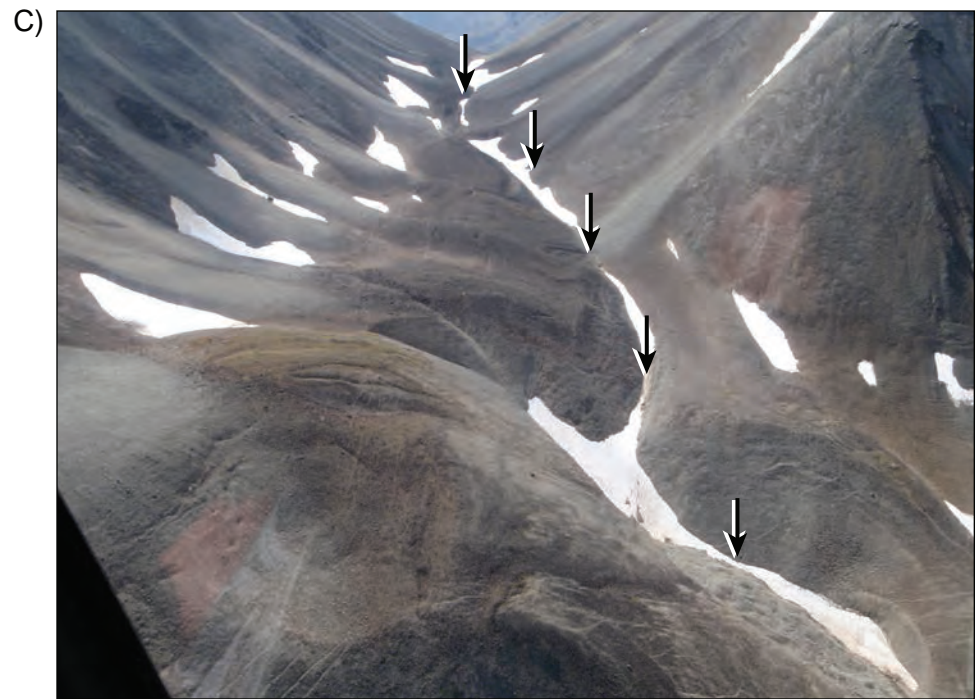




View looking southeasterly at lineament expressed at erosional drainage cutting through the likely Holocene rock glacier deposit.

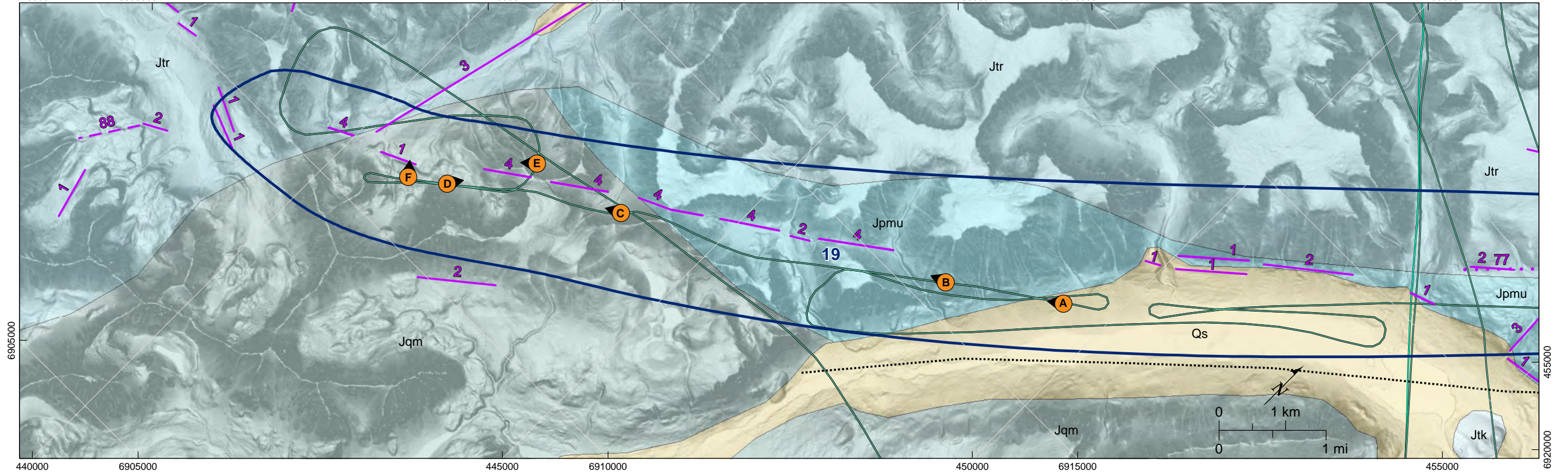
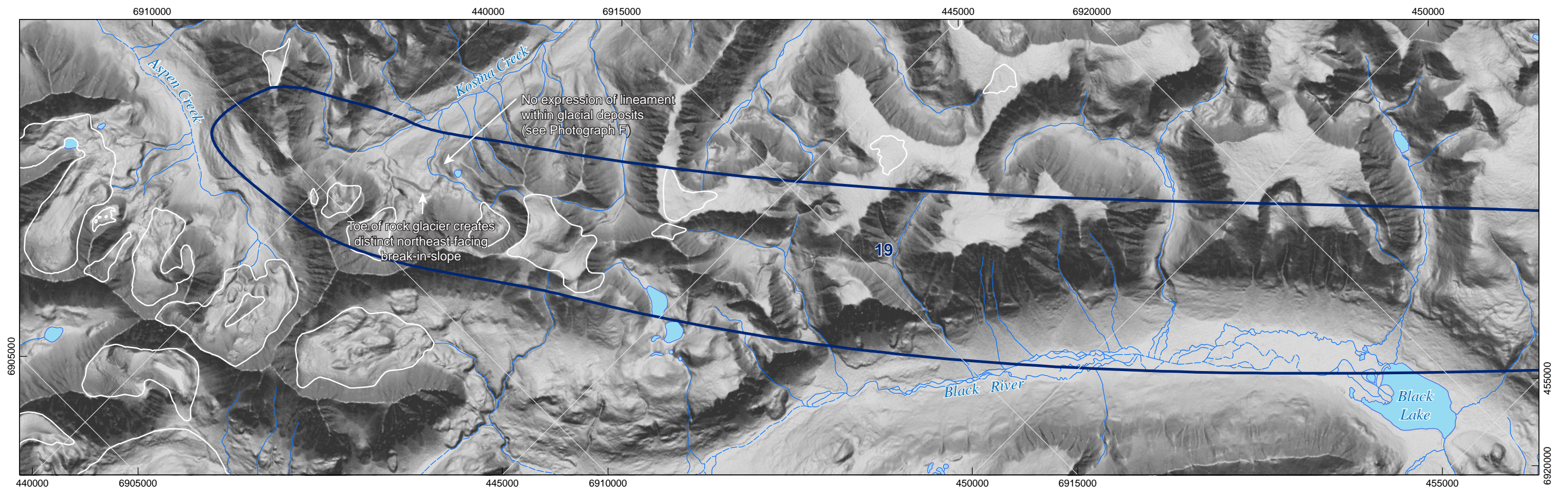


View looking northwesterly (opposite that in Photograph A) at lineament expressed as erosional drainage cutting through the likely Holocene rock glacier deposit.



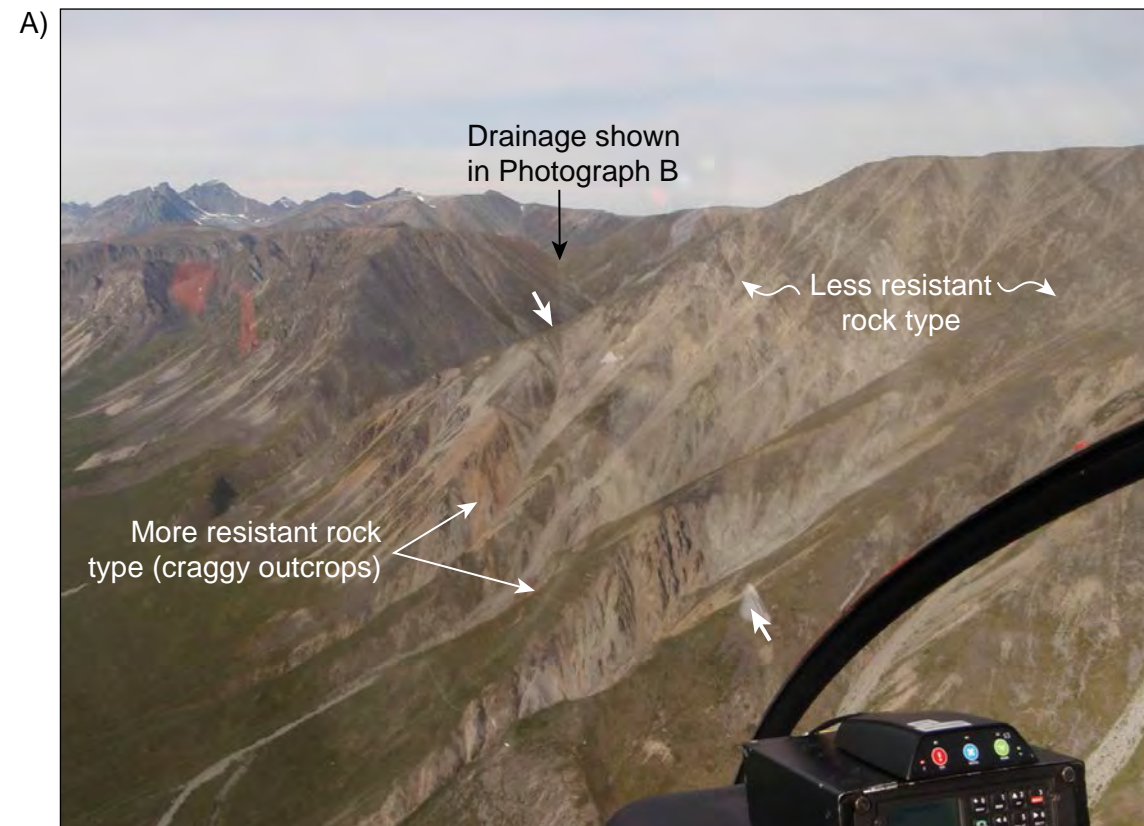
View looking southeasterly at lineament expressed as likely Holocene rock glacier deposit contacting the valley floor.





Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 45° east of north.  
 3. Geologic map from Wilson et al., 2009.





Photograph taken from location A looking southwest along apparent rock type contrast (contact?) and towards mapped lineaments in steep-walled, v-shaped, linear drainage. Arrows point along apparent contact between less-resistant rock on the north and more resistant and craggy outcrops on the south.



Photograph taken from location B looking west along mapped lineaments and apparent rock contact in steep-walled, v-shaped, linear drainages.



Photograph taken from location C looking west at head of steep-walled, v-shaped, linear drainage where mapped lineaments correspond to apparent rock contact.

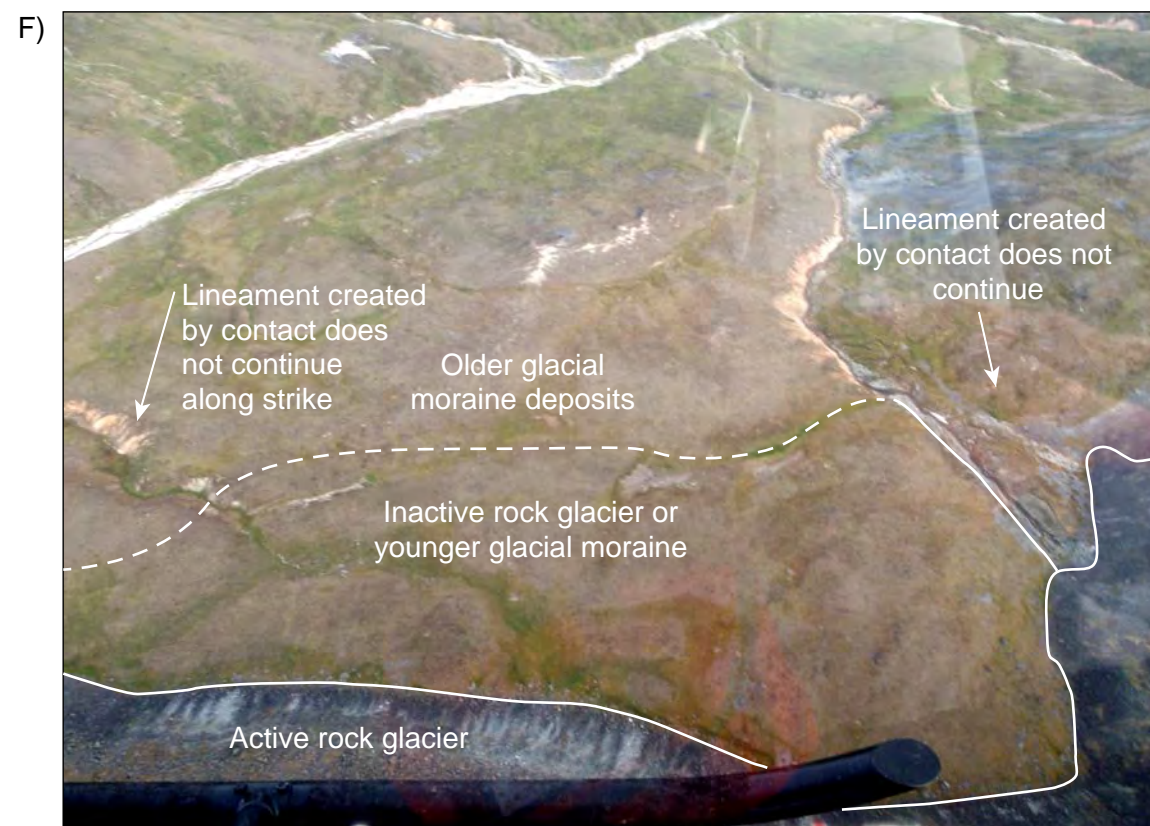




Photograph looking northeast from location D along the western continuation of the apparent rock type contrast shown in Photographs A, B, and C. Arrows point along apparent contact.

