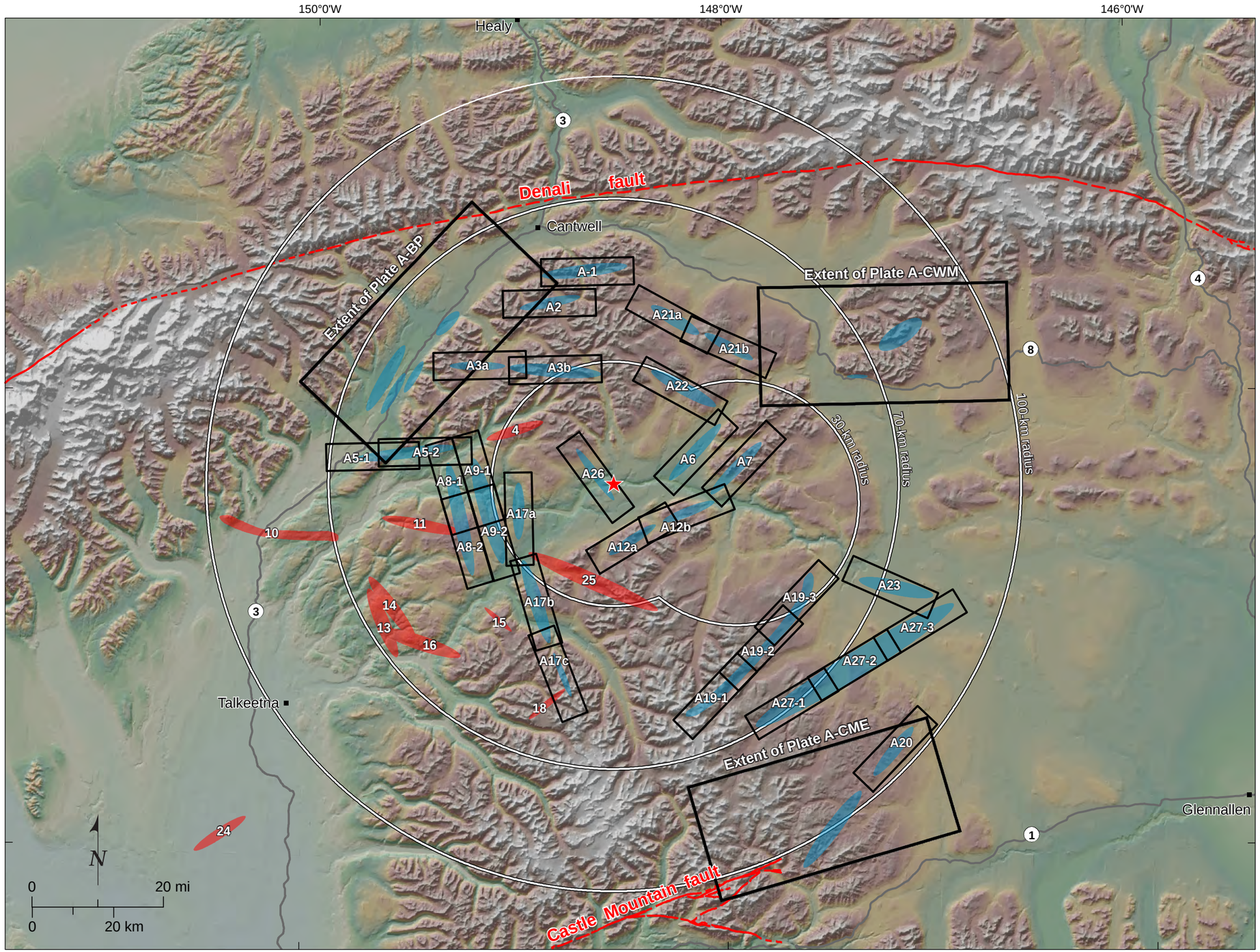
Appendix A:
Strip Maps and Photographic Documentation of Lineament Data Presented in FCL (2013)



Explanation

- Quaternary fault, solid where well constrained, long dash where moderately constrained, short dash where inferred (Koehler et al., 2012)
- A5-1 — 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

Date 12/16/13

STATE OF ALASKA
ALASKA ENERGY AUTHORITY

SUSITNA-WATANA HYDROELECTRIC PROJECT

STRIP MAP TILE AND PLATE INDEX

FIGURE
A0.1

79_218900_Alaska_Railbelt\2189_Lineament Report October 2013, modified 12.16.13

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

Unconsolidated Deposits

- Qs — Surficial deposits, undivided
- Qat — Alluvium along major rivers and in terraces
- Qlc — Landslide and colluvial deposits
- Qm — Glacial deposits, undivided
- Qhg — Young moraine deposits
- Qg — Major moraine and kame deposits
- Qgc — Glacioalluvium
- Qgo — Outwash in plains, valley train, and fans
- Qge — Glacioestuarine deposits

Sedimentary Rocks

- Tsu — Sedimentary rocks, undivided
- Tkn — Kenai Group, undivided
- Tts — Tsadaka Formation
- Tch — Chickaloon formation
- Km — Matanuska formation
- KJs — Turbiditic sedimentary rocks of the Kahiltna flysch sequence
- Jtxc — Undivided Chinitna and Tuxedni formations
- Jn — Naknek Formation, undivided
- Jtk — Talkeetna Formation, undivided
- JTrlm — Limestone and Marble
- Pe — 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

- Tvu — Tertiary volcanic rocks, undivided
- Tfv — Felsic volcanic and sub-volcanic rocks
- Tem — Mafic volcanic rocks
- TKd — Dikes and sills
- Trn — Nikolai Greenstone and related rocks
- Pzv — Slana Spur Formation, volcaniclastic rocks
- Pat — Station Creek Formation andesitic volcanic rocks

Plutonic Rocks

- Ti — Intrusive rocks, undivided
- Toegr — Granitic rocks
- Tpgr — Granitic rocks of Paleocene age
- Tgd — Biotite-hornblende-granodiorite
- TKg — Granitic rocks, undivided
- TKgd — Granodioritic rocks
- Kgd — Granodiorite
- Jtr — Trondhjemite
- JPaur — Diorite, gabbro, picrite, and pyroxenite sill and dike swarm complex
- Jqd — Quartz diorite, tonalite, and diorite
- Jqm — Granodiorite and quartz monzonite

Melange and Metamorphic Rocks

- TKgg — Gneiss
- Jpmu — Plutonic and metamorphic rocks, undifferentiated
- JPam — Amphibolite
- JPmb — Marble
- Trnm — Metabasalt and slate
- TrPavs — Basaltic to andesitic metavolcanic rocks
- PPast — Metamorphosed Skolai Group

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

- g — Ice fields or glaciers
- Water
- Qs — Surficial deposits, undifferentiated
- Tvu — Tertiary volcanic rocks, undivided
- Thf — Hypoabyssal felsic and intermediate intrusions
- Tiv — Granitic and volcanic rocks, undivided
- Tegr — Granite and granodiorite
- Mzpca — Phyllite, pelitic schist, calc-schist, and amphibolite of the MacLaren metamorphic belt
- Kgu — Granitic rocks
- KJf — Kahiltna flysch sequence
- Trcs — Calcareous sedimentary rocks
- Trnm — 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.

T-2 — 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

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

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FUGRO Date 01/06/14	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT STRIP MAPS EXPLANATION 1 OF 4	FIGURE A0.2

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

Reconnaissance (INSAR)

1 - 5
10
77
88

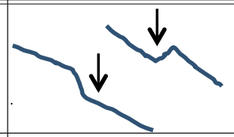
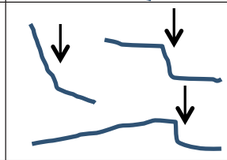
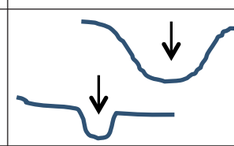
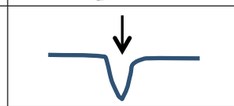
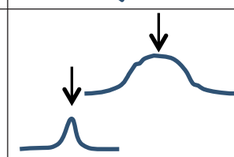
Detail (LiDAR)

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 rouche 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 abovemodern 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) morainal 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

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

Ice boundary, morainal 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.

d — 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.

D / U — Active (?) fault, lower Sonona 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.

FUGRO — Date 01/06/14

STATE OF ALASKA
ALASKA ENERGY AUTHORITY
ALASKA ENERGY AUTHORITY

SUSITNA-WATANA HYDROELECTRIC PROJECT

STRIP MAPS EXPLANATION
2 OF 4

FIGURE
A0.3

fwla-wc-file1/project/Projects/79_2000/79_218900_Alaska_Railbelt/005_Graphics/79_218900_TM14 Janurary 2014 Lineament Report /79_218900 Appendix A/

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_3 — TILL OF LATE WISCONSIN AGE - 11,800 to 25,000 yr B.P.

Qdt_2 — TILL OF EARLY WISCONSIN AGE - 40,000 to 75,000 yr B.P.

Ks — 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 ampbibole-bearing phyllite (Khp) unit.

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

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

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

L — 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 discontinuosly mapped

Glaciation of Illinoian age, dashed where discontinuosly mapped

Glaciation of late Wisconsin age, dashed where discontinuosly mapped

Glaciation of Holocene age, dashed where discontinuosly mapped

OTHER FEATURES

Prominent meltwater drainage channel

B — 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

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Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT STRIP MAPS EXPLANATION 3 OF 4	FIGURE A0.4

Explanation for relevant geologic units of Grantz (1960) shown on Figure A20.1

Explanation

Geologic Units

Bar beneath letter symbol indicates map units identified on aerial photographs or from distant views (Tf, Qd, etc.)

Pleistocene and Recent

- Qrg — Rock glaciers
- Qal — Alluvial deposits
- Qtc — Talus and colluvium
- Qls — Landslide deposits
- Qg / Qgd / Qgo — Glacial deposits
  - Qg, *moraine, outwash, and proglacial lake deposits*
  - Qgd, *proglacial lake delta deposits*
  - Qgo, *stratified gravel, probably outwash deposits older than the last major glaciation*
- Qd — Surficial deposits, undifferentiated

QUATERNARY

UNCONFORMITY

Eocene

- Tf — Fluviatile conglomerate and coaly sandstone

TERTIARY

UNCONFORMITY

Upper Cretaceous(?)

- Km — Matanuska formation(?)
  Siltstone and shale
- Kcc — Cobble conglomerate

UNCONFORMITY(?)

WESTERN PART OF AREA

Lower Cretaceous

- Kc — Calcareous sandstone, siltstone, and claystone
- Kn — Nelchina limestone
  A calcarenite
- Ks — Sandstone, locally conglomeratic and coquinoid to west, siltstone and claystone

EASTERN PART OF AREA

- Knu — Calcareous sandstone, siltstone, and claystone

CRETACEOUS

UNCONFORMITY

Upper Jurassic

- Jnbs / Jns / Jnbsm / Jnc / Jnbc — Naknek formation
  Jnbs *and* Jnbsm, *biotitic sandstone and siltstone with coquinoid beds;*
  Jns, *siltstone and shale with limestone concretions;*
  Jnbc, *cobble and boulder conglomerate at base of formation;*
  Jnc, *cobble and boulder conglomerate above base of formation*

UNCONFORMITY

- Jcsl / Jcs — Chinitna formation
  Jcsl, *siltstone and shale with limestone concretions;*
  Jcs, *sandstone and siltstone*

Middle or Upper Jurassic

- Js — Sandstone
  Sandstone, siltstone, and conglomerate with fossil wood fragments, and many mollusk shells in some beds. Equivalent to, or only slightly older than Jcs

UNCONFORMITY

Middle Jurassic

- Jt — Tuxedni formation
  Sandstone with calcareous concretions and some siltstone and shale

UNCONFORMITY

Lower Jurassic

- Jtk — Talkeetna formation
  Lavas and pyroclastic rocks of intermediate composition, sandstone, and argillite, all dominantly marine. Sedimentary rocks become dominant in upper part of the formation