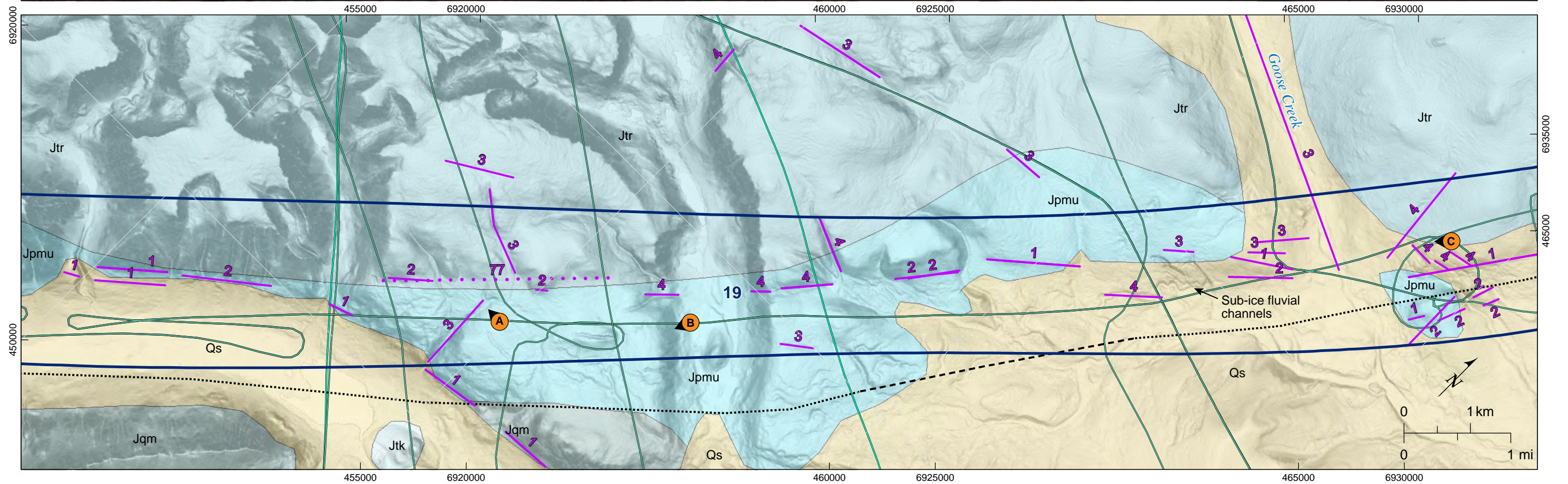
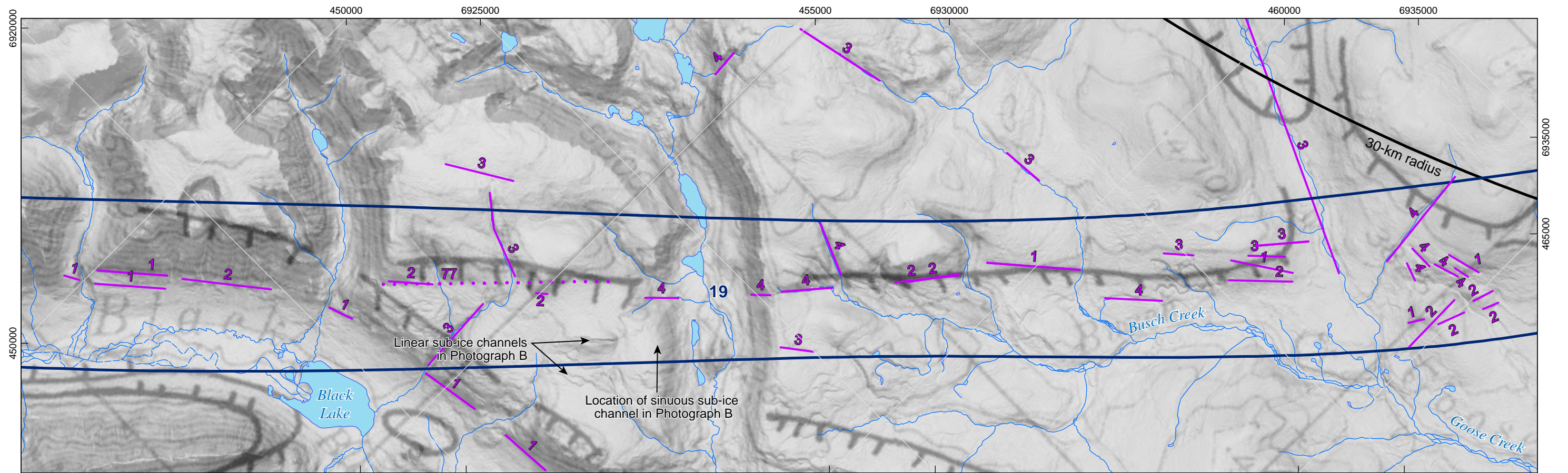


Photograph from location E looking southwest down the ridgeline shown in Photograph D. View is 180 degrees from that in Photograph D. Note presence of rock glacier and glacial deposits in valley bottom. Arrows point along apparent contact.



Photograph looking northwest from location F showing apparently undeformed rock glacier and/or glacial deposits along strike of the mapped lineaments and apparent rock contact shown in Photographs A through D.



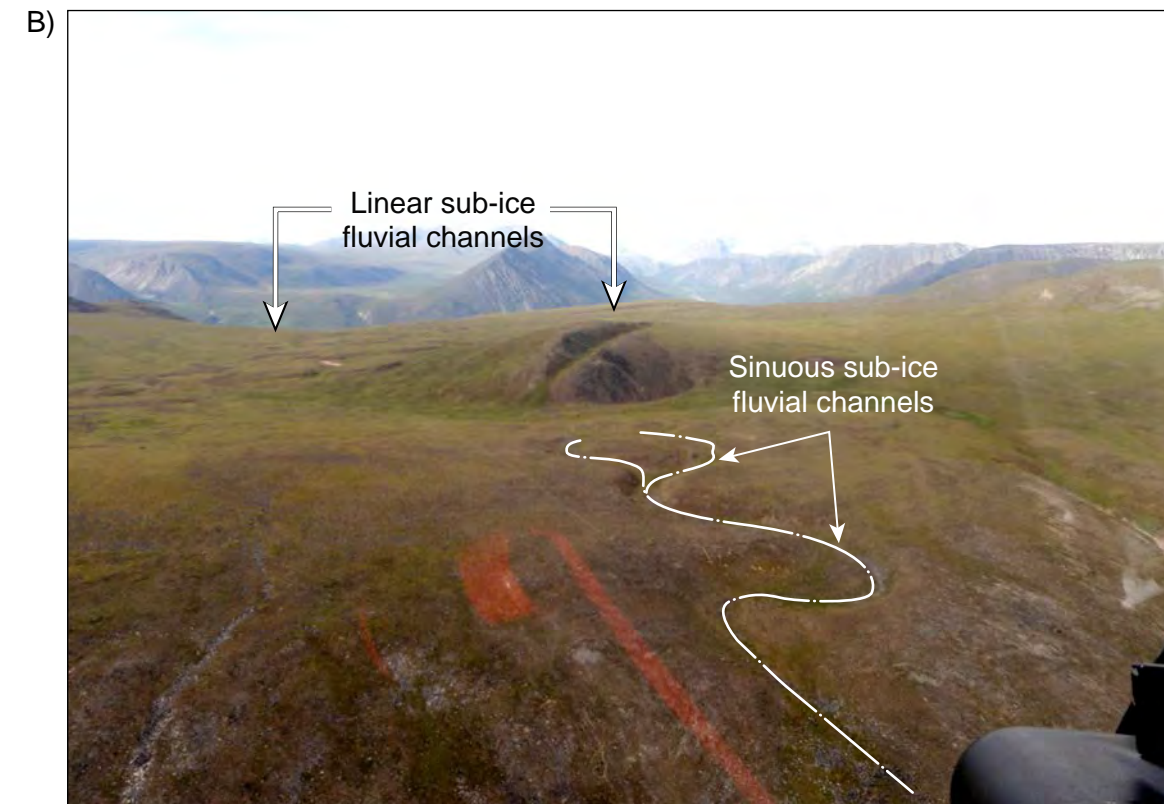


Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 45° east of north.  
 3. Geologic map in top panel by Williams and Galloway, 1986 and bottom panel by Wilson et al., 2009





Photograph taken from location A looking west. Arrows point along trend of mapped lineaments along southwest-facing aligned break-in-slope. Note the rounded and subdued nature of break-in-slope. Relief across break-in-slope is ~125 m.

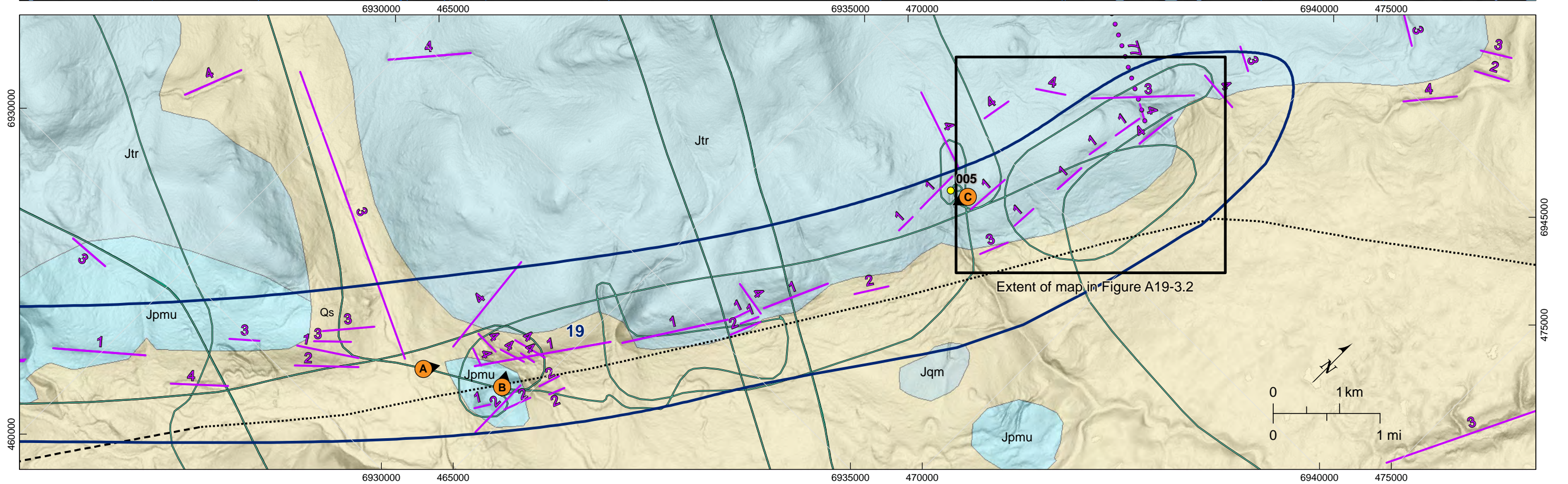
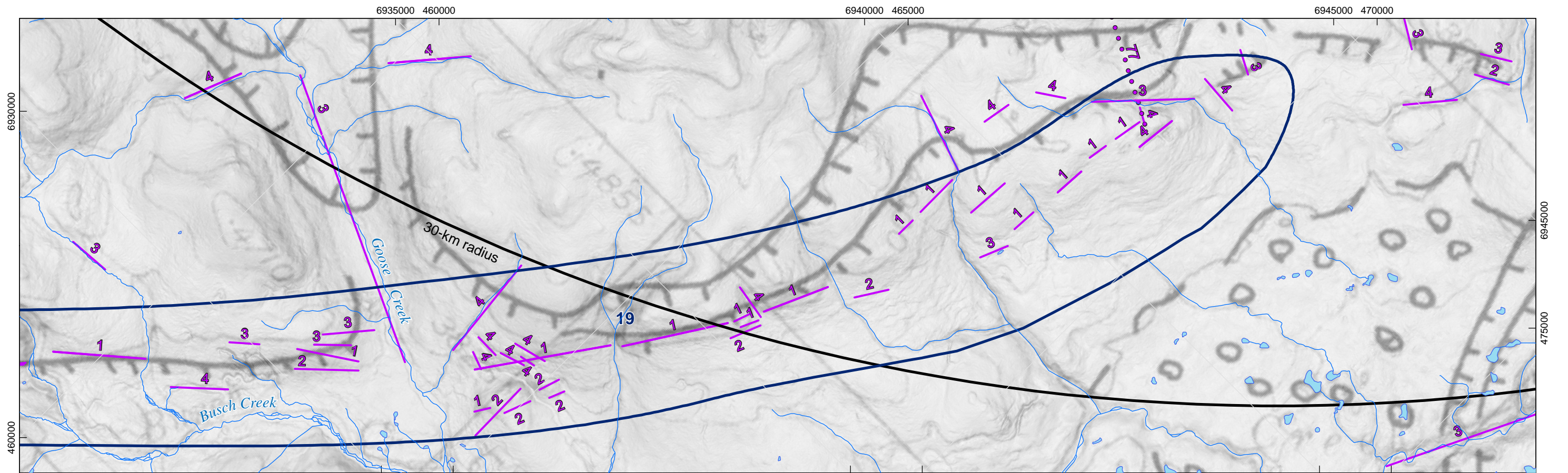


Photograph looking southwest from location B. The sinuous sub-ice channels are not large enough features to be seen on INSAR data.

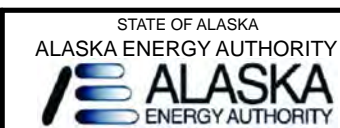


Overview photograph looking southwest from location C along alignment of mapped lineaments. Arrows point along trend of lineament group 19. Note absence of expression of lineaments within the landscape across the Goose Creek portion of the lineament group.





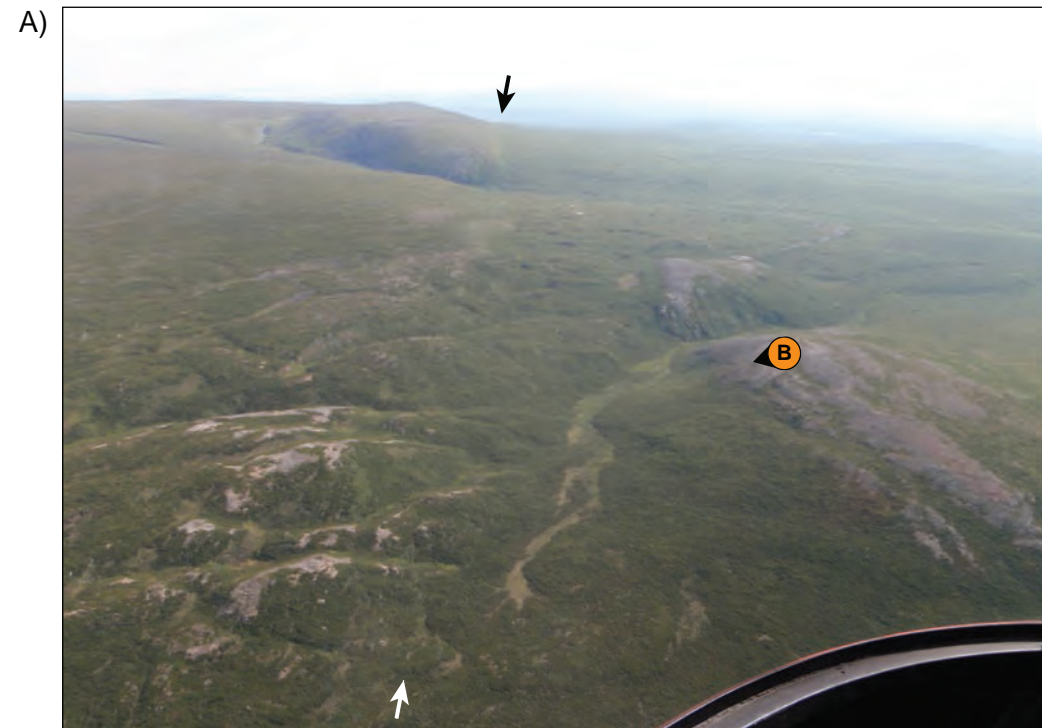
Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 45° east of north.  
 3. Geologic map in top panel by Williams and Galloway, 1986  
 and bottom panel by Wilson et al., 2009



SUSITNA-WATANA HYDROELECTRIC PROJECT  
 LINEAMENT GROUP 19  
 MAP DATA

FIGURE  
 A19-3.1





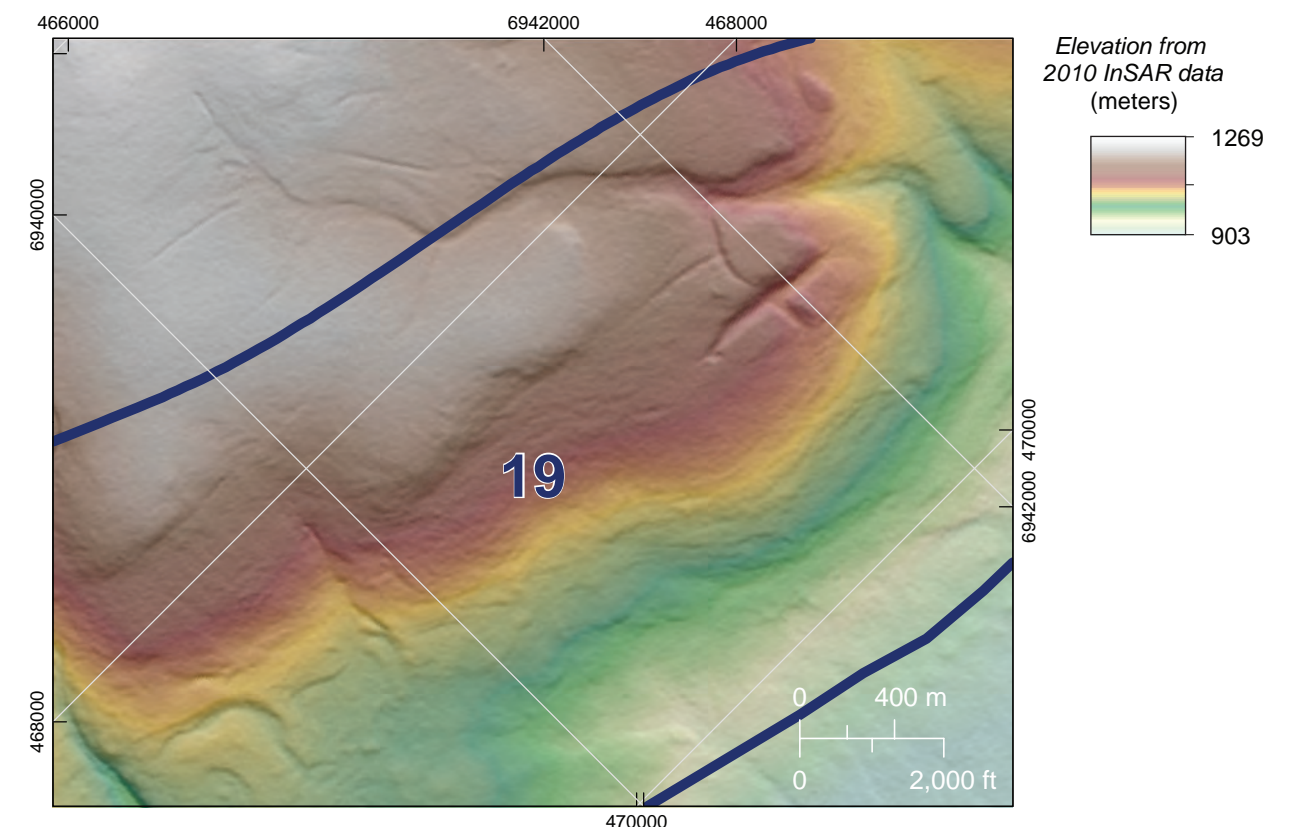
Photograph looking north-northeast from location A along the east-facing break-in-slope that defines the northeast portion of LG 19. Arrows point along alignment of mapped lineaments.



Photograph looking northwest from location B at sub-ice fluvially-eroded channels. Arrows point along the trend of mapped lineaments that make up group 19.



Photograph looking south-southwest from location C at widely spaced, near vertical, well-developed joints in trondhjemite (aka tonalite) bedrock. Joint spacing is 1 to 1.5 meters. Predominant orientations of joints are 042/80SE, 012/85SE, and 082/85SE but other orientations exist. Joint faces have clean surfaces with relief of minerals of 1 to 3 mm. No gouge or mineralization observed on joint surfaces, nor any sense of movement indicators (striae or mullions).



Detailed DEM showing orthogonal joint sets at northeast end of group 19.





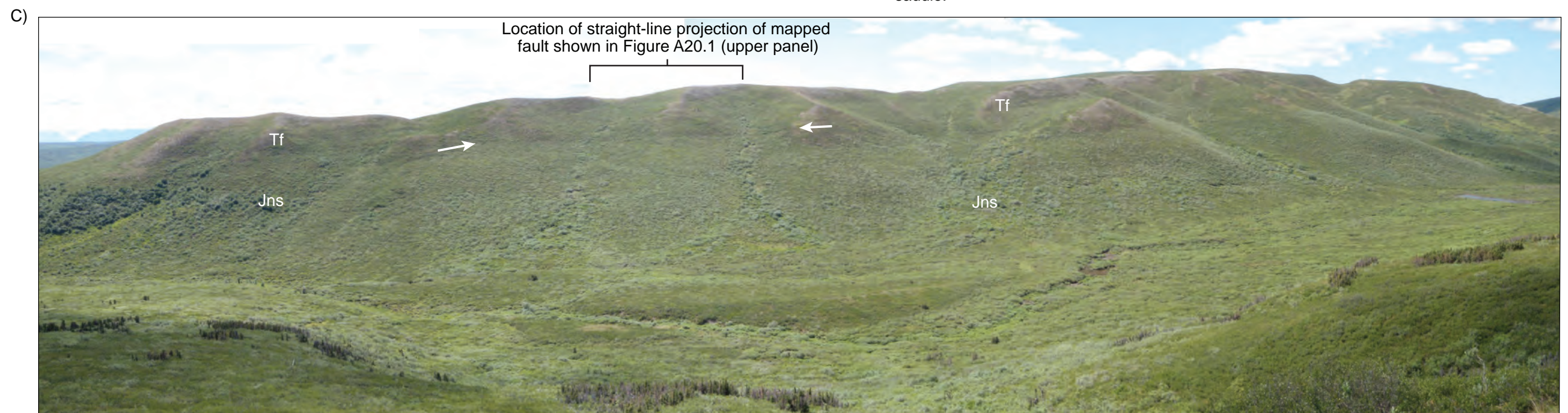




Photograph looking northeast from location A.



Photograph looking west-southwest from location B. Geologist standing in 3- to 6-m deep- and ~30-m-wide swale. Swale only exists in saddle; it does not continue down either side of saddle.



Photograph looking southwest from location C. Basal contact shown by arrows. Note that base of contact is not apparently deformed along projection of fault and that no expression of faulting in valley bottom is apparent.

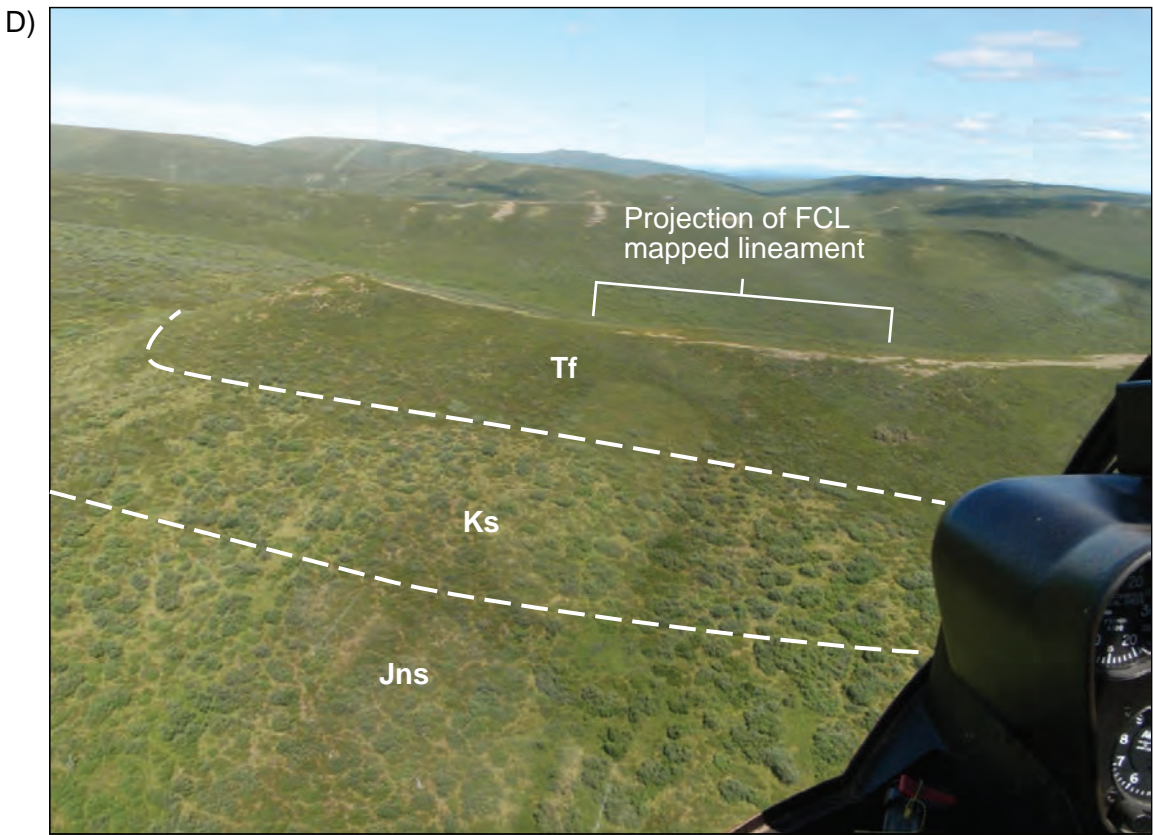




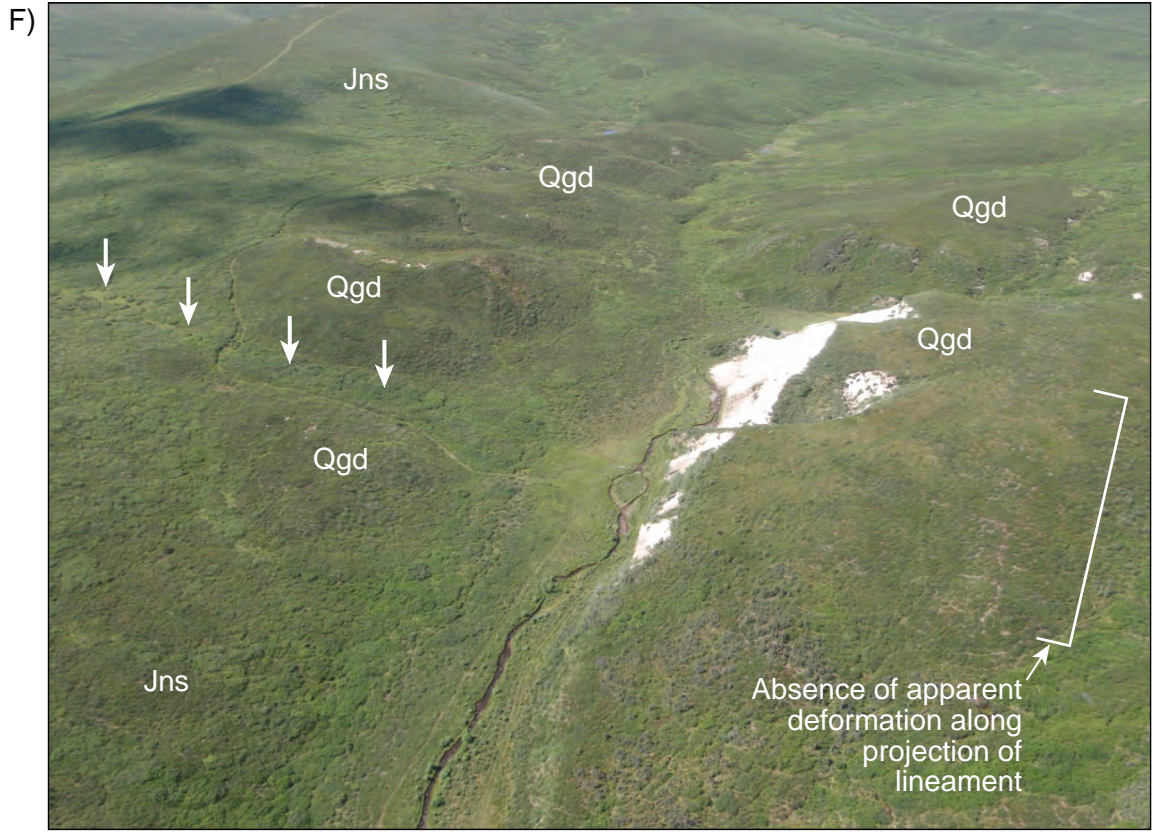
Photograph looking north from location G along mapped fault of Grantz (1960). Arrows point to approximate location of mapped fault. Note absence of apparent geomorphic expression fault.



Arrows show location of FCL mapped lineament (shallow U-shaped swale). Note no apparent deformation of white-bedded sediments (glacial lake sediments) along projection of lineament.