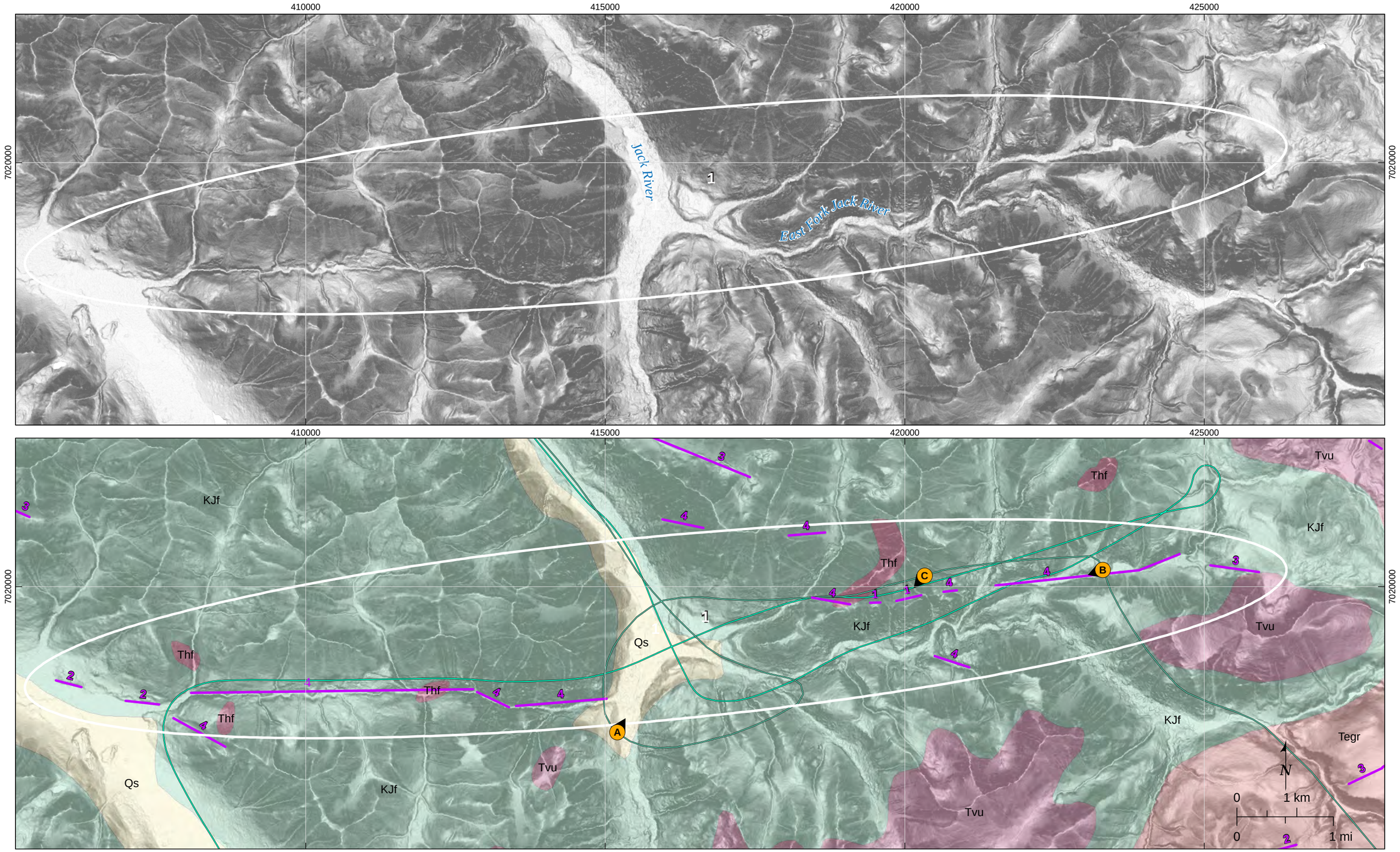
JURASSIC

Lineaments, Faults, Contacts, Synclines, and Anticlines

- Anticline, dashed where approximate, dotted where concealed
- Contact; solid where certain, dashed and queried where uncertain
- Fault; solid where certain, dashed and queried where uncertain, dotted where concealed
- Lineament, approximate
- Syncline, approximate

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FUGRO Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT STRIP MAP EXPLANATION 4 OF 4	FIGURE A0.5

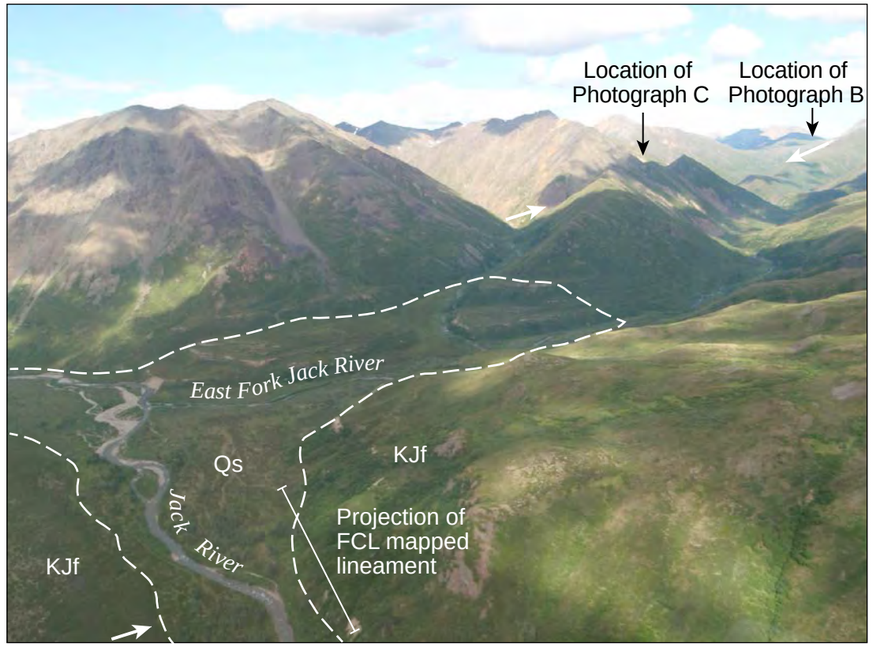


Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.
2. Geology by Wilson et al., 1998

TUGRO Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 1 MAP DATA	FIGURE A1.1

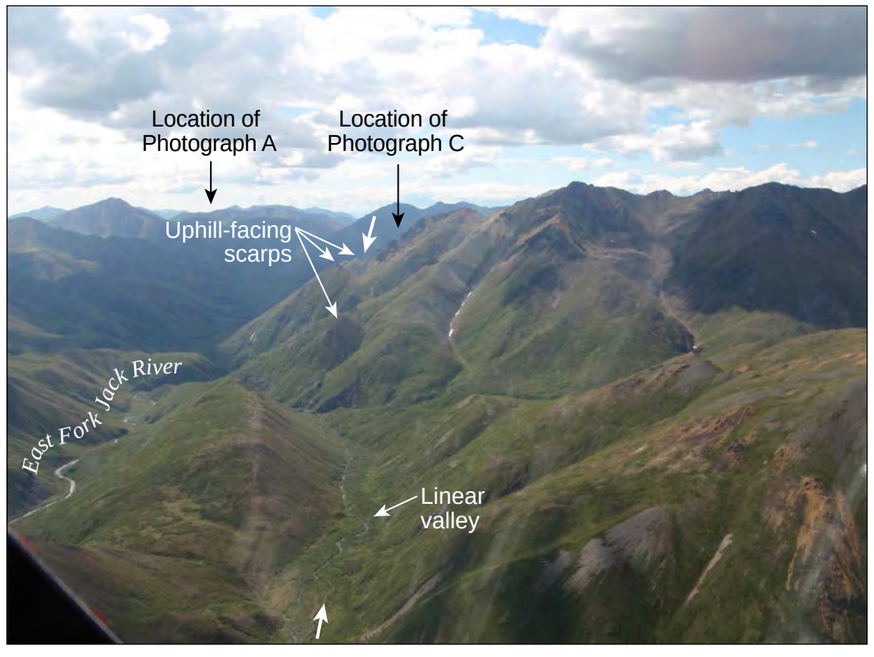
79_218900_Alaska_RailbelI/2189_Lineament Report October 2013, modified 10.18.13

A)



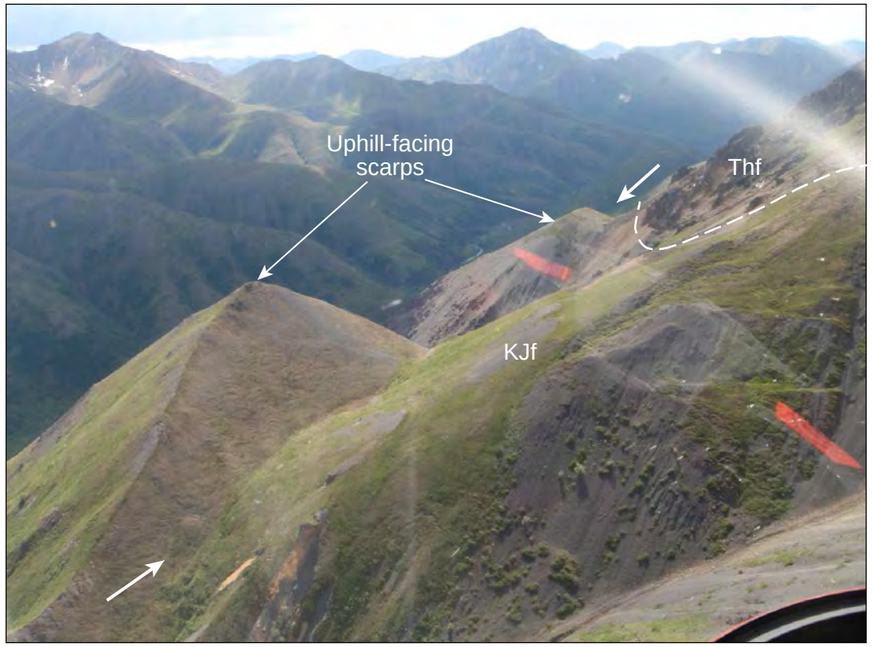
View looking northeast from location A towards the confluence of the Jack River and the East Fork Jack River. Arrows point along the alignment of mapped lineaments. Note absence of linear expression in Quaternary deposits.

B)



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

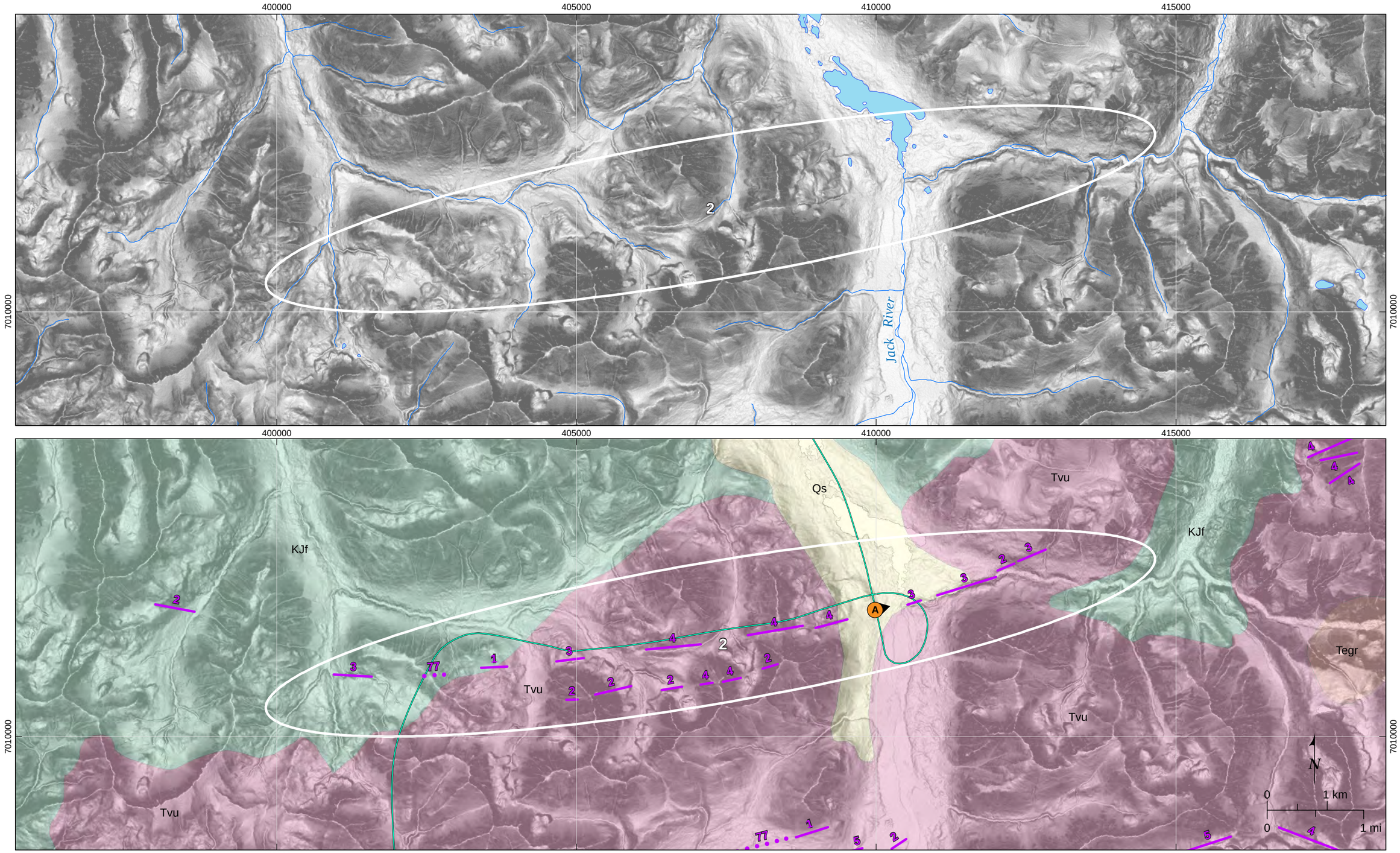
C)



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.

TUGRO Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 1 PHOTOGRAPHS	FIGURE A1.2

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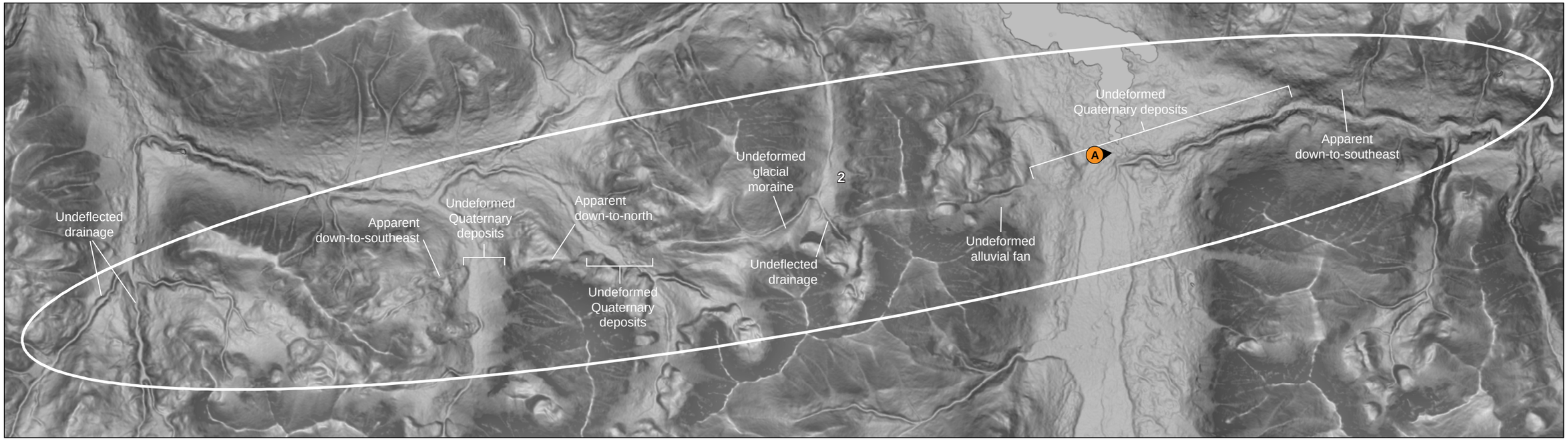
Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.
2. Geology by Wilson et al., 1998.