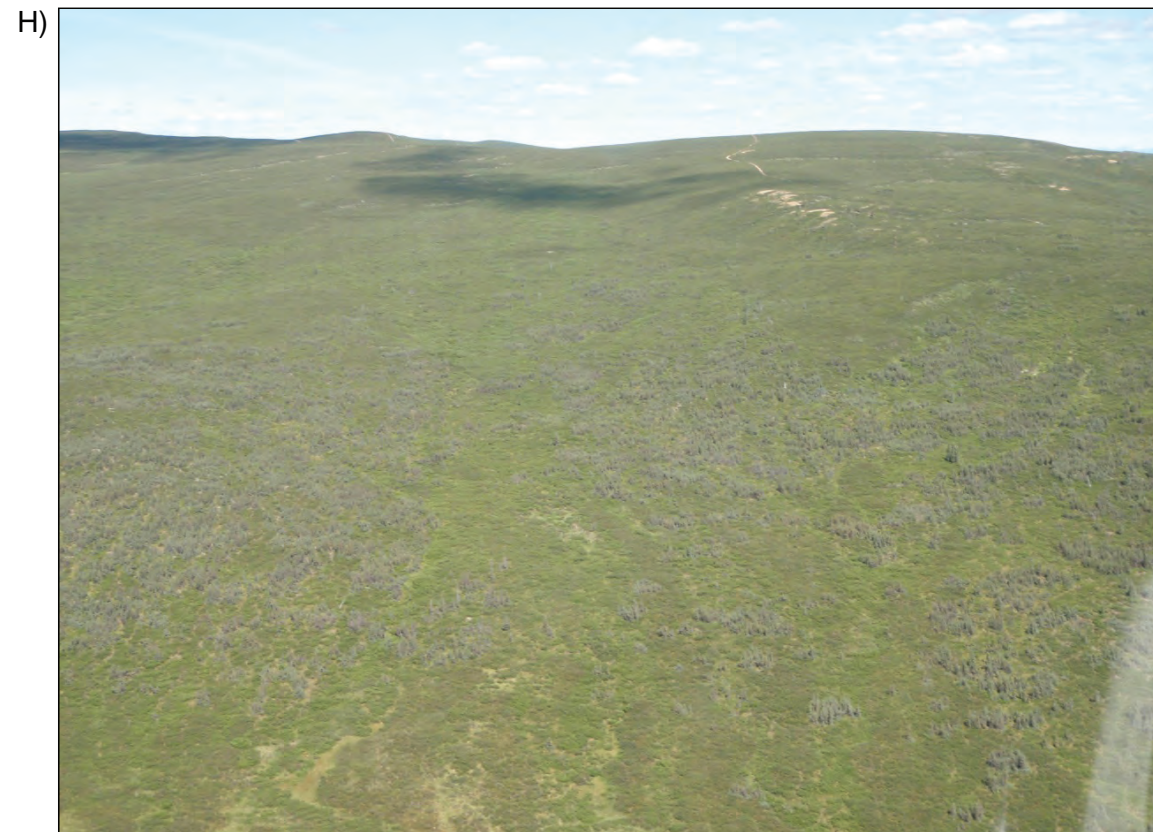


Photograph looking northeast from location D. Note absence of deformation in ridge line of Tf.



Photograph looking northwest from location F.





Photograph looking north-northeast from location H along queried mapped fault of Grantz (1960) that lies outside of lineament group. Note absence of fault expression.

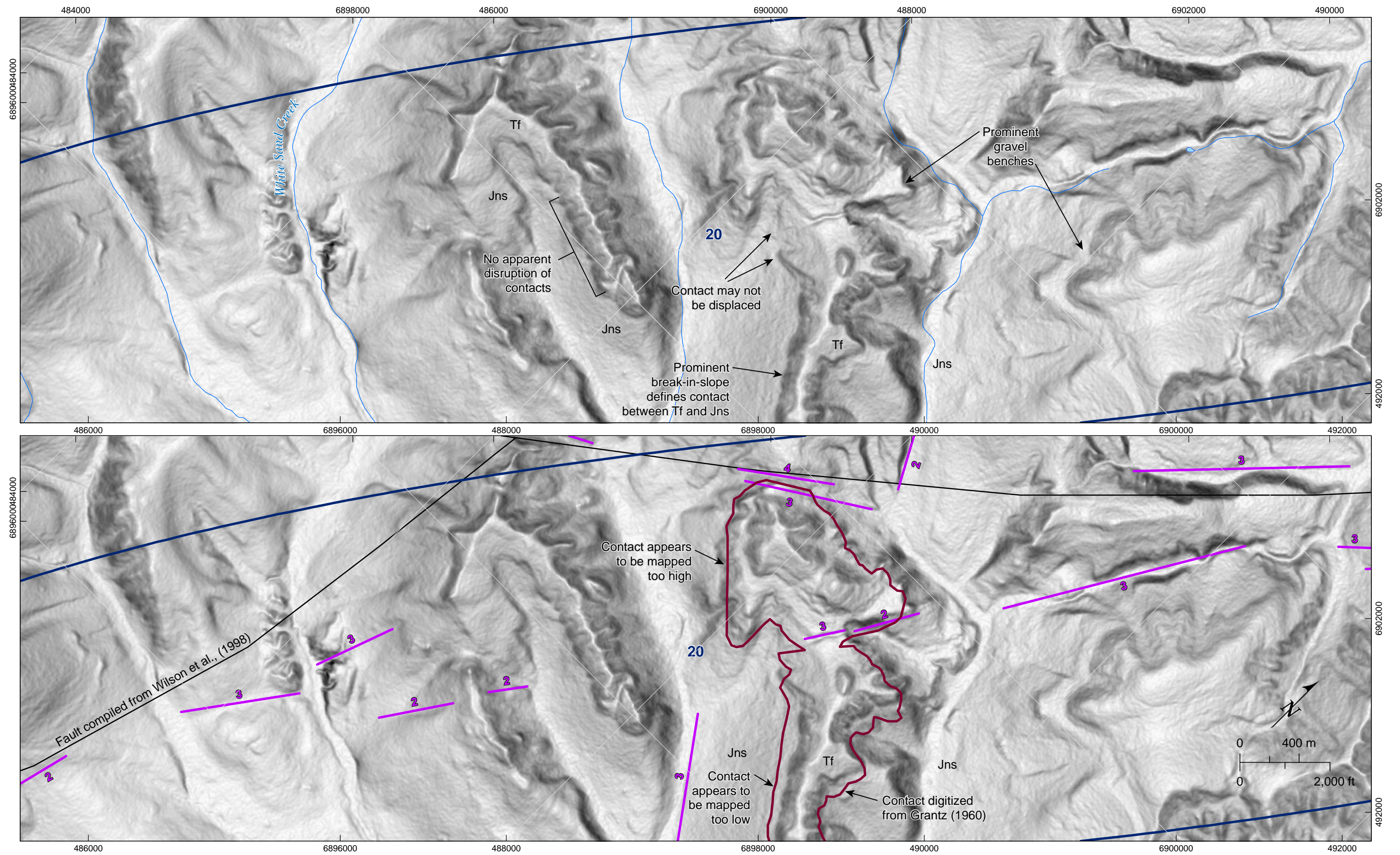


Photograph looking north-northeast from location I along queried mapped fault of Grantz (1960) that lies outside of lineament group. Note absence of fault expression.









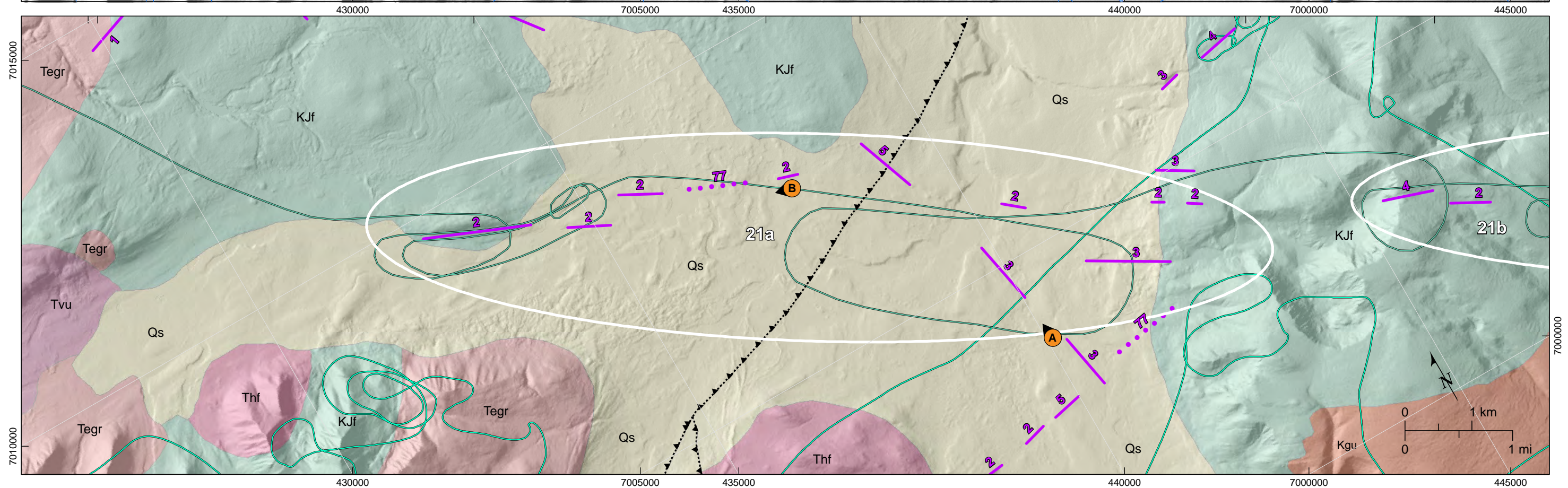
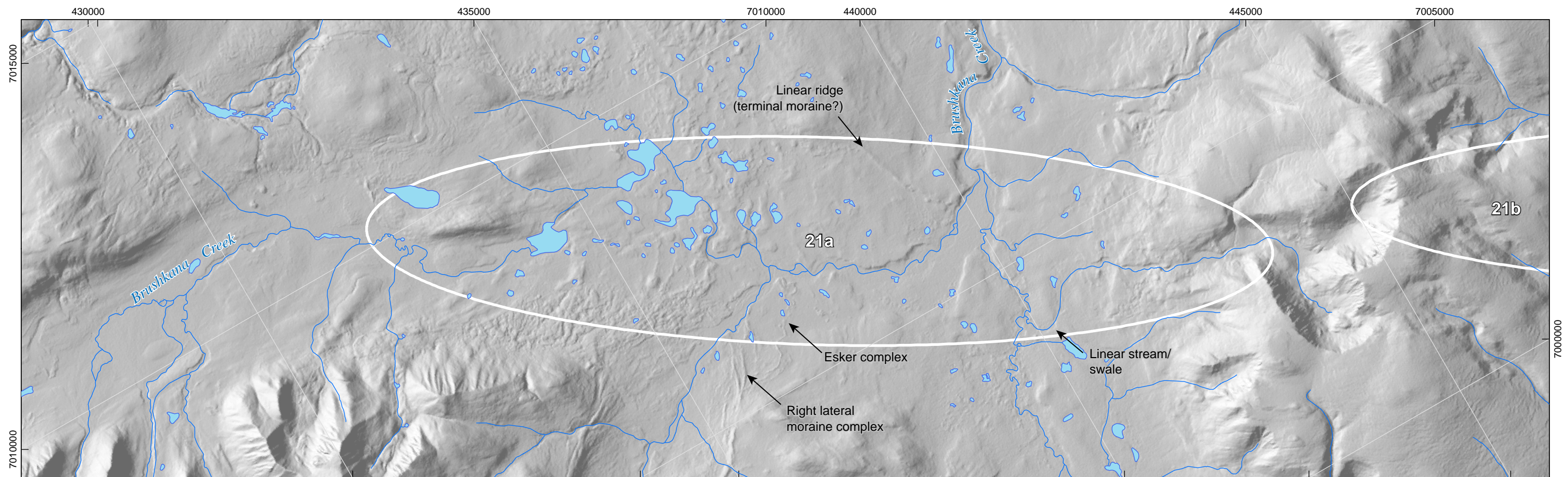
Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 45° east of north.  
 3. Base map is slopeshade derived from INSAR data.