TUGRO Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 2 MAP DATA	FIGURE A2.1

79_218900_Alaska_Railbelt/2189_Lineament Report October 2013, modified 10.18.13

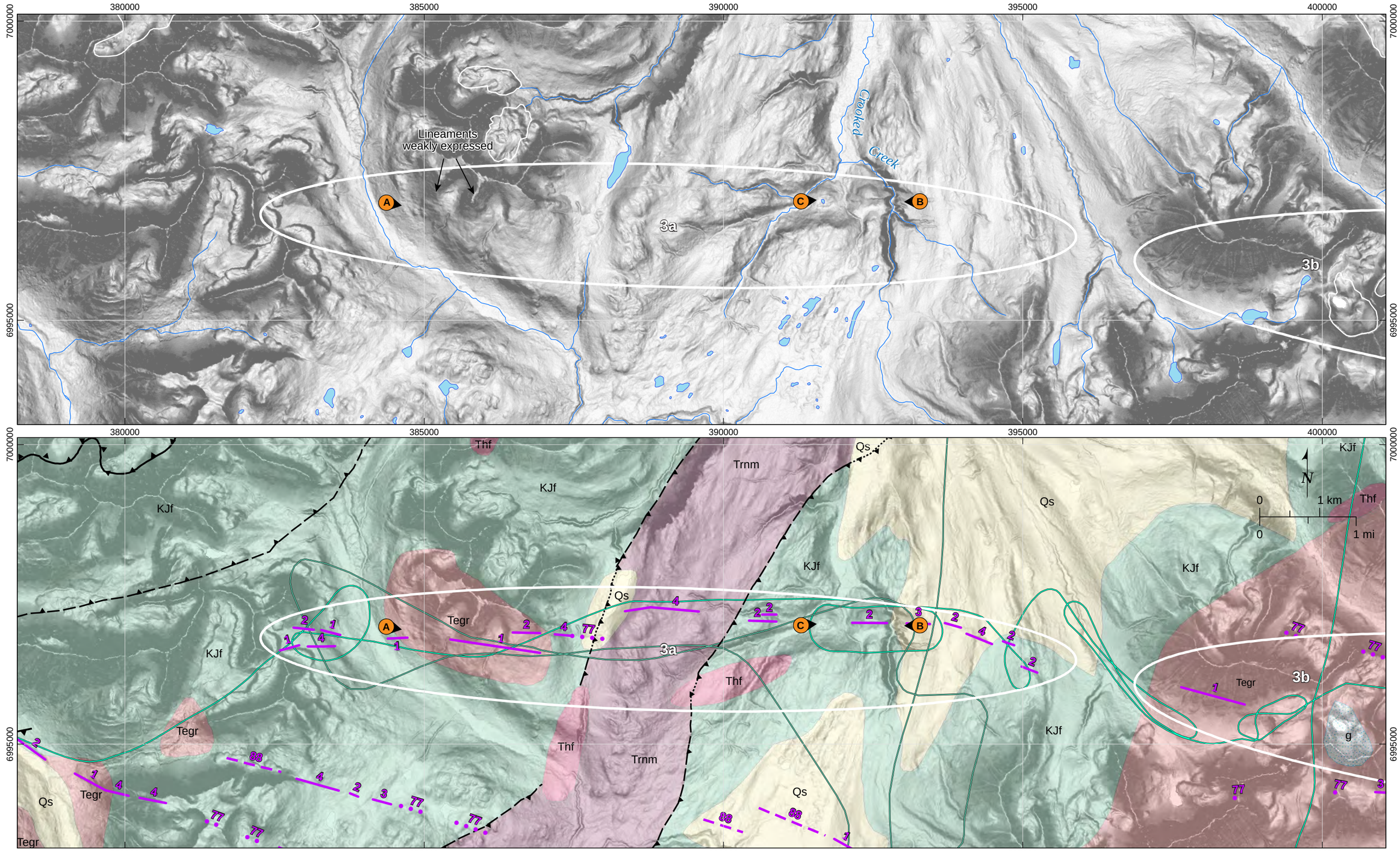


Photograph taken from location A looking east-northeast. Arrows show the alignment of FCL-mapped lineament. Note lack of apparent deformation in bedrock exposure along Jack River.



79_218900_Alaska_Railbelt/2189_Lineament Report October 2013, modified 12.16.13

FUGRO Date 12/16/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 2 MAP DATA AND PHOTOGRAPH	FIGURE A2.2

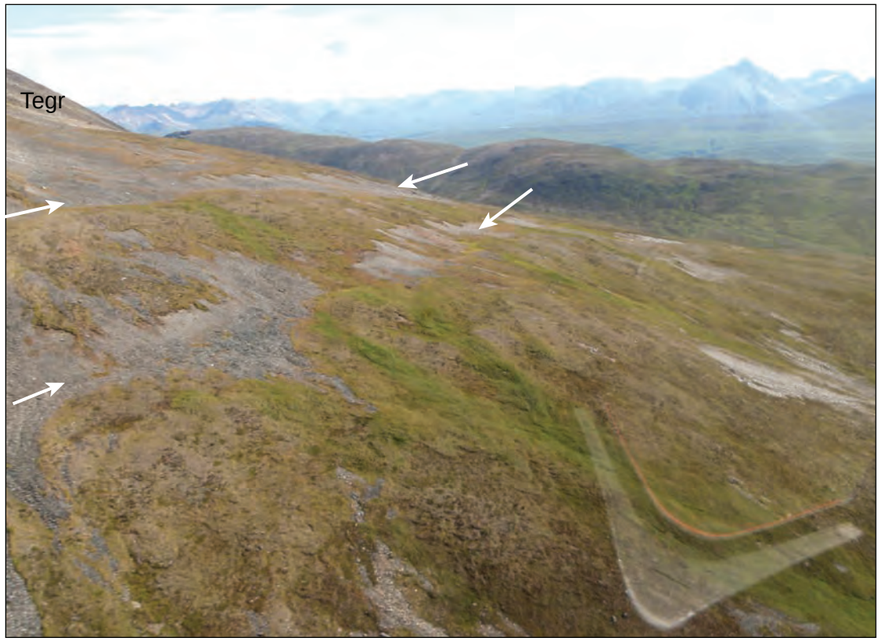


Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.
2. Geology by Wilson et al.,1998.

FUGRO Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 3a MAP DATA	FIGURE A3a.1

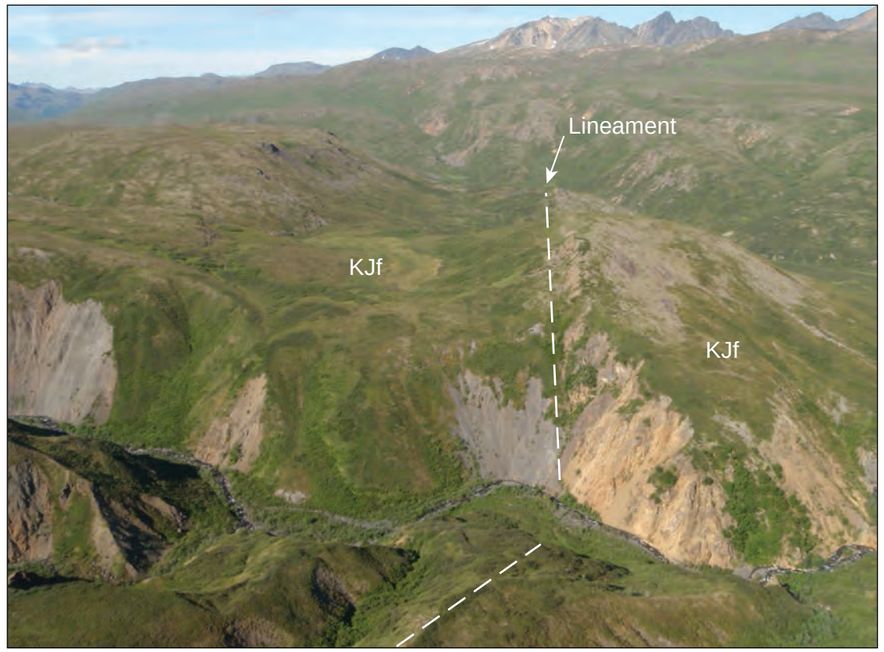
79_218900_Alaska_Railbelt/2189_Lineament Report October 2013, modified 10.18.13

A)



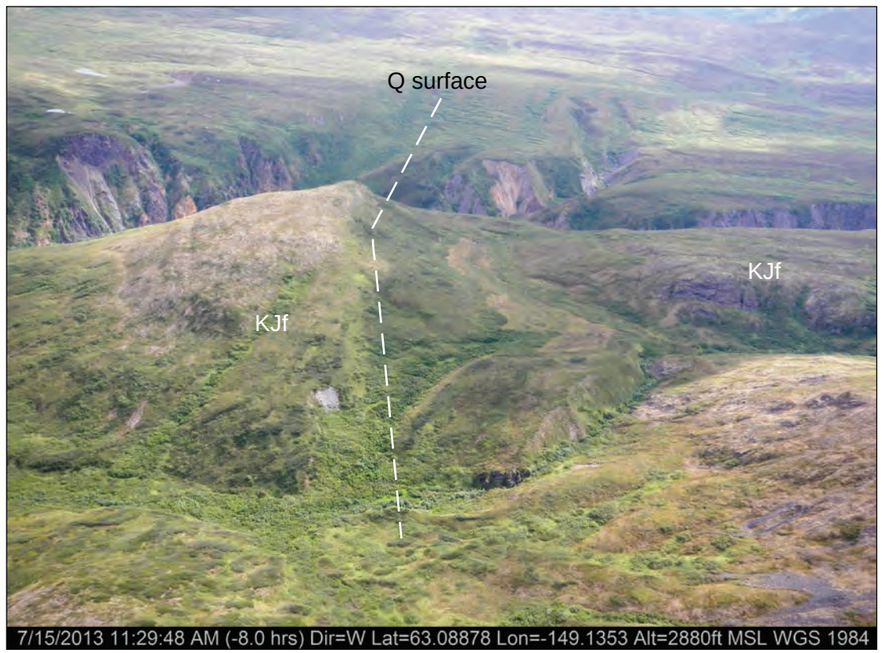
View looking east at likely solifluction-related scarps on hillside that correspond with mapped lineaments. Large arrows point along lineaments.

B)



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.

C)

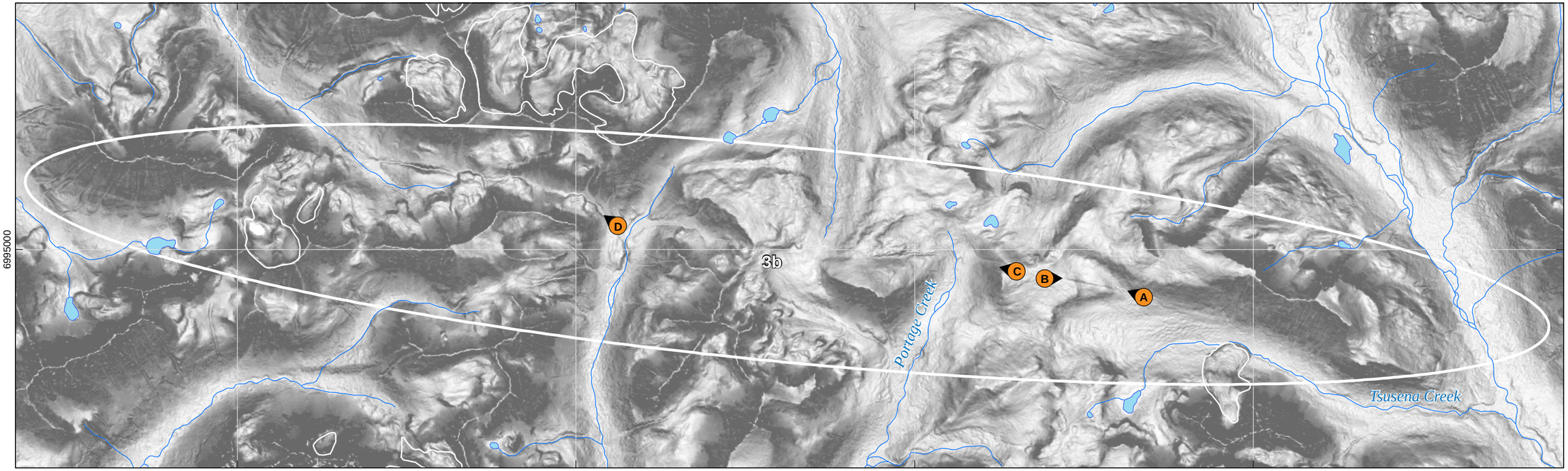


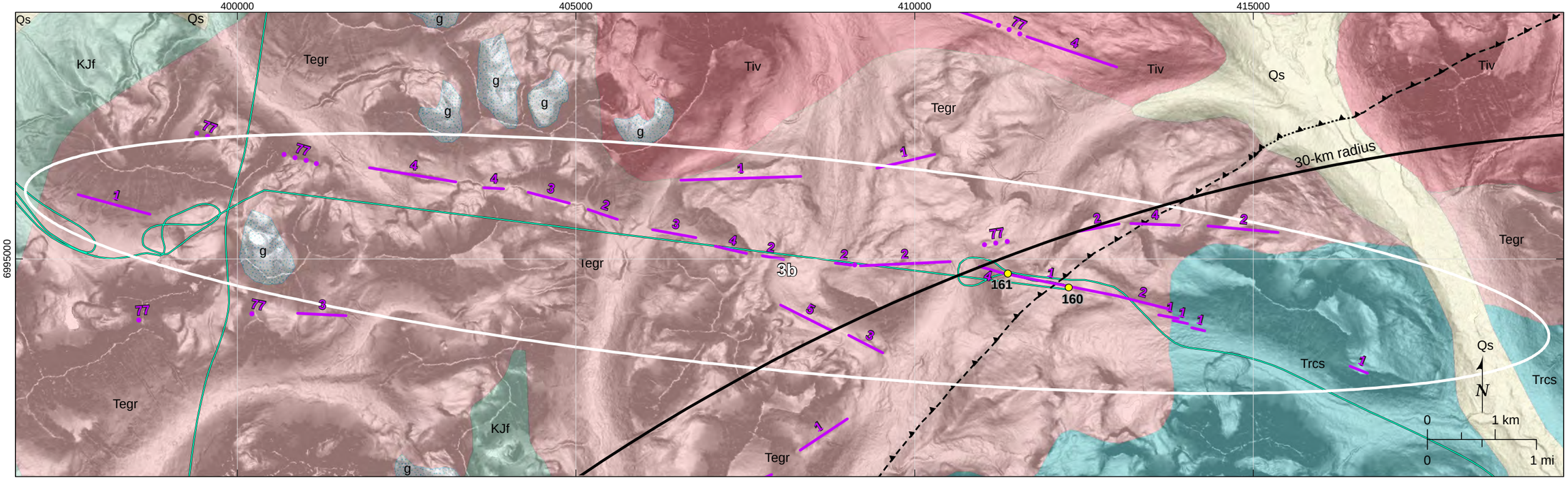
View looking east past ridge, with unfaulted Quaternary sediments in the foreground and far distances.