SUSITNA-WATANA HYDROELECTRIC PROJECT  
 LINEAMENT GROUP 20  
 MAP DATA

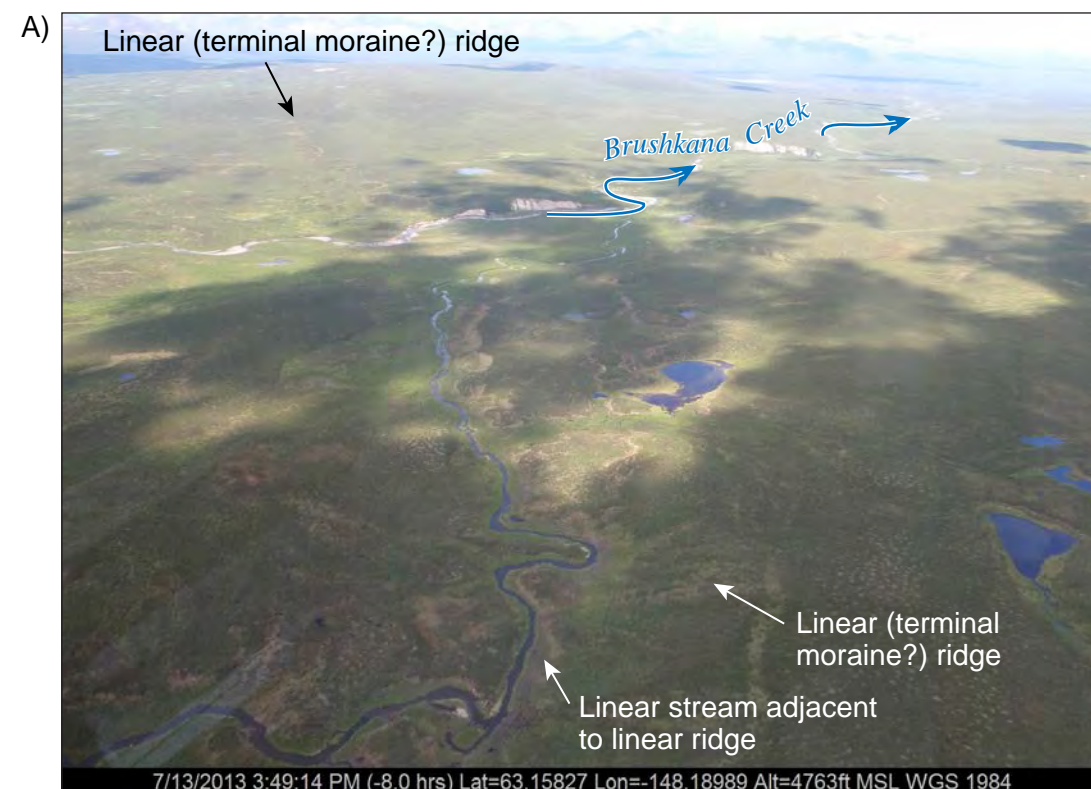
FIGURE  
 A20.6



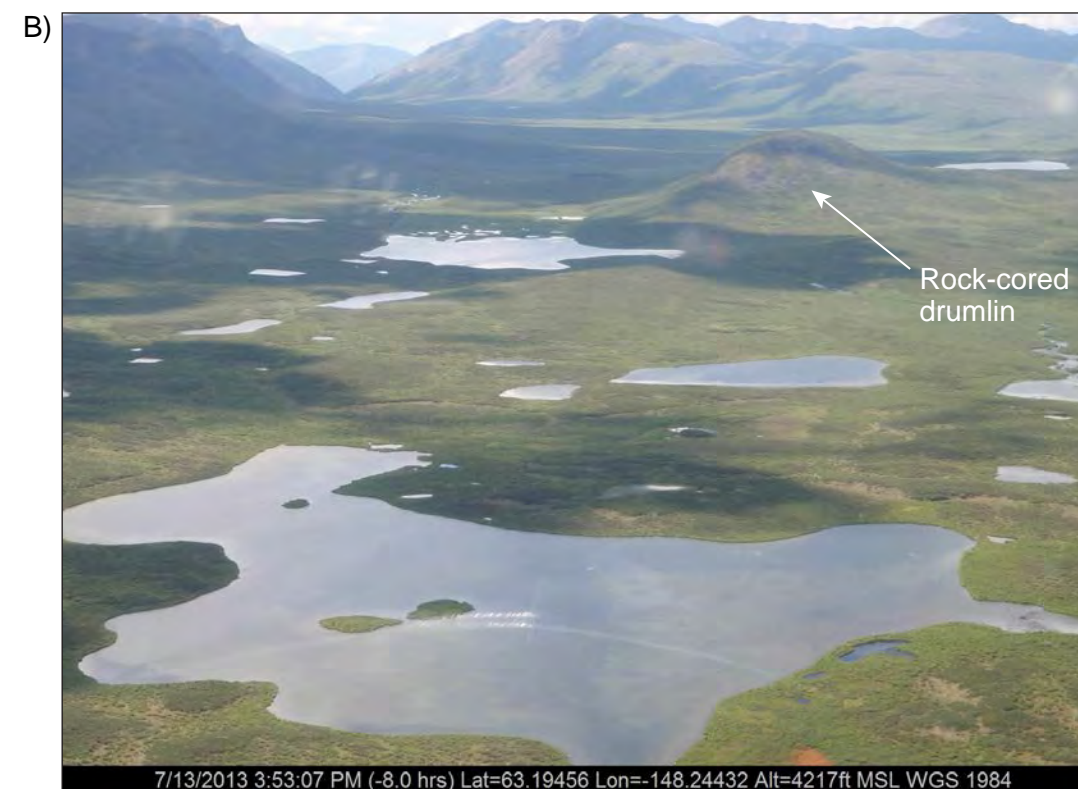


Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 30° west of north.  
 3. Geology by Wilson et al., 1998.

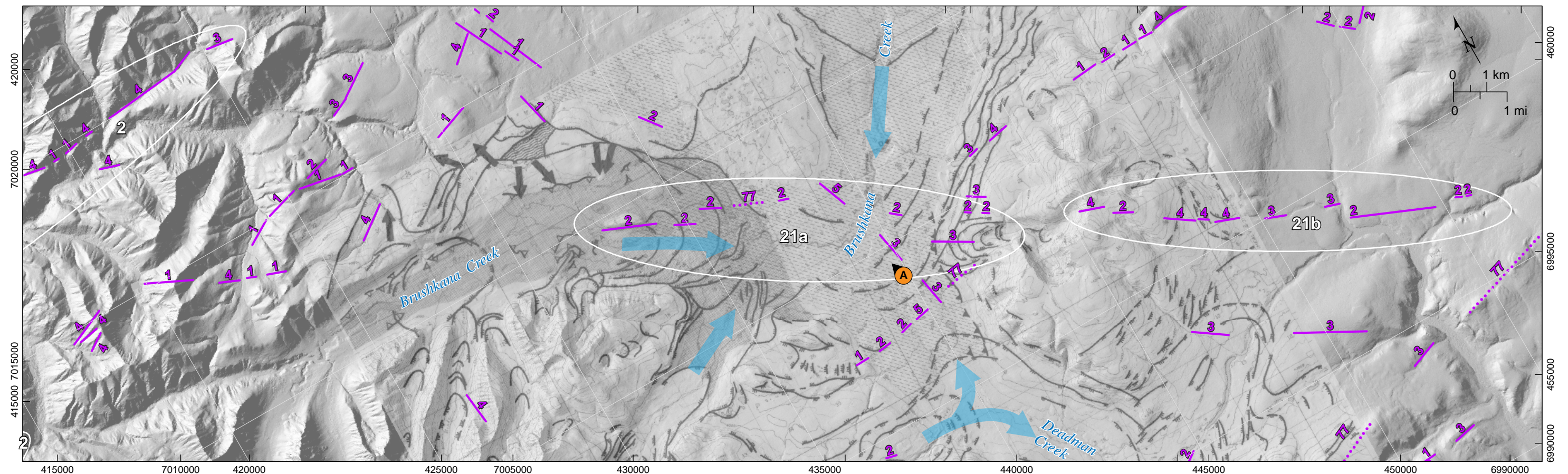





View looking north across Brushkana Creek along north-trending linear ridge and roughly linear stream. Arrows point along alignment of ridges interpreted to be terminal moraine from northeasterly flowing ice.

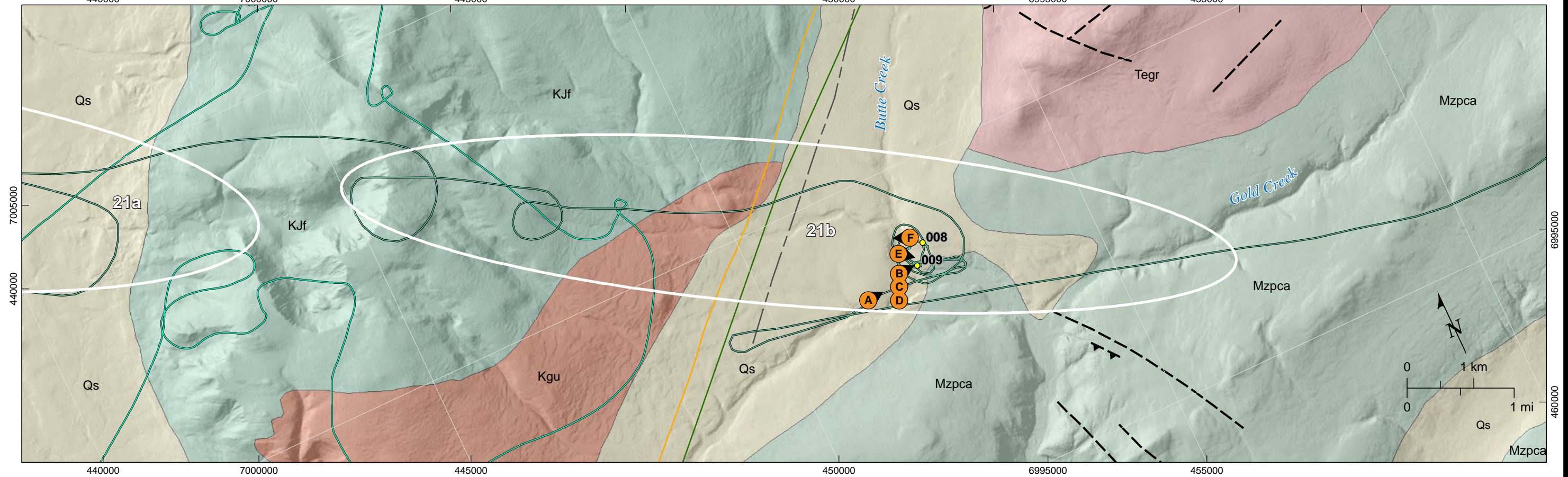
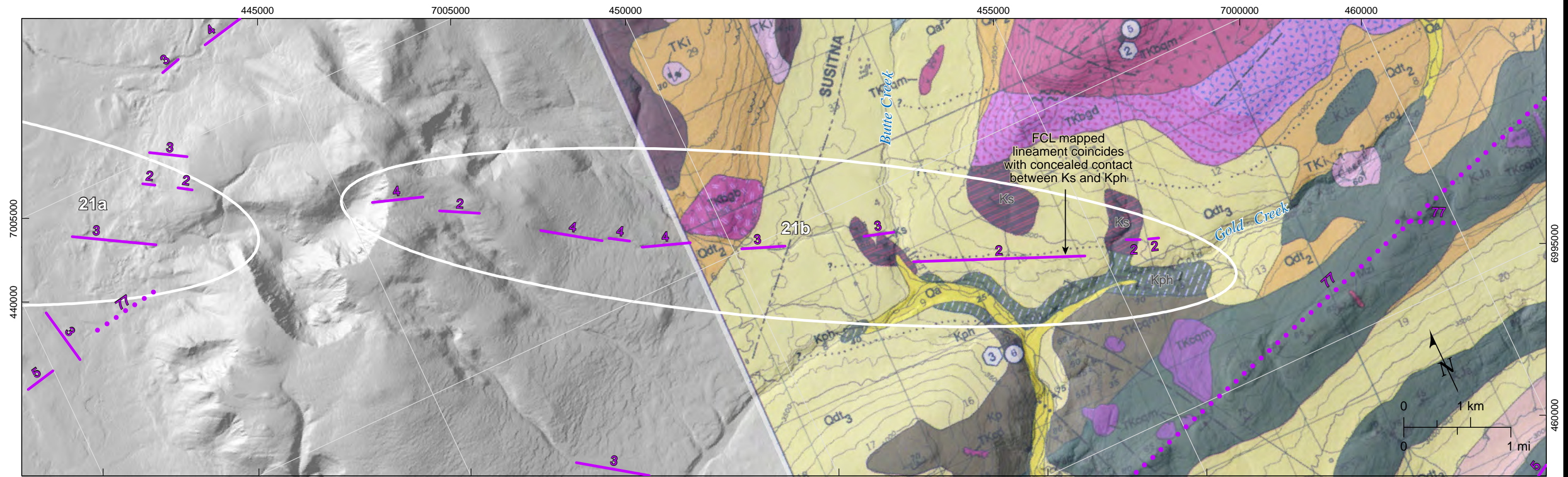


View looking northwest across western portion of lineament group 21a towards approximately 120-meter-tall rock-cored drumlin. View is looking up the Brushkana Creek valley. Note lack of obvious expression of mapped lineaments in the foreground.



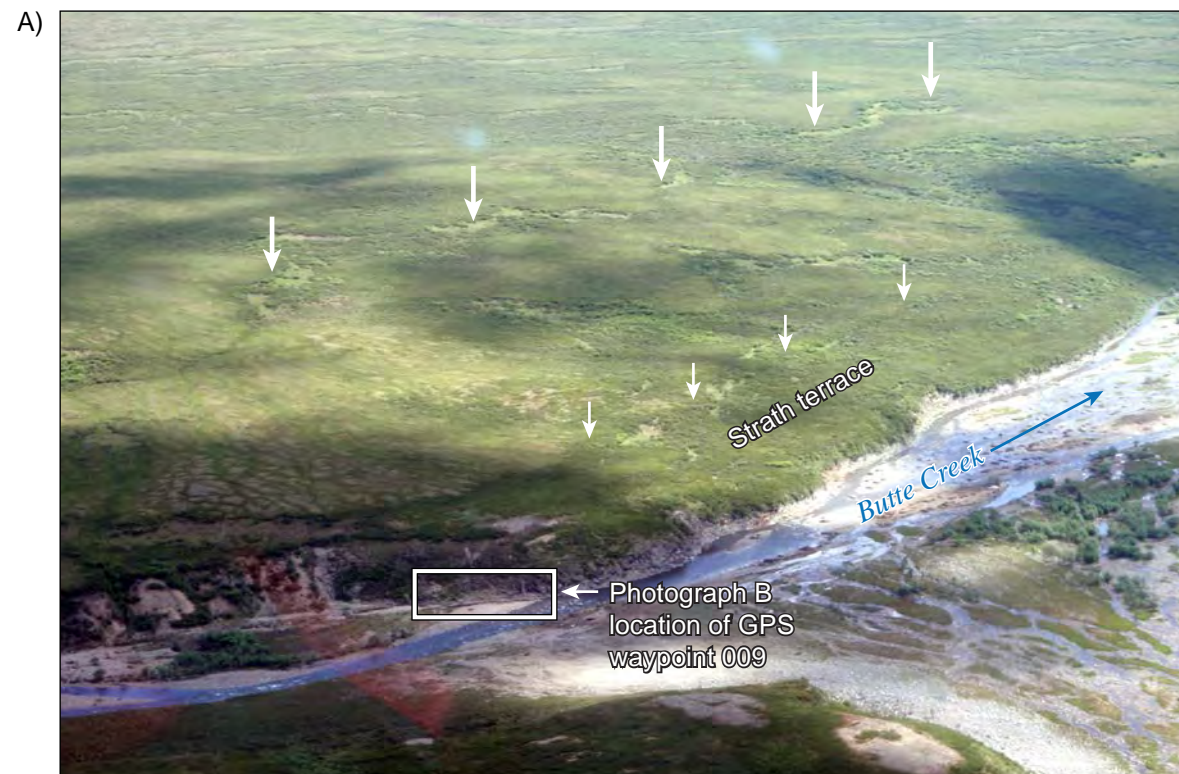
- Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 30° west of north.  
 3. Photointerpretive map of glacial extents by Reger, 1990.  
 4.  indicates ice flow direction.