FUGRO Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 3a PHOTOGRAPHS	FIGURE A3a.2

400000 405000 410000 415000

6995000



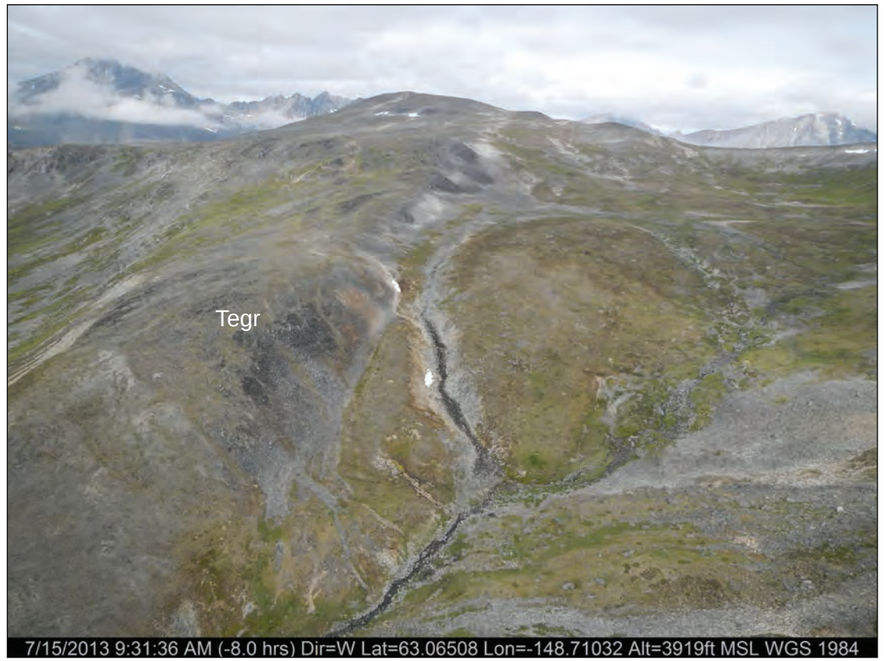


Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.
2. Geology by Wilson et al.,1998.

Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 3b MAP DATA	FIGURE A3b.1

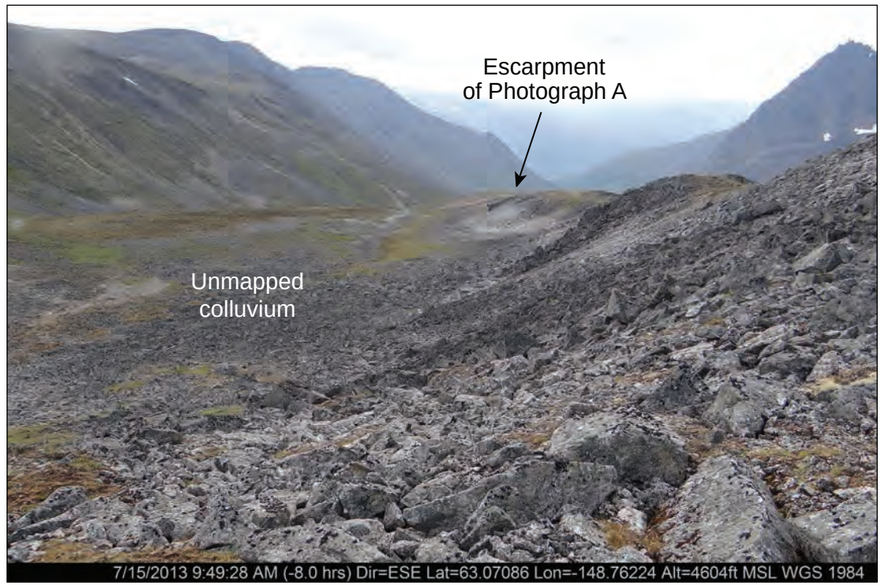
79_218900_Alaska_Railbelt/2189_Lineament Report October 2013, modified 10.18.13

A)



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

B)



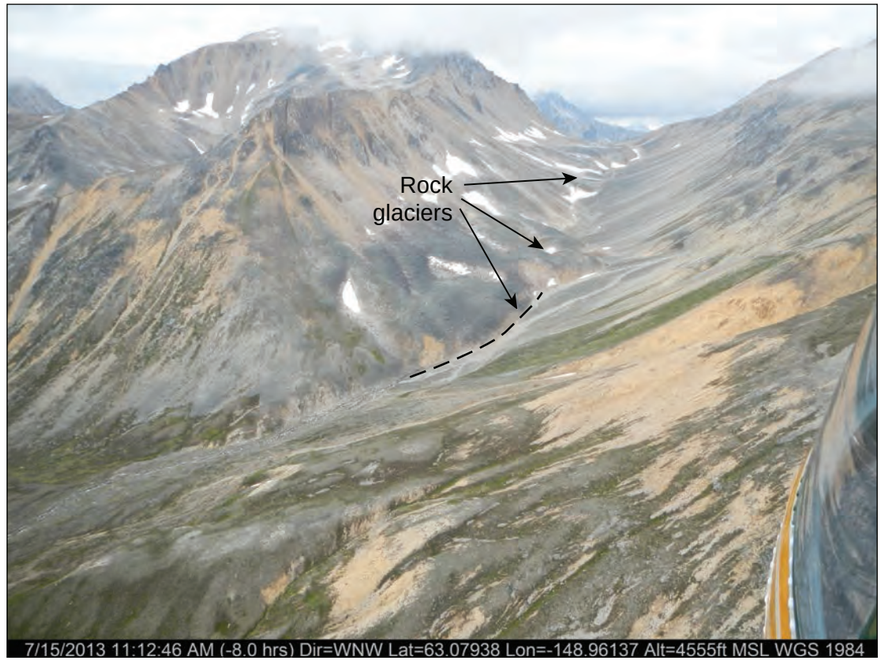
View looking east along lower talus scree field that shows decreasing relief at west end of lineament 3b.

C)



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

D)



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

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79_218900_Alaska_Railbelt/2189_Lineament Report October 2013, modified 10.18.13

355000 360000 365000 370000

6975000

70-km radius

Qat

Qg

Chulitna River

KJs

Little Coal Creek

Tpgr

5

Indian River

Tpgr Tpgr

355000 360000 365000 370000

6975000

D

N

0 1 km

0 1 mi

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

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FUGRO

Date 10/18/13

STATE OF ALASKA
ALASKA ENERGY AUTHORITY
ALASKA ENERGY AUTHORITY

SUSITNA-WATANA HYDROELECTRIC PROJECT

LINEAMENT GROUP 5
MAP DATA

FIGURE
A5-1.1

365000 370000 375000 380000 385000

6975000

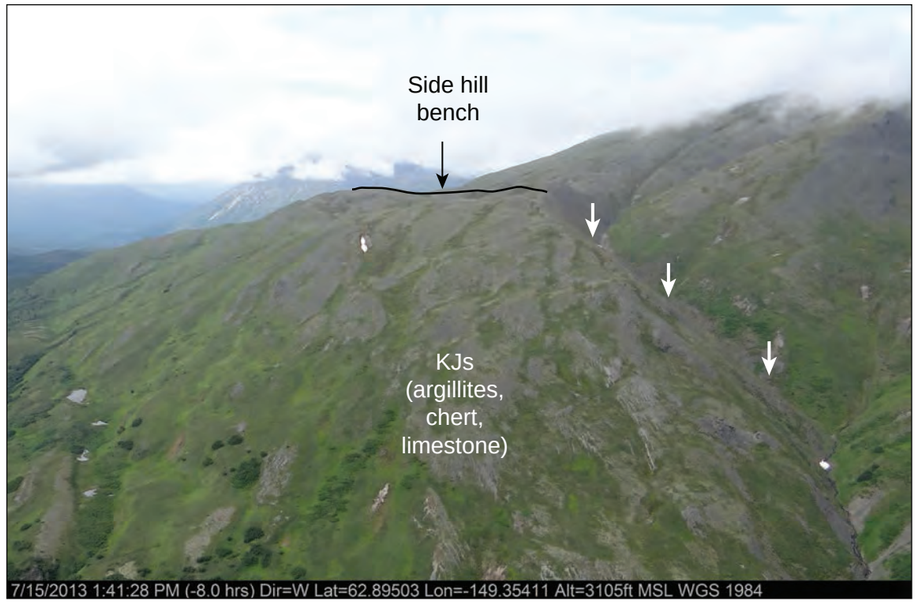
Qg
Tpgr
KJs
Chulitna Pass
Indian River
Portage Creek
5
8
9
A
B
C
1 km
1 mi
N

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

Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 5 MAP DATA	FIGURE A5-2.1

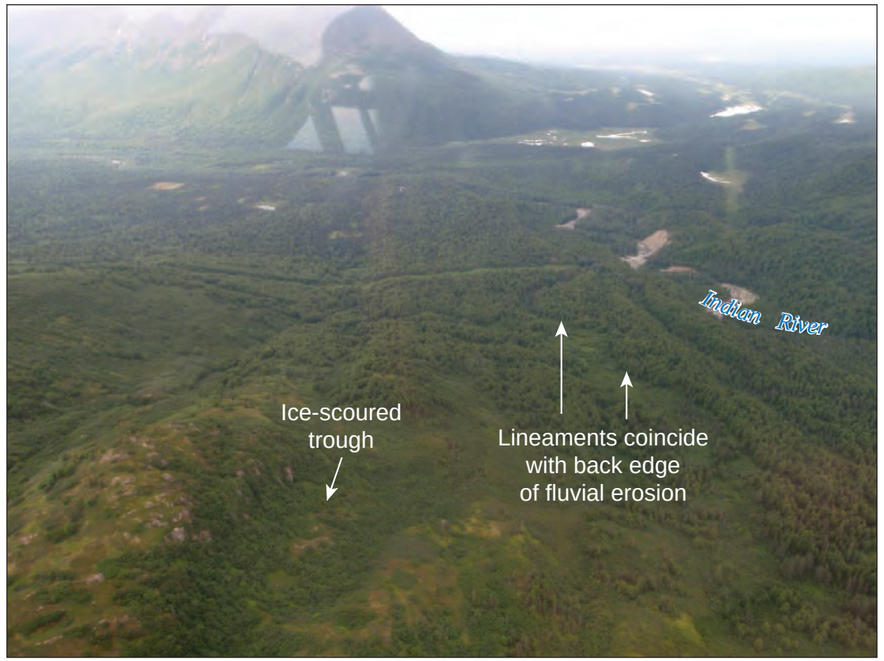
79_218900_Alaska_Railbelt\2189_Lineament Report October 2013, modified 10.18.13

A)



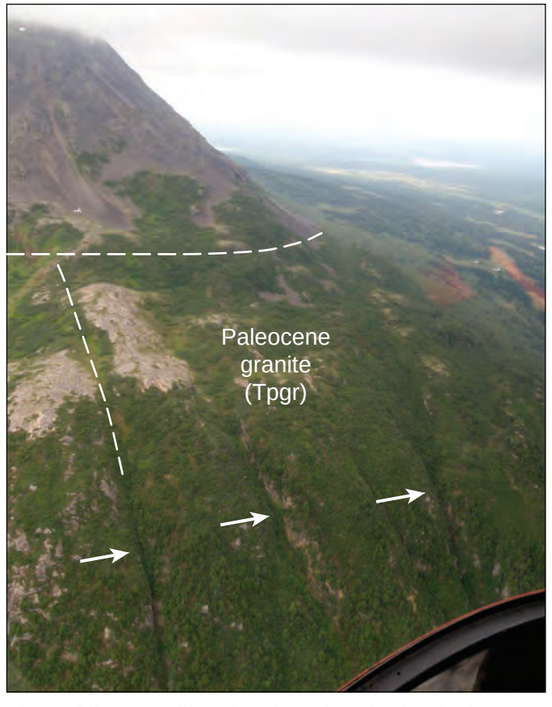
View looking west at eastern part of apparent side hill bench.

B)



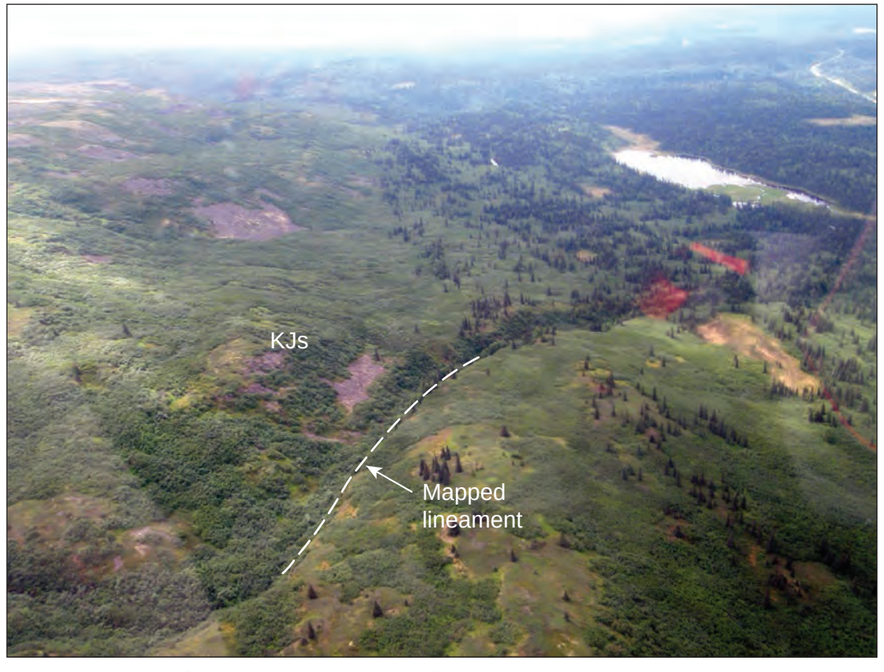
View looking west along ice-scoured terrain, with the Indian River flowing from right to left.

C)



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

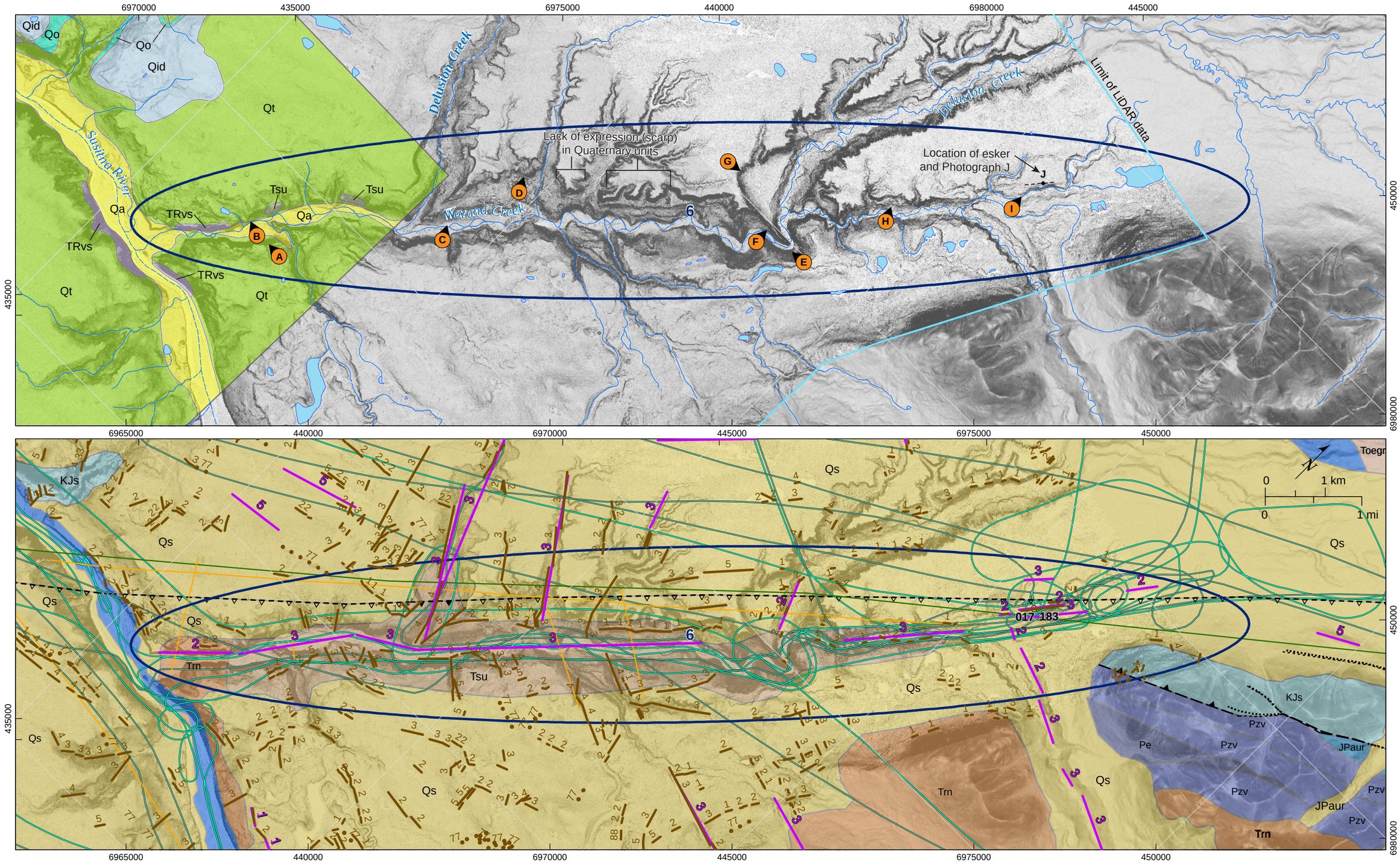
D)



View of drainage with mapped lineament approximately shown.

FUGRO Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 5 PHOTOGRAPHS	FIGURE A5-2.2

79_218900_Alaska_Railbelt\2189_Lineament Report October 2013, modified 10.18.13

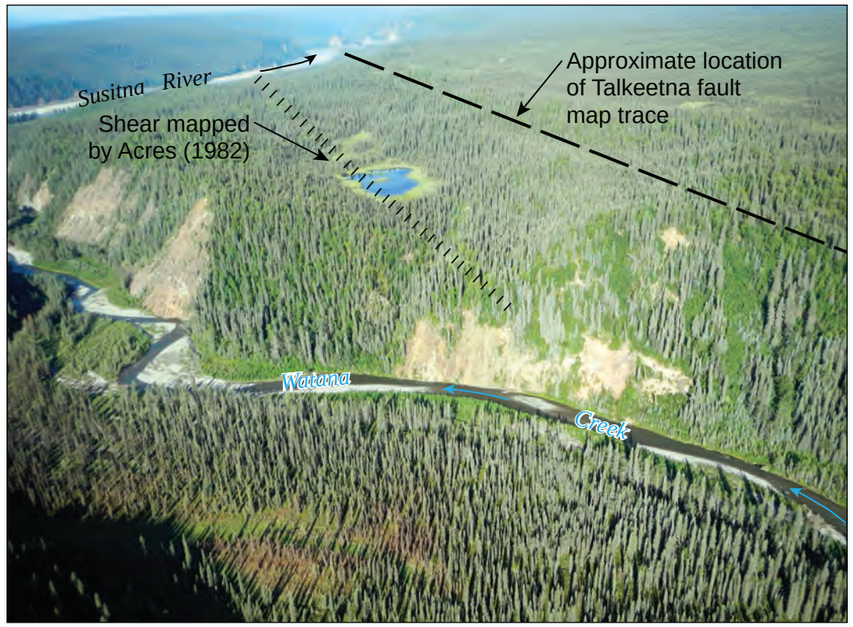


Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.
2. Data frame has been rotated 45° east of north.
3. Geology from Acres, 1982 (top) and by Wilson et al., 2009 (bottom)

FUGRO Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 6 MAP DATA	FIGURE A6.1

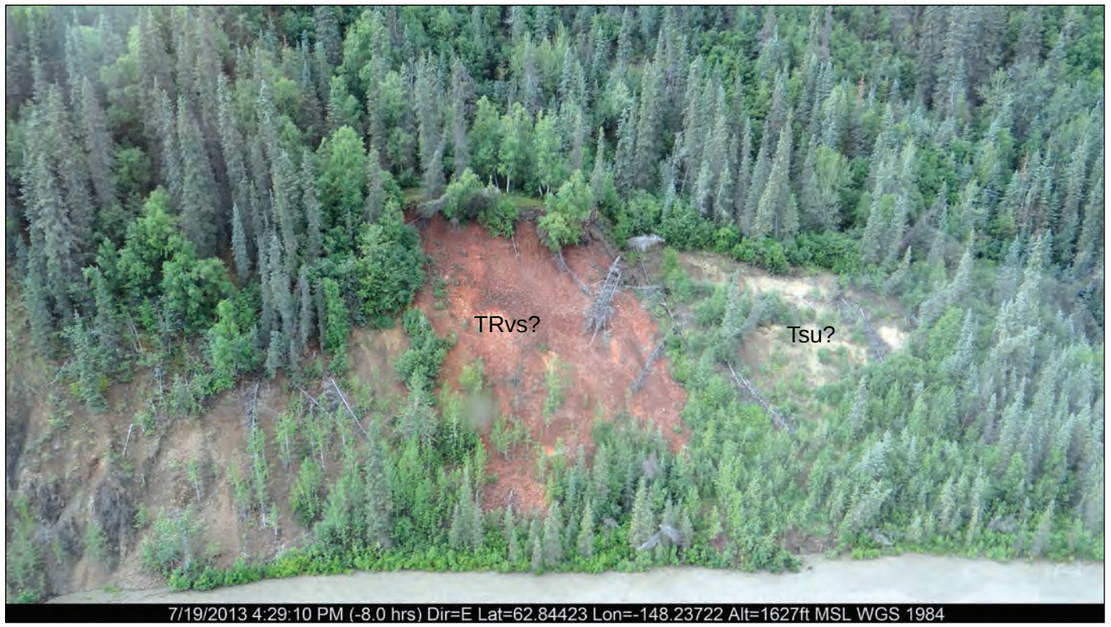
fwla-wc-file1:/project/Projects/79_2000/79_218900_Alaska_Railbelt/05_Graphics/79_218900_TM14 January 2014 Lineament Report /79_218900 Appendix A

A)



View looking west along oblique to projection of Talkeetna fault

B)



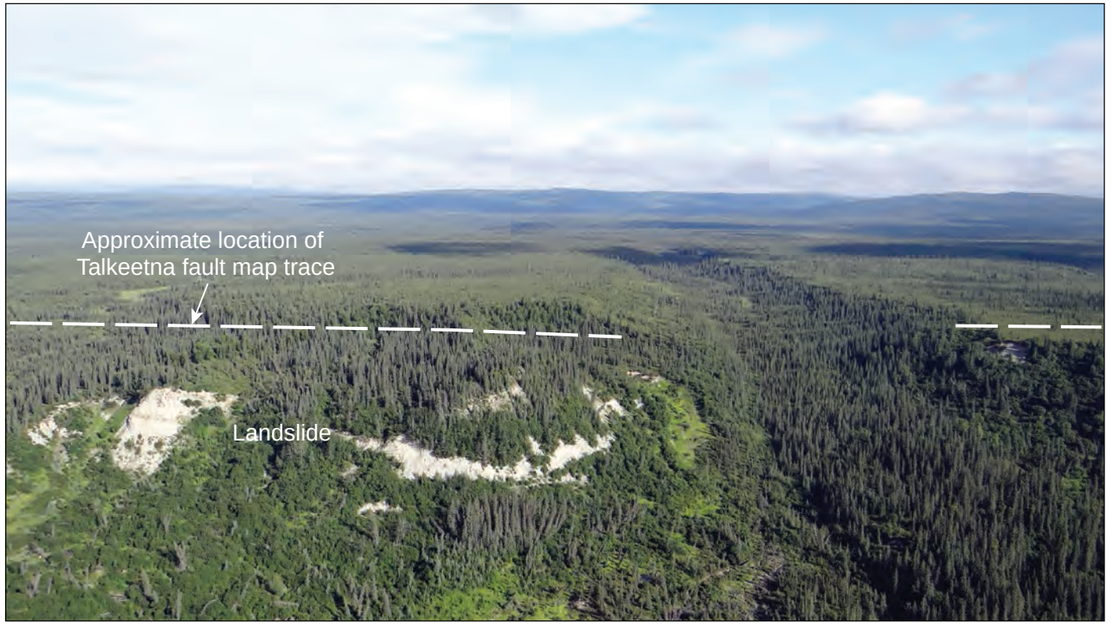
View looking east along lower river bank at apparent alternation zone distinguished by color contrast, possible juxtaposition of Triassic metabasalts and undifferentiated Tertiary sediments. This location is east of the mapped projections of the Talkeetna fault.