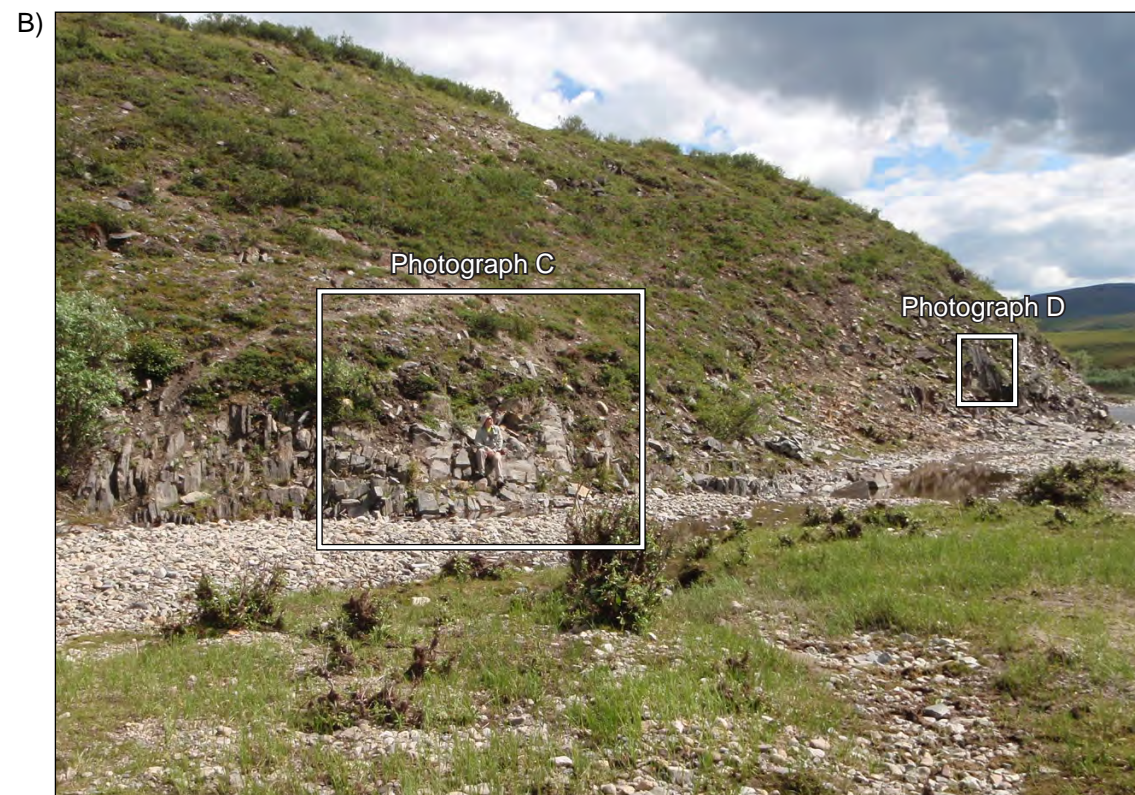


- Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
2. Data frame has been rotated 25° west of north.  
3. Map in top panel from Smith et al., 1988.  
4. Geology in bottom panel from Wilson et al., 1998





Photograph looking east from location A. Large arrows point to downhill facing slope break visible in INSAR and mapped by Fugro (2013). Field reconnaissance revealed smaller lineament (not visible in INSAR data) lies along the small arrows and projects toward the vertically-dipping bedrock exposed in the creek bank shown in Photograph B.



Overview of east-southeast striking, vertically-dipping phyllite exposures located at GPS waypoint 009.

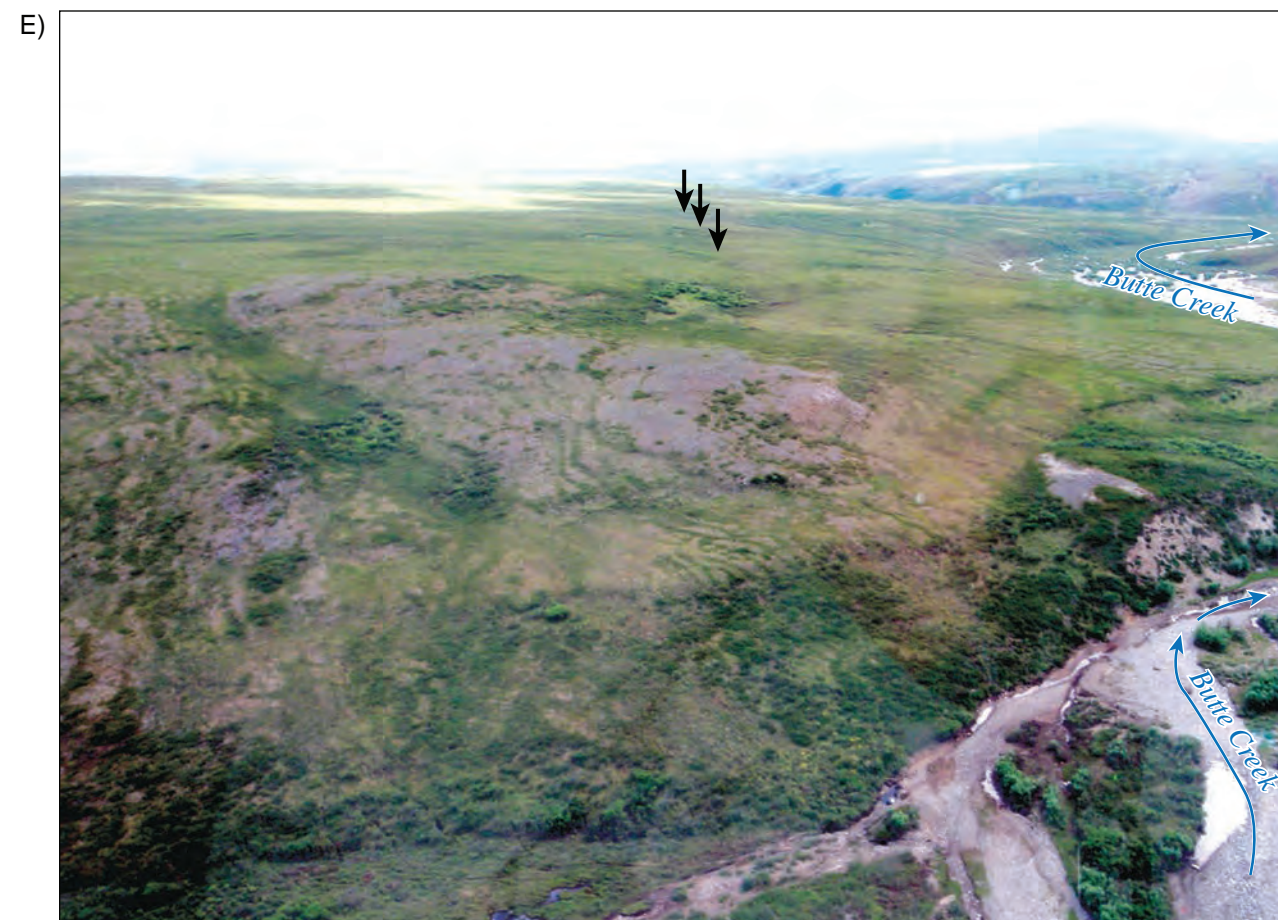


Detail of phyllite exposure showing ~3-meter-wide resistant bed of metamorphosed fine to medium sand. Thick, resistant beds, such as this, are interpreted to create the lineament shown by small arrows in Photograph A above. Geologist for scale.



Detail of vertically-dipping phyllite.



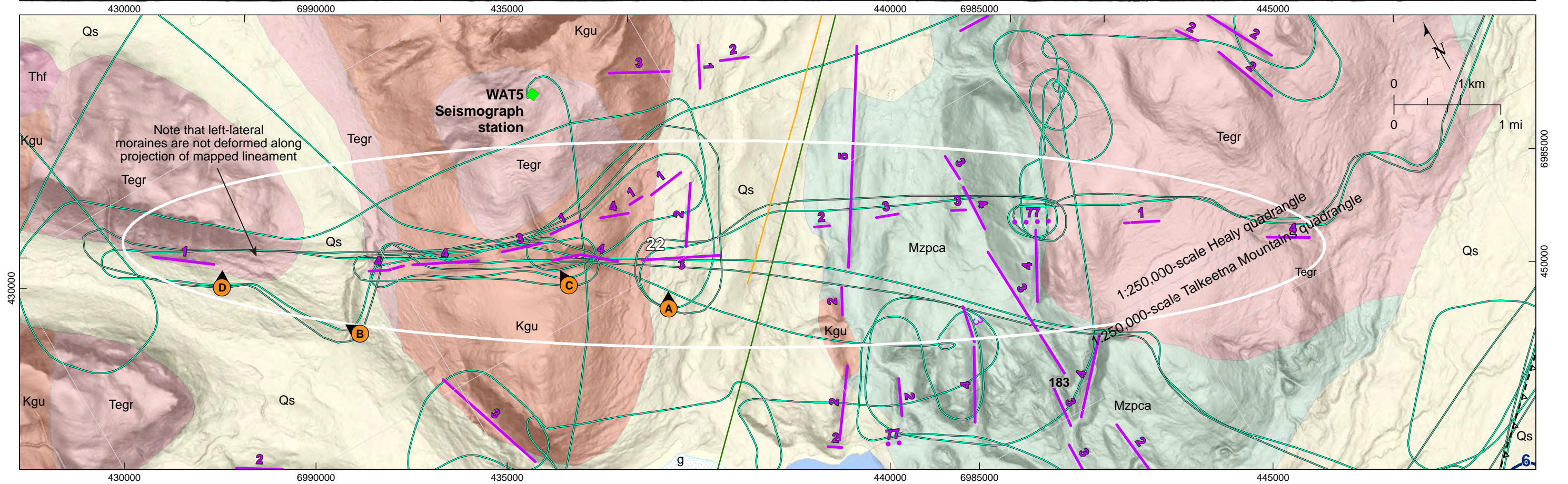
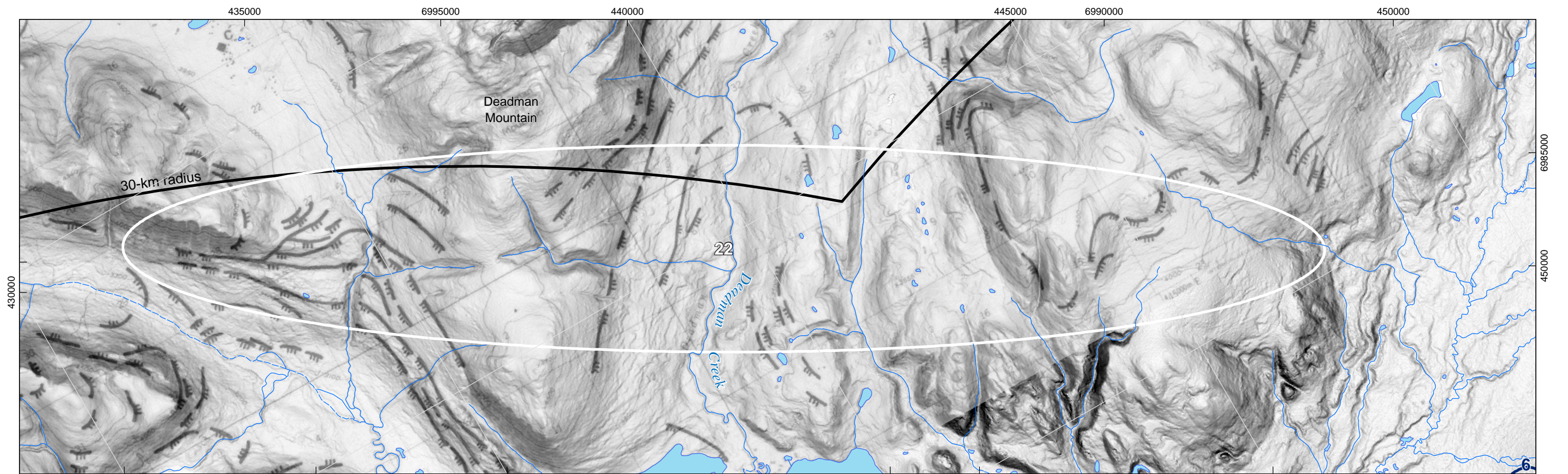


Photograph taken from location E looking east-southeast along trend of FCL mapped lineament (shown by arrows). Note absence of any apparent deformation in surficial deposits or in terrace riser on left bank of Butte Creek.



Photograph taken from location F looking west along trend of FCL mapped lineament to west of Butte Creek. Note no apparent deformation in right bank of stream or any expression of faulting in broad, flat terrace surface mapped as Qdt3 by Smith et al. (1988).





Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 30° west of north.  
 3. Geologic map by Reger et al., 1990 (top) and by Wilson et al., 1998 (bottom)





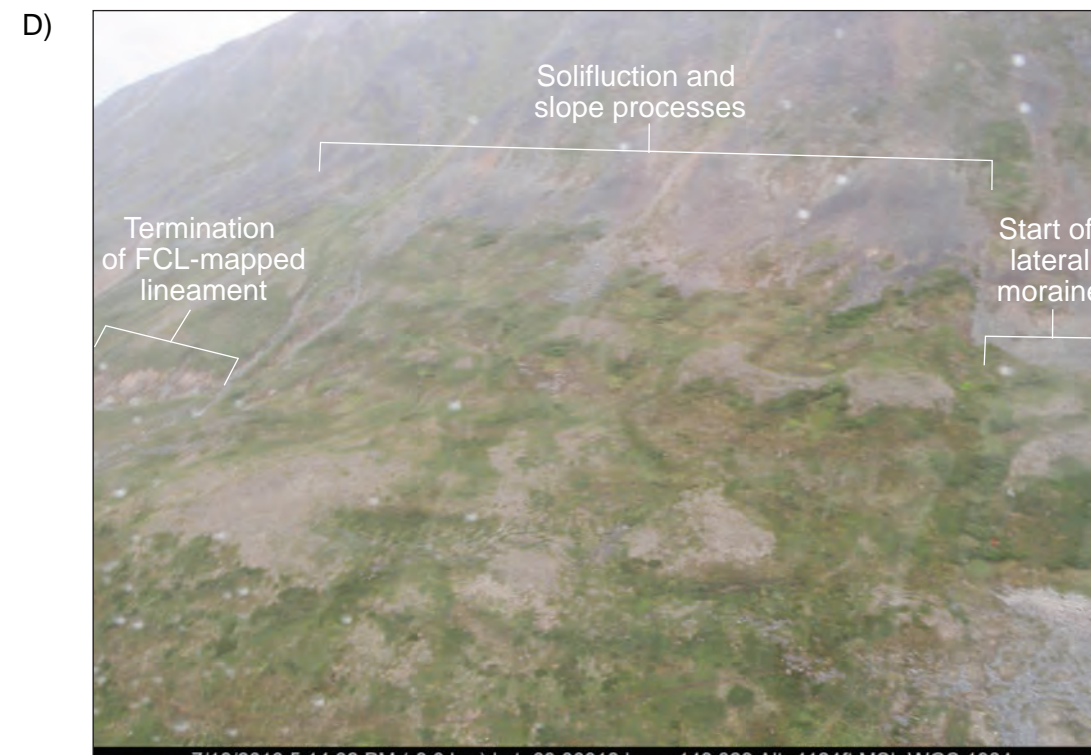
View looking north-northeast up the Deadman Creek valley. Note the numerous downhill-facing solifluction scarps. Large arrows point along mapped lineaments.