C)



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

D)



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

FUGRO Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 6 PHOTOGRAPHS	FIGURE A6.2

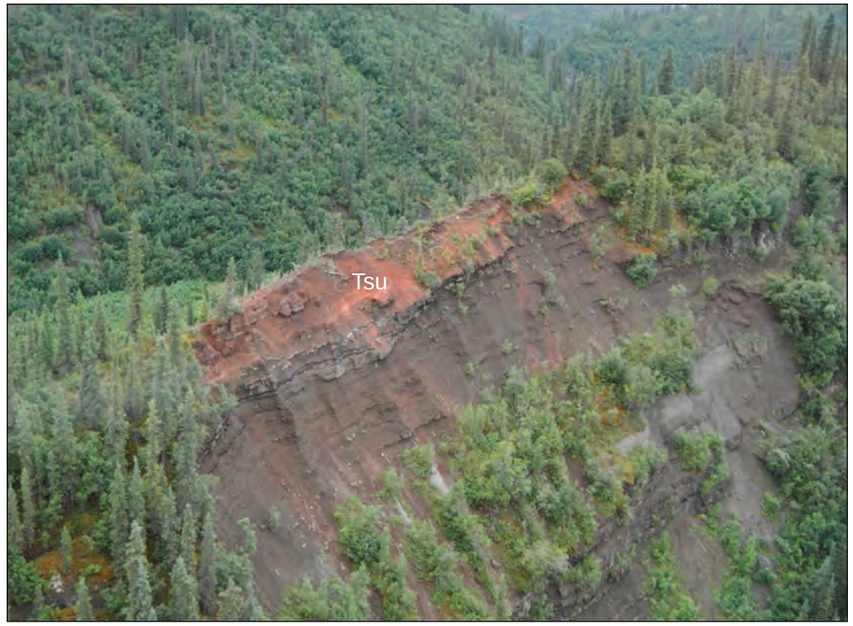
79_218900_Alaska_Railbelt\2189_Lineament Report October 2013, modified 10.18.13

E)



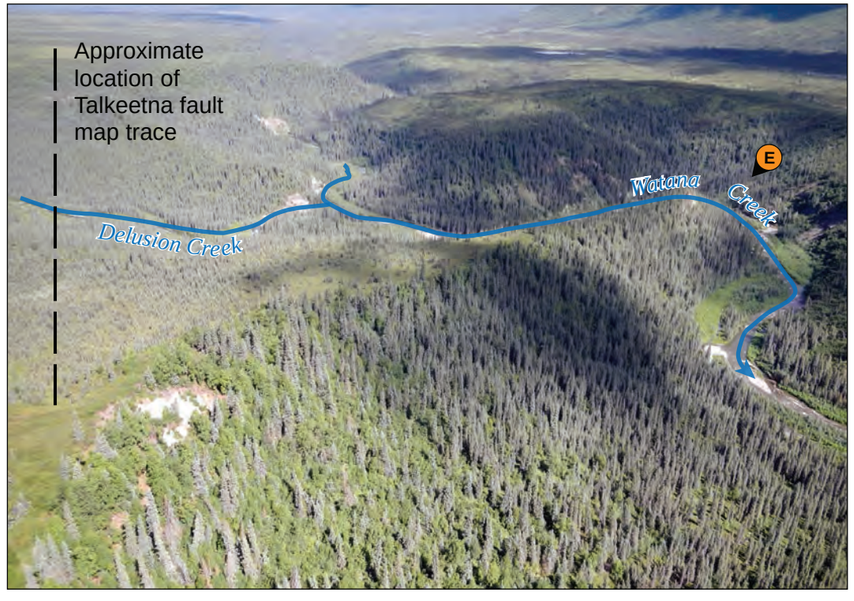
View looking south at erosion-resistant ridge of Tertiary sediments whose beds dip gently to the northwest but appear undisrupted.

F)



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.

G)



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

H)

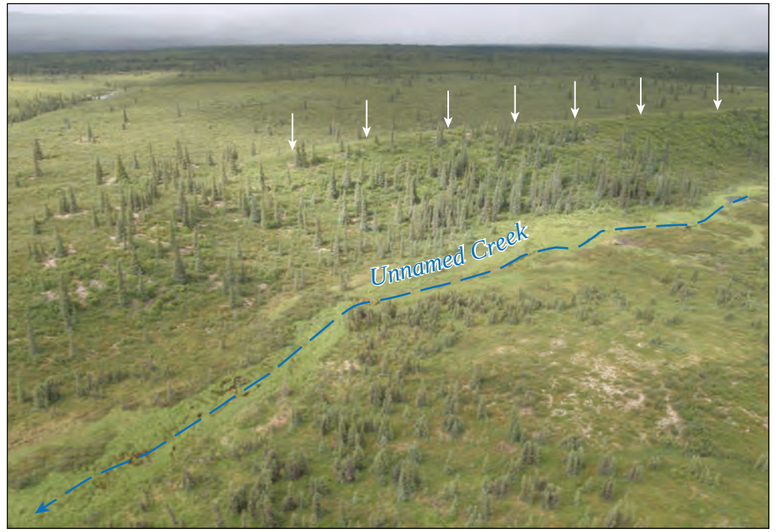


View looking west at bedded (lake?) stratigraphy exposed in eroding bluff. Beds appear relatively horizontal, but may have a sense of non-planar geometry because of semi-circular outcrop. Note fallen trees that indicate erosion/slope movement.

FUGRO Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 6 PHOTOGRAPHS	FIGURE A6.3

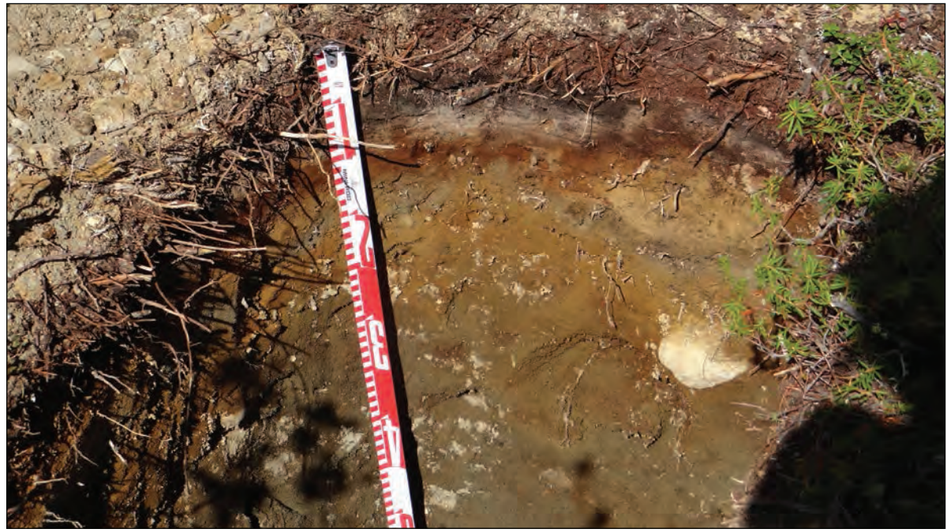
79_218900_Alaska_Railbelt/2189_Lineament Report October 2013, modified 10.18.13

I)



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.

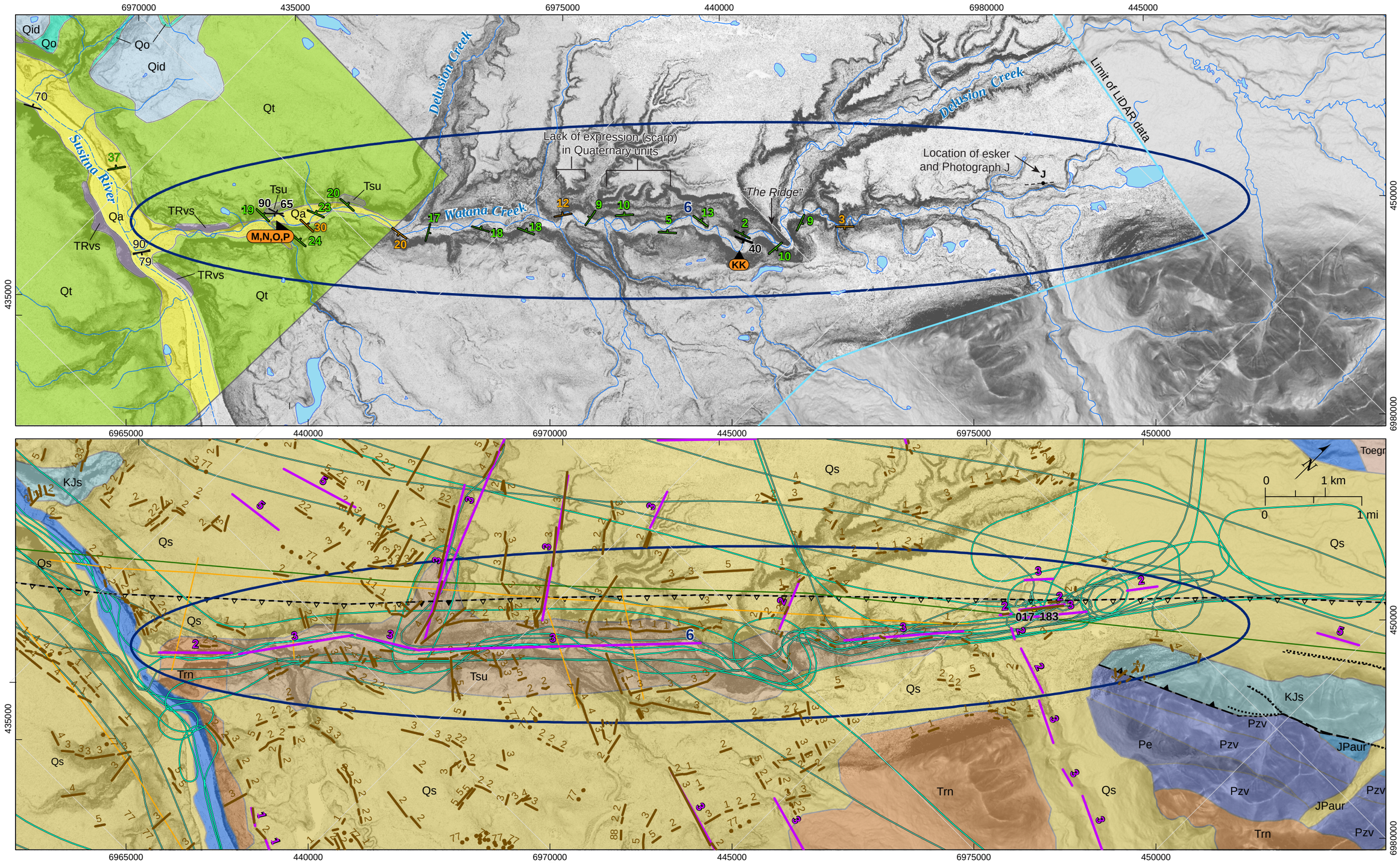
J)



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.

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FUGRO Date 12/30/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 6 PHOTOGRAPHS	FIGURE A6.4



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)

Explanation

21 Strike/dip Tsu FCL 2014

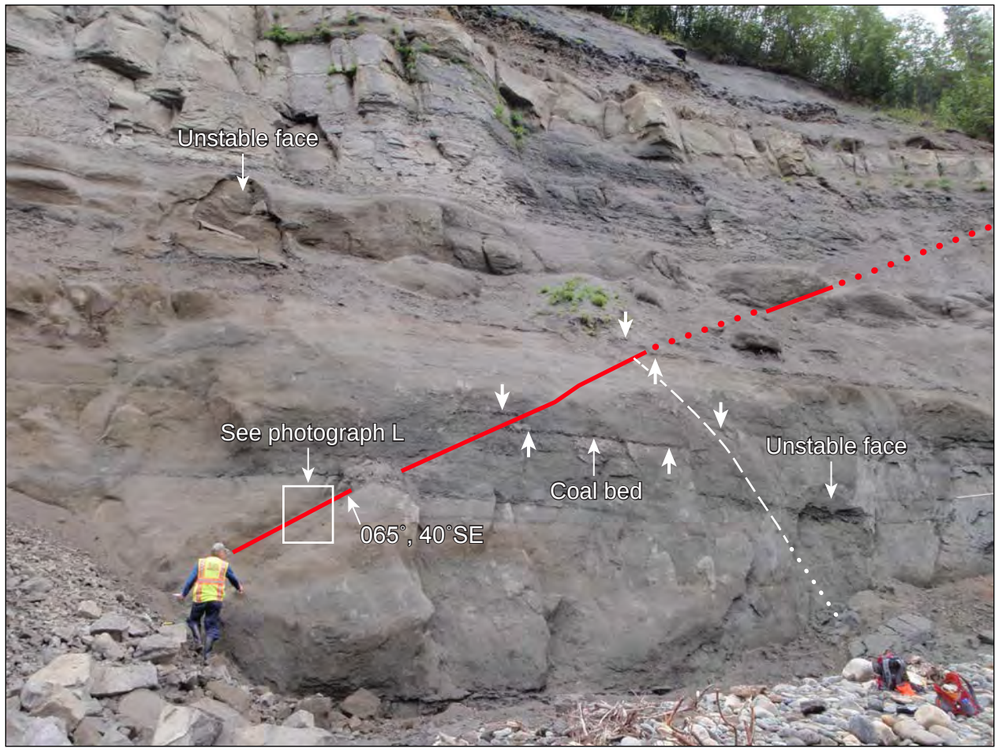
17 WCC strike/dip measurements

65 Fault locations (FCL, 2014)

TUGRO Date 10/31/14	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 6 MAP DATA	FIGURE A6.5

fwla-wc-file1/project/Projects/79_2000/79_218900_Alaska_Railbelt/05_Graphics/79_218900_TM14 January 2014 Lineament Report /79_218900 Appendix A

K)



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.

L)



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
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STATE OF ALASKA
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ALASKA ENERGY AUTHORITY

SUSITNA-WATANA HYDROELECTRIC PROJECT

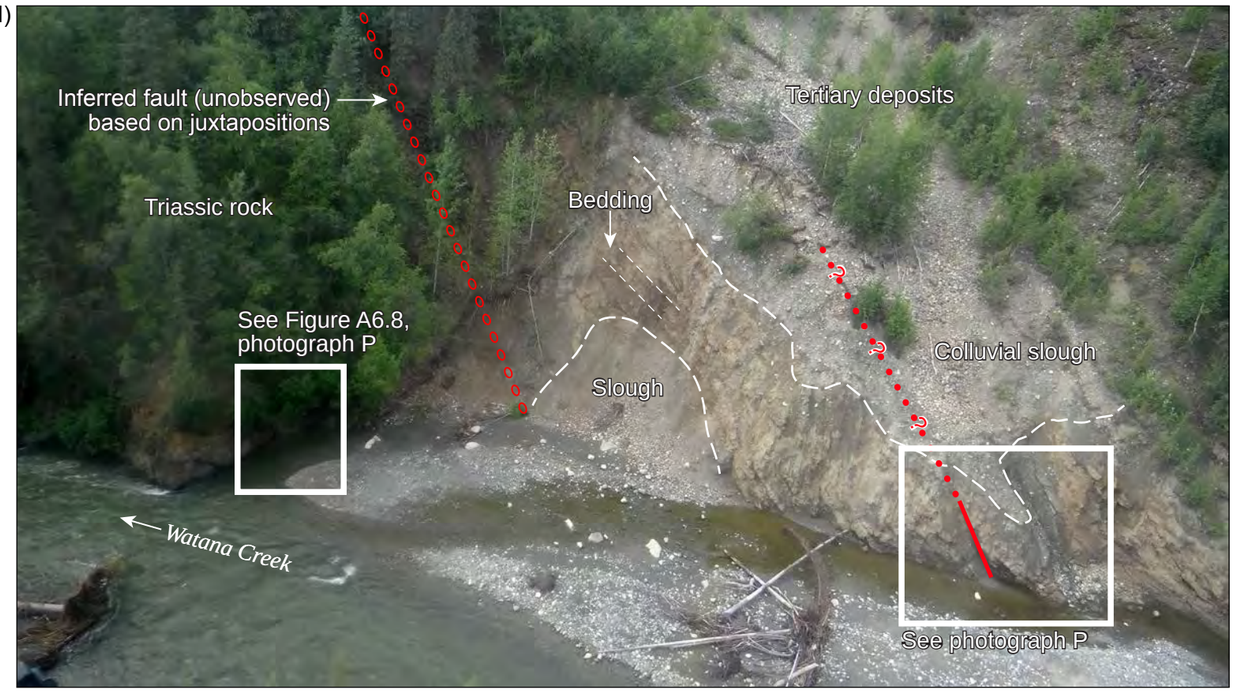
PHOTOGRAPHS SHOWING FAULTED OUTCROP AND FAULT PLANE

FIGURE

FIGURE A6.6

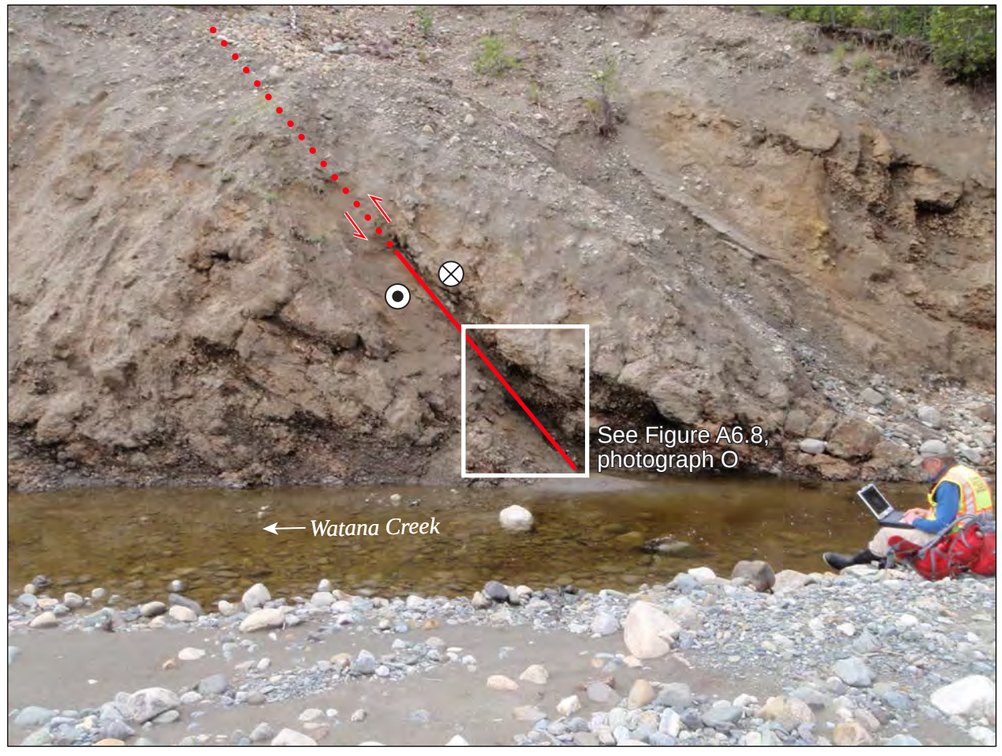
fwla-wc-file1/project/Projects/79_2000/79_218900_Alaska_Railbelt/05_Graphics/2189_TM14 January 2014 Lineament Report /

M)



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

N)



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.

fwla-wc-file1/project/Projects/79_2000/79_218900_Alaska_Railbelt/05_Graphics/2189_TM14 Janurary 2014 Lineament Report /

REV	DESCRIPTION	BY	DATE

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STATE OF ALASKA
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ALASKA ENERGY AUTHORITY

SUSITNA-WATANA HYDROELECTRIC PROJECT

PHOTOGRAPHS SHOWING AERIAL VIEW OF FAULT

FIGURE

FIGURE A6.7

O)



Close up of fault in cobble-rich Tertiary deposit.

P)



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

fwla-wc-file1/project/Projects/79_2000/79_218900_Alaska_Railbelt/05_Graphics/2189_TM14 Janurary 2014 Lineament Report /

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STATE OF ALASKA
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ALASKA ENERGY AUTHORITY

SUSITNA-WATANA HYDROELECTRIC PROJECT

PHOTOGRAPHS OF FAULTING AT WATANA CREEK

FIGURE

FIGURE A6.8

445000 6970000 450000 6975000 455000 6980000

6965000 460000

445000 6980000

Susitna River

Watana Creek

7

450000 6965000 455000 6970000 460000 6975000

6965000 460000

445000 6980000

7

A

B

C

D

115 116 114

Additional lineaments inspected

0 1 km

0 1 mi

450000 6965000 455000 6970000 460000 6975000

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.

79_218900_Alaska_Railbelt/2189_Lineament Report October 2013, modified 12.16.13

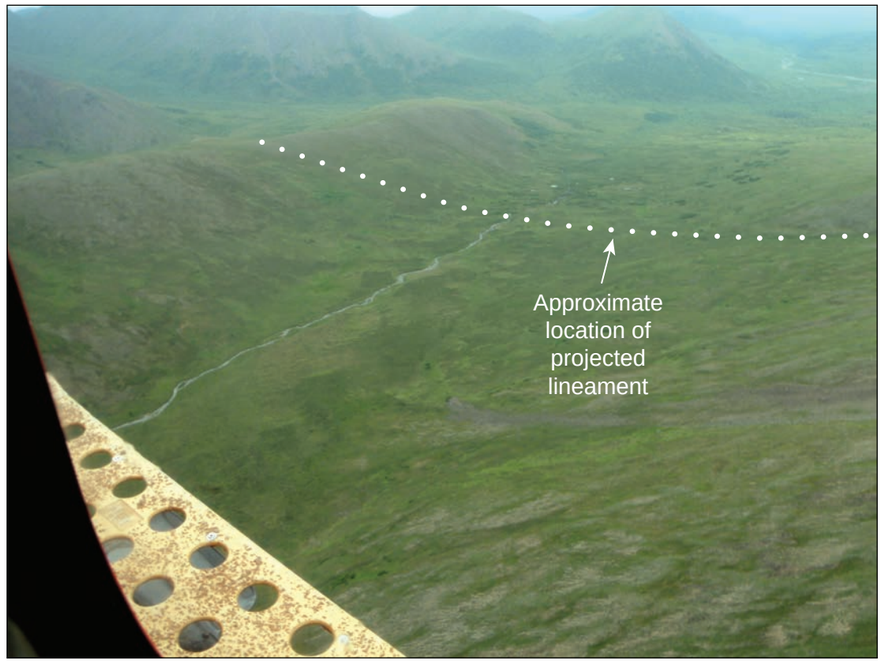
Date 12/16/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 7 MAP DATA	FIGURE A7.1

A)



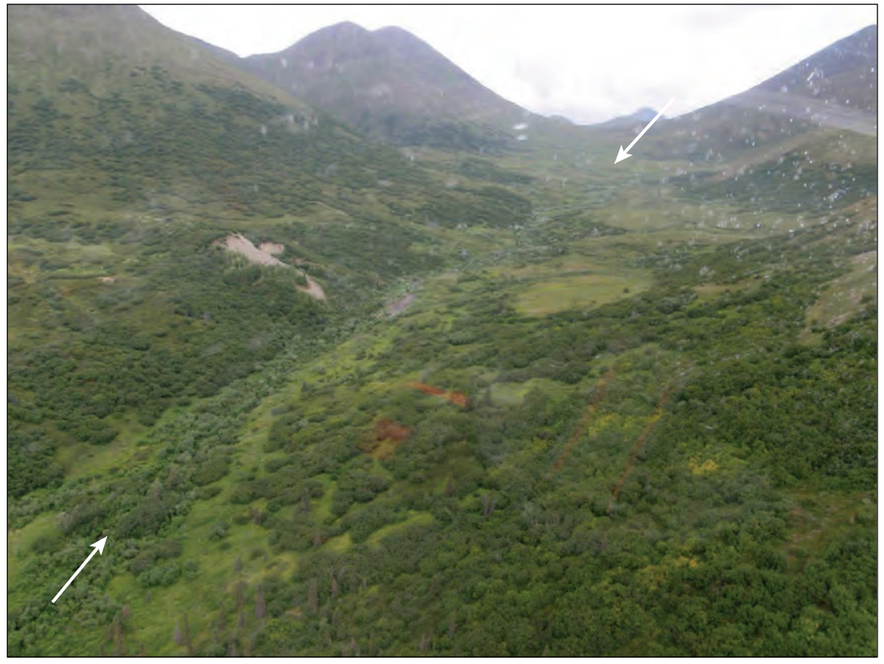
View looking at color contrast at previously mapped bedrock fault.

B)



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

C)



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

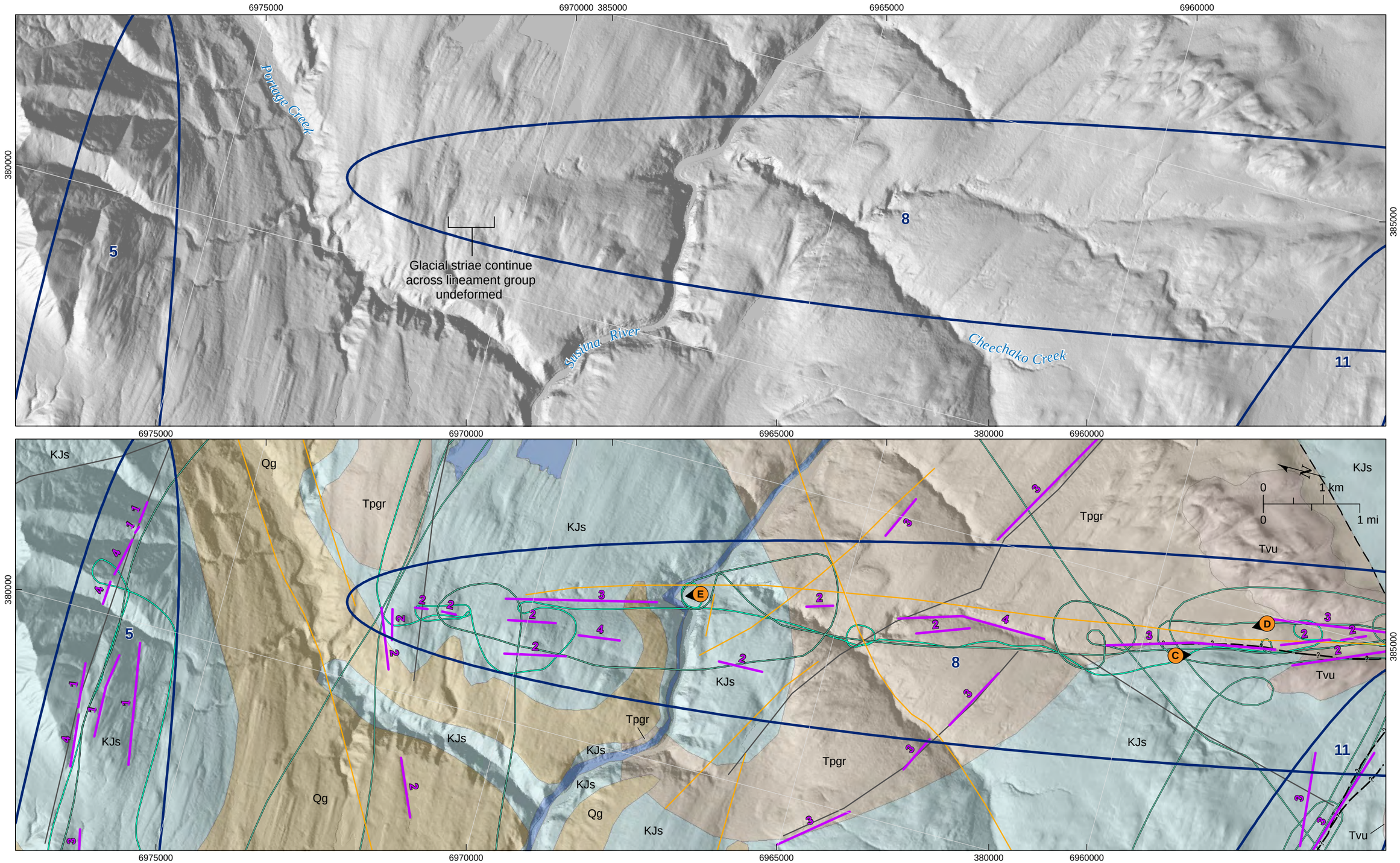
D)



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

FUGRO Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 7 PHOTOGRAPHS	FIGURE A7.2