View looking north-northwest up-valley along the margin of the left-lateral moraine and kame terrace complex. No lineaments were observed cutting these deposits.

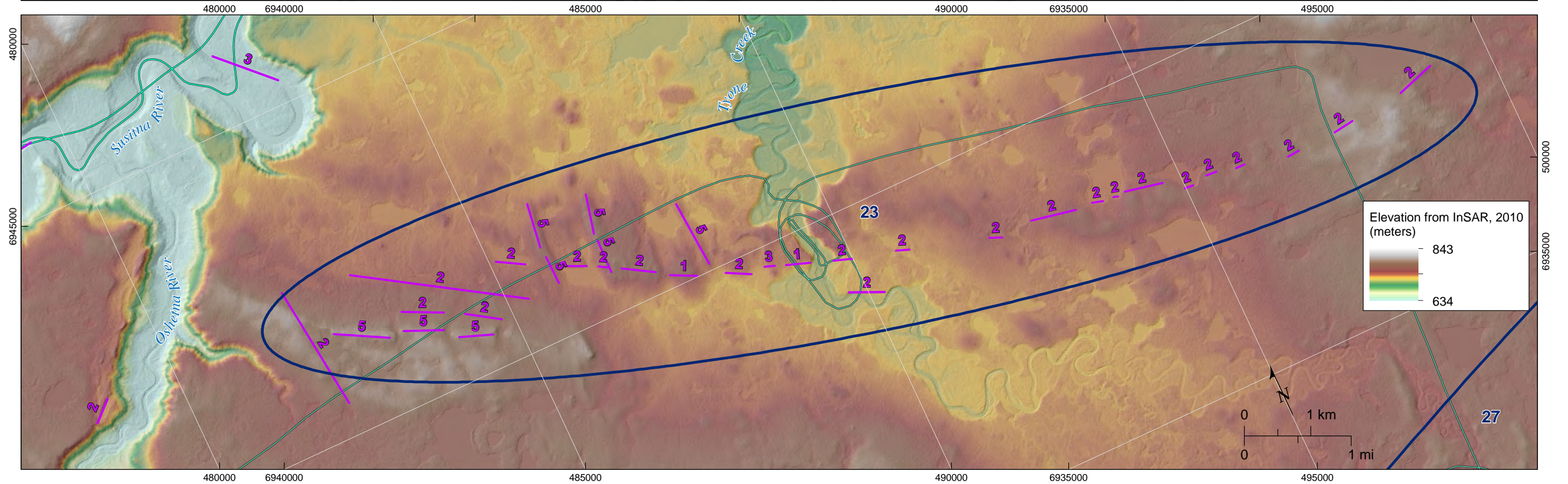
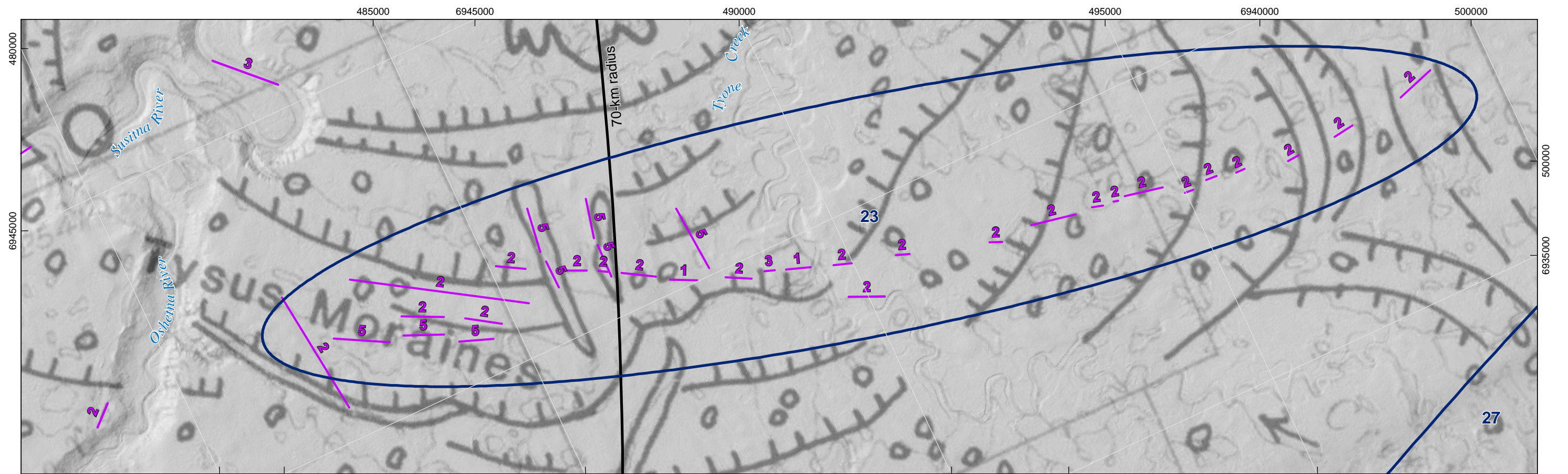


View looking north at deep drainages whose margins coincide with nivation terraces and hollows. The large size of these drainages is inconsistent with the weakly expressed lineaments located east of Deadman Creek. Such deeply incised drainages are interpreted to be a result of sub-ice erosion.



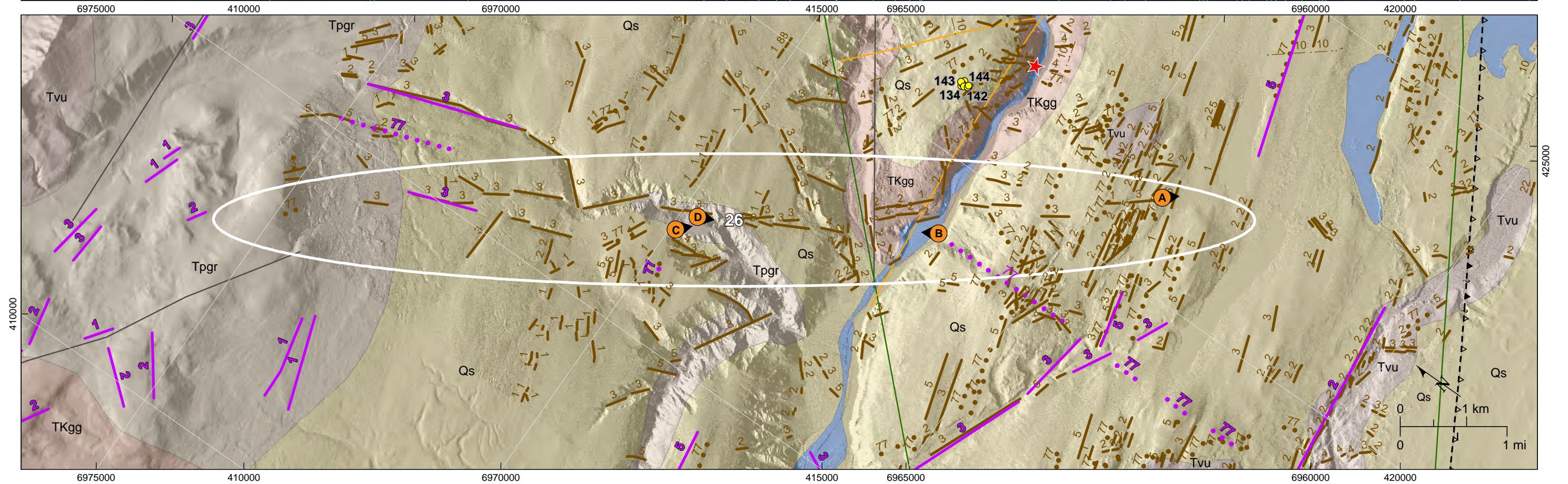
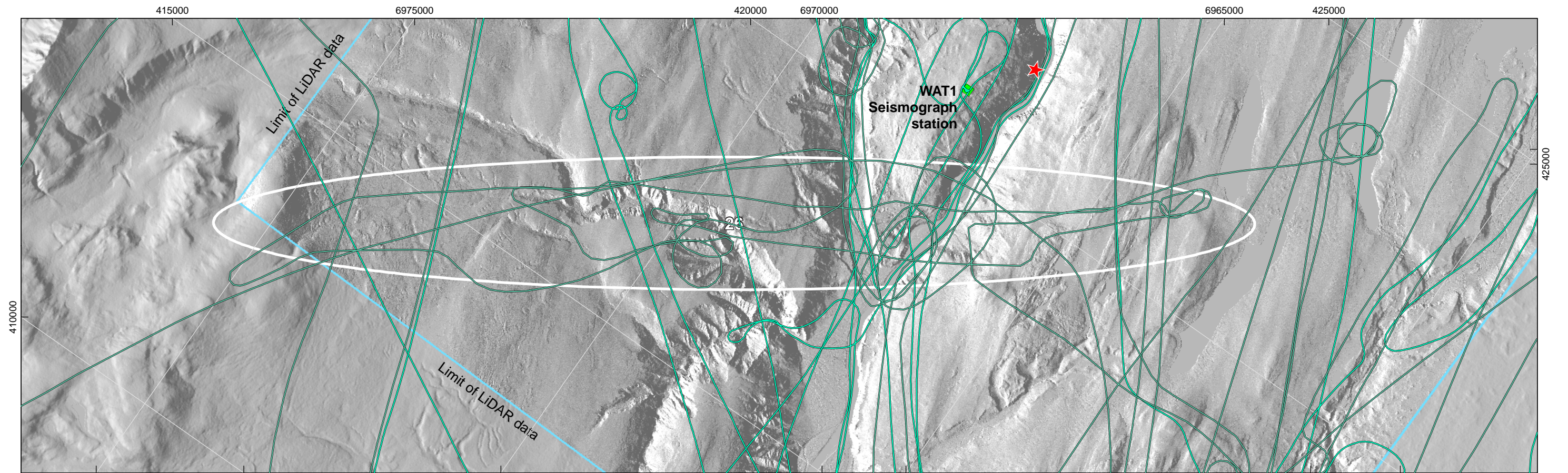
View looking northeast at area of solifluction and termination of mapped lineament.



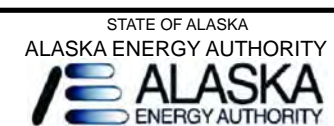


Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 25° west of north.  
 3. Geologic map in top panel by Williams and Galloway, 1986.





Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 55° west of north.  
 3. Geology by Wilson et al., 2009.



SUSITNA-WATANA HYDROELECTRIC PROJECT  
 LINEAMENT GROUP 26  
 MAP DATA

FIGURE  
 A26.1





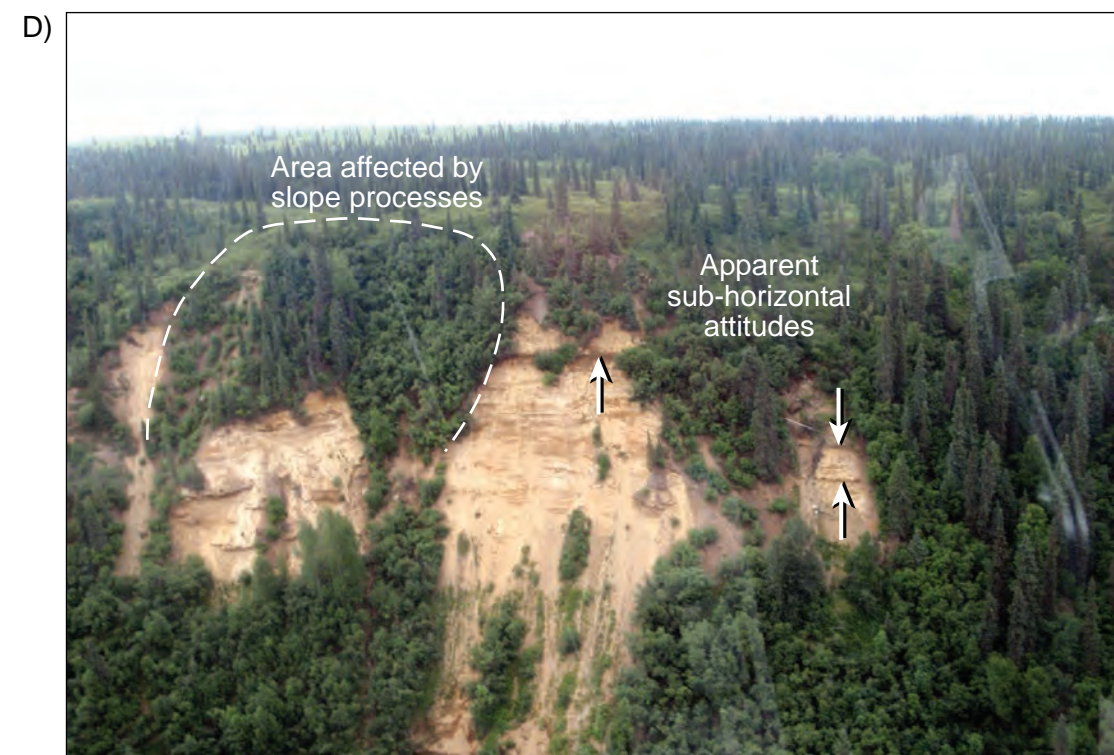
View looking west at unnamed canyon and smooth Quaternary surface in the background.



View looking northwest at layered bedrock (on left) with apparently undisrupted horizontally-bedded outwash (on right).

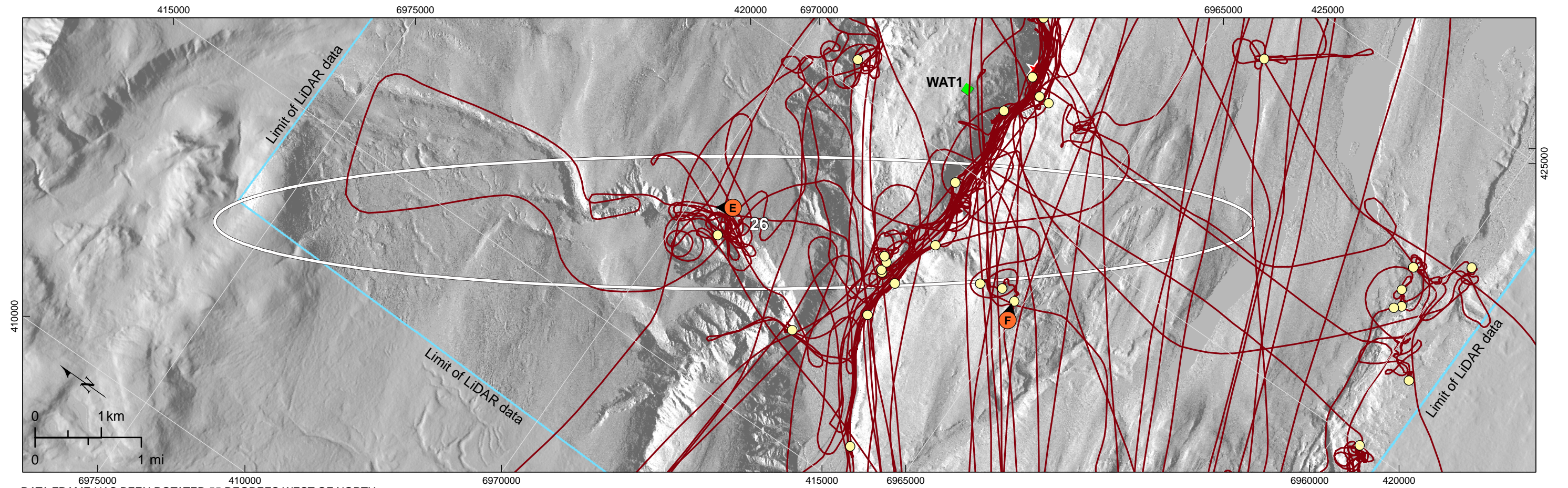


View looking southeast at exposure in left bank of unnamed drainage creek where till apparently overlies lake sediments and fluvial washout gravel. The lenticular beds in the fluvial gravel appear horizontal but are not laterally extensive.



Close up view of exposure shown in Photograph (B). Note the apparently sub-horizontal basal contact between overlying till and underlying lacustrine deposits. Note sediments on the left of the image are influenced by landslide processes and not in-place locally.



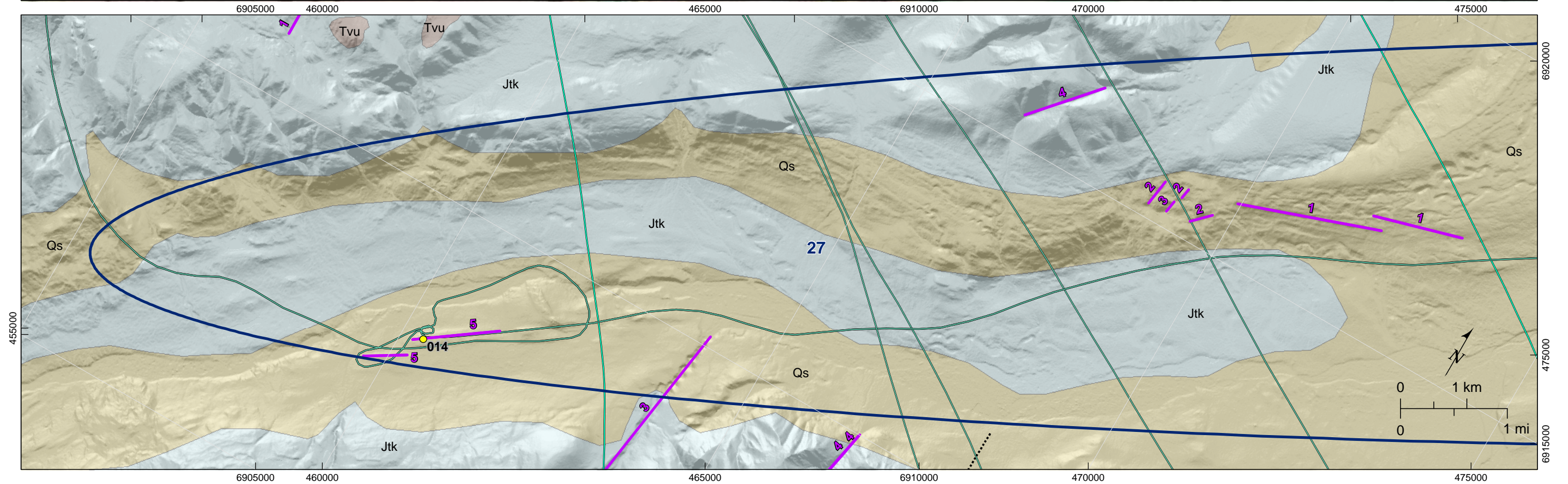
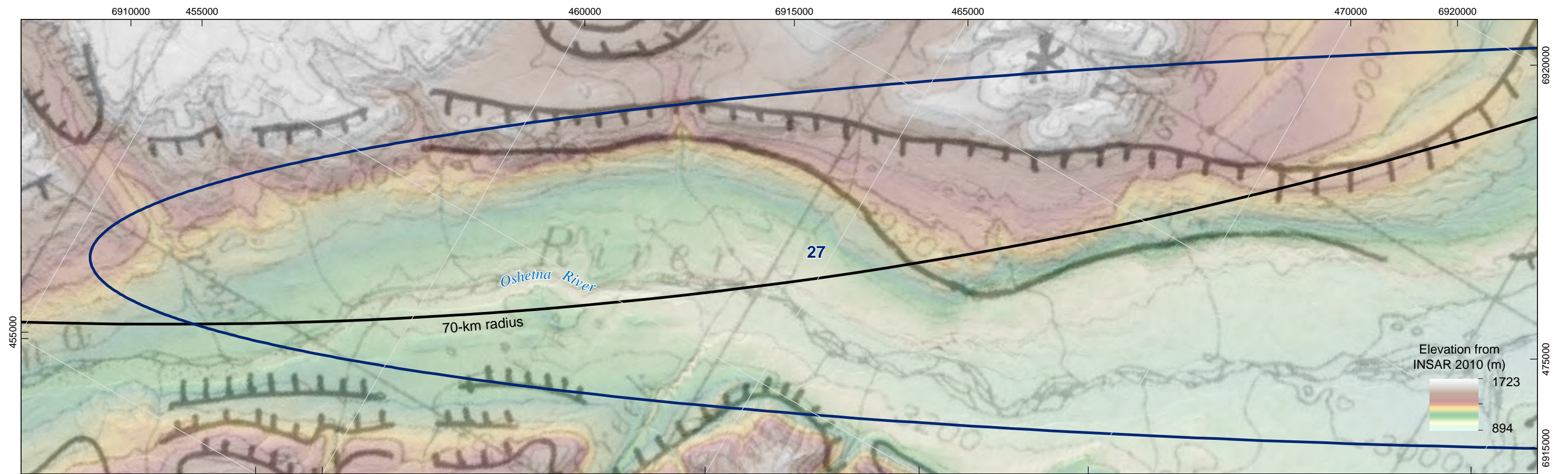


View looking north at ridge along projection of mapped lineaments. Orange color is attributed to chemical weathering of rock. Lithologies appear consistent across ridge and discontinuities or shear zones absent.



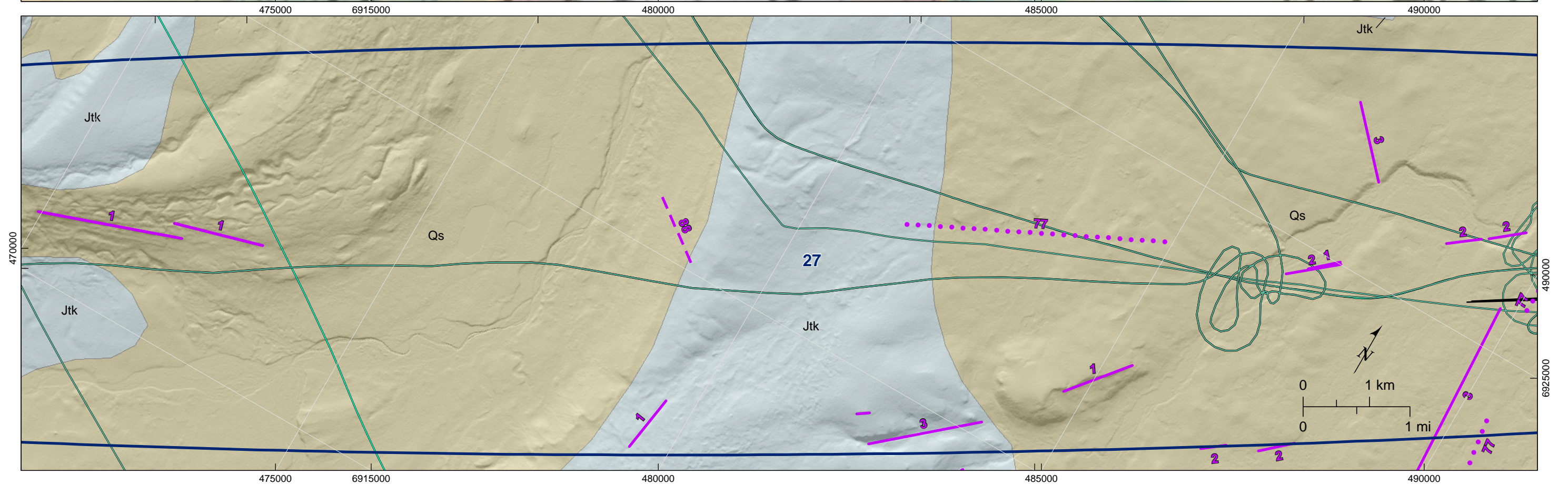
Photograph of fluted ice-scoured rock surface with cracks and joints.





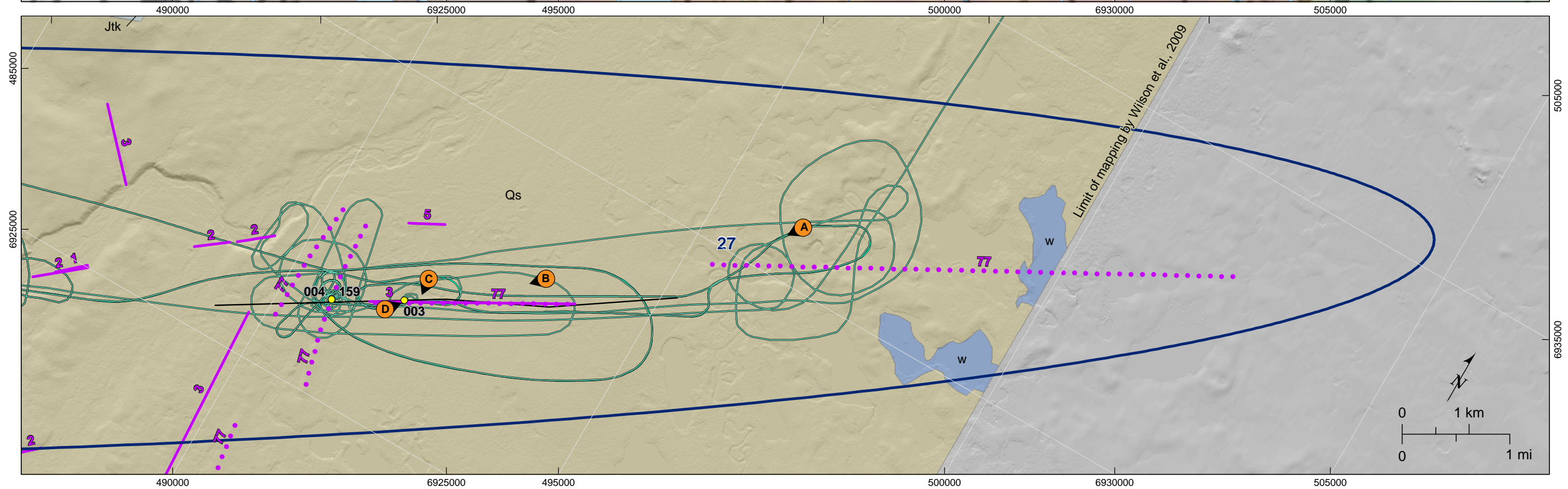
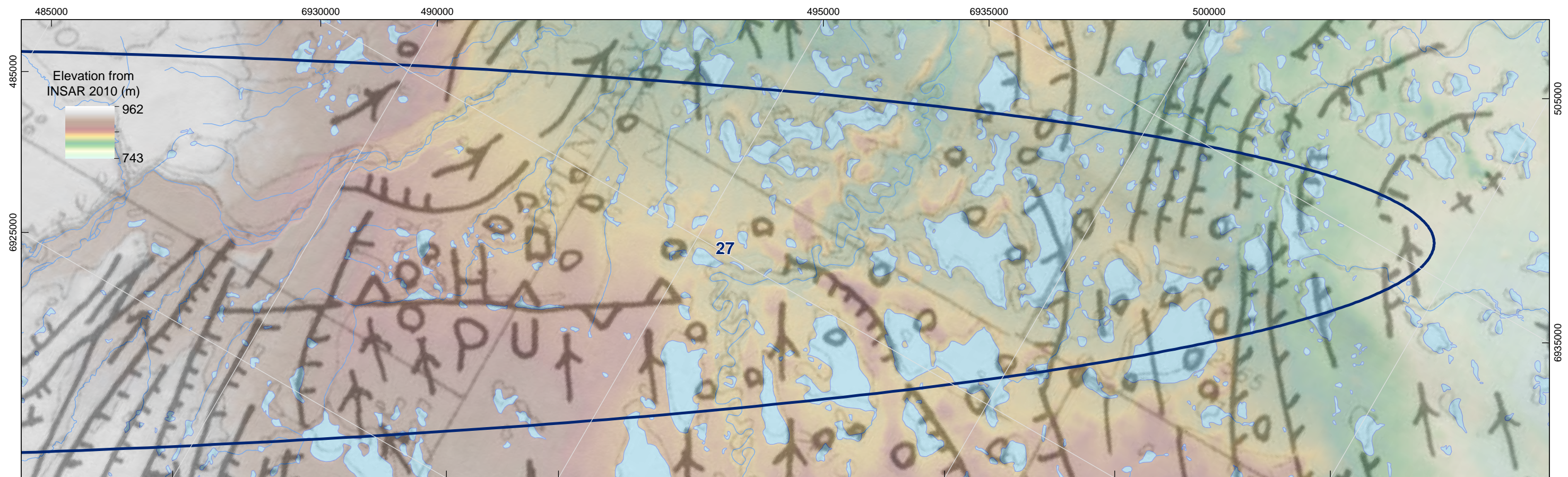
Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.  
 2. Data frame has been rotated 30° east of north.  
 3. Geologic map by Williams and Galloway, 1986 (top) and by Wilson et al., 2009 (bottom).





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