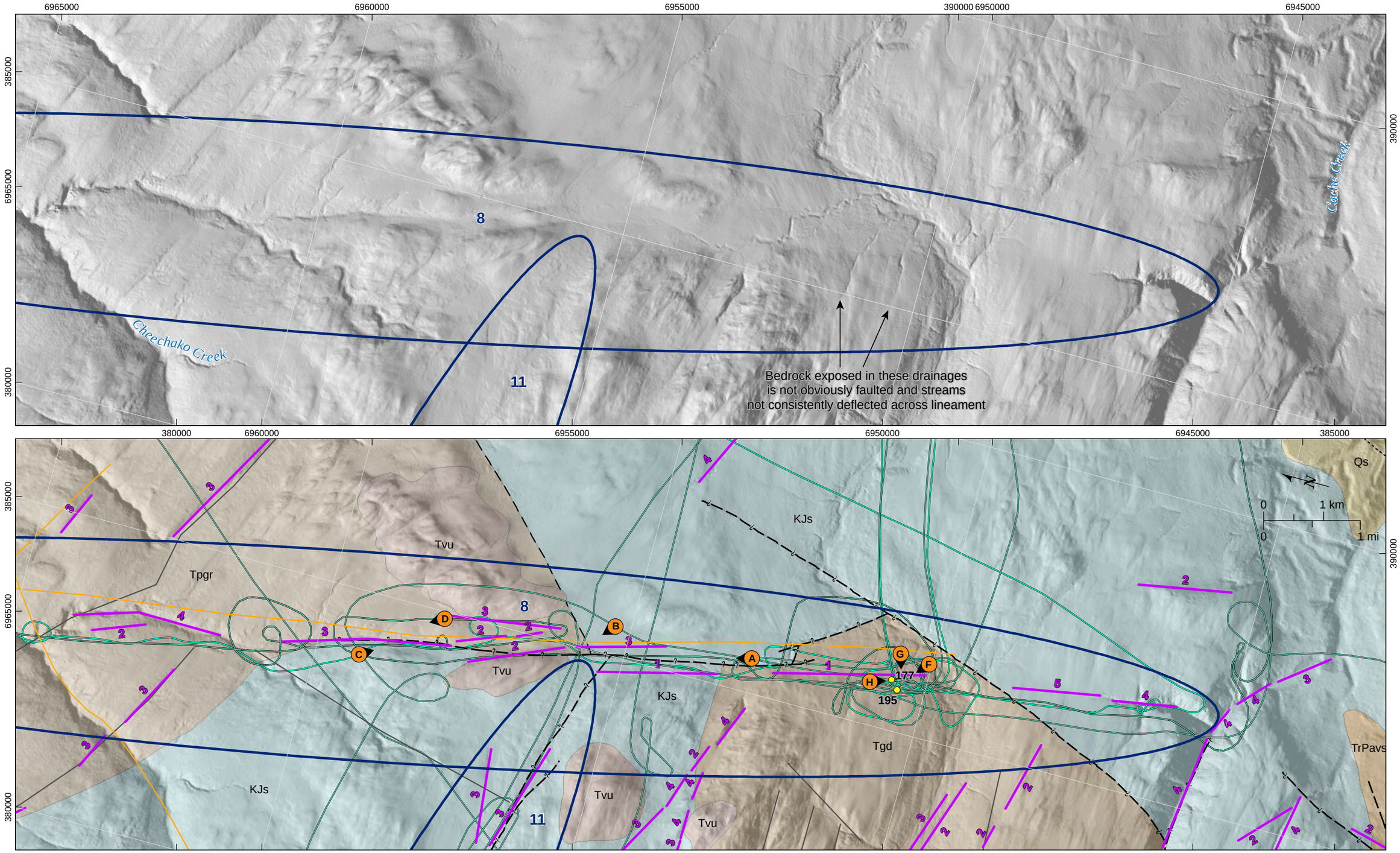
79_218900_Alaska_Railbelt/2189_Lineament Report October 2013, modified 10.18.13



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.

FUGRO Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 8 MAP DATA	FIGURE A8-1.1

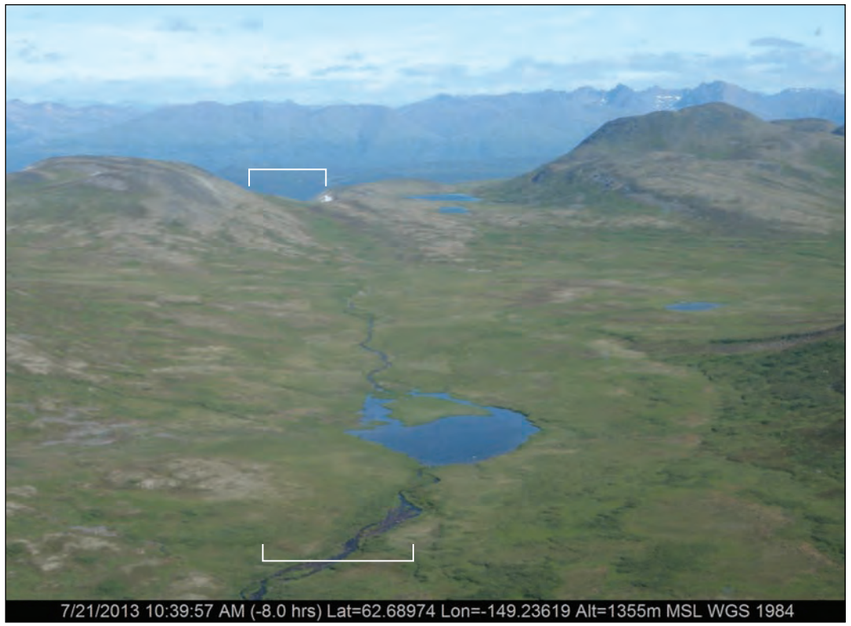
79_218900_Alaska_Railbelt/2189_Lineament Report October 2013, modified 10.18.13



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.

FUGRO Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 8 MAP DATA	FIGURE A8-2.1

A)



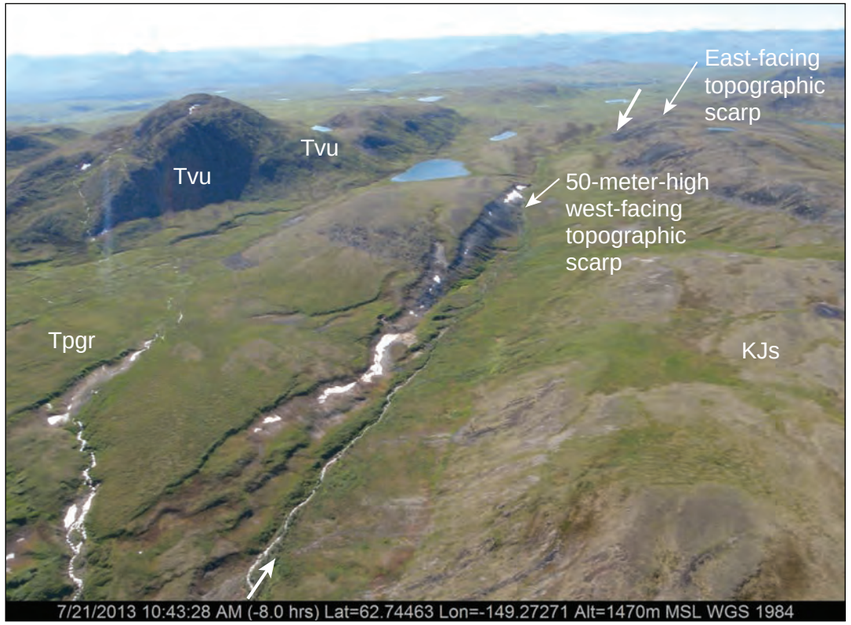
View looking north at middle portion of lineament group 8 along mapped inferred fault. Brackets show position of fault but note that no geomorphic expression of faulting is readily apparent.

B)



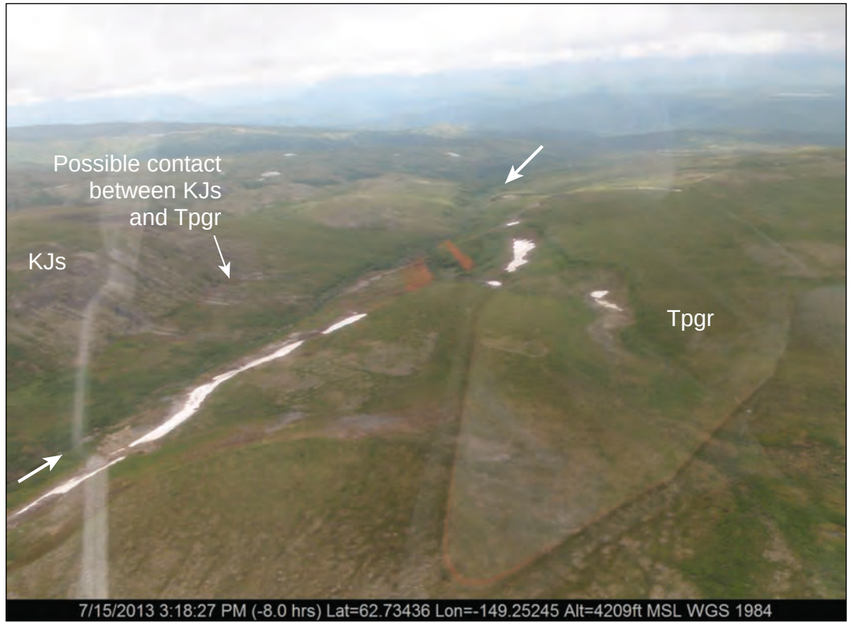
Close up view of saddle area shown in Photograph A. Brackets, again, show position of fault but note that no geomorphic expression of faulting is readily apparent.

C)



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.

D)



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

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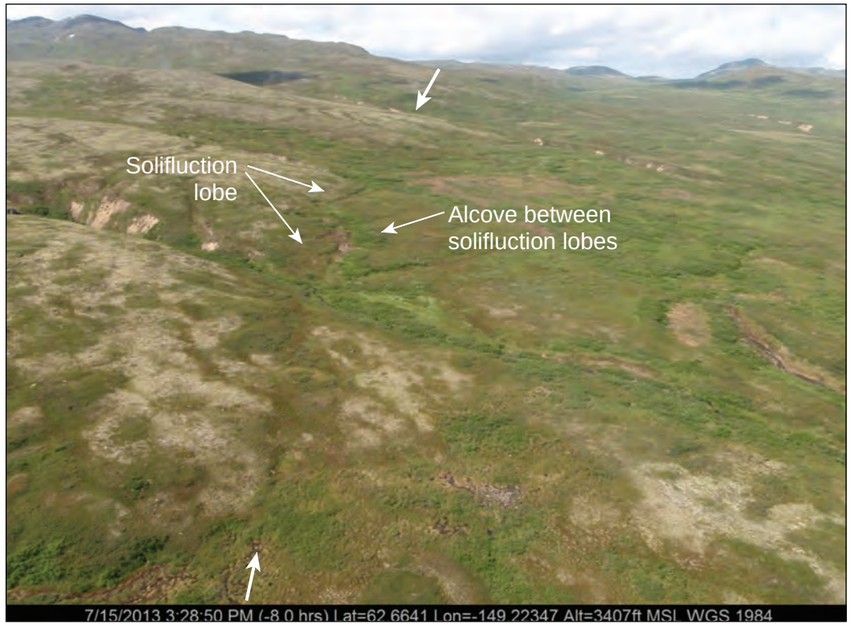
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E)



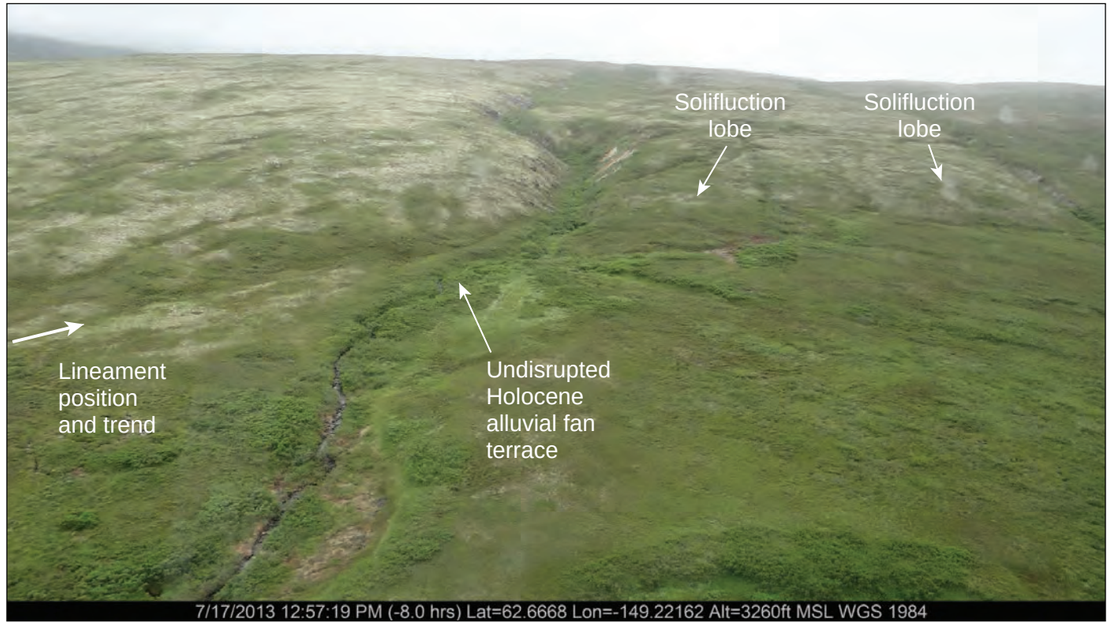
View looking north at north (right) bank of Susitna River showing oxidized mafic dike interpreted by WCC (1982) to not be truncated by the linear drainage.

F)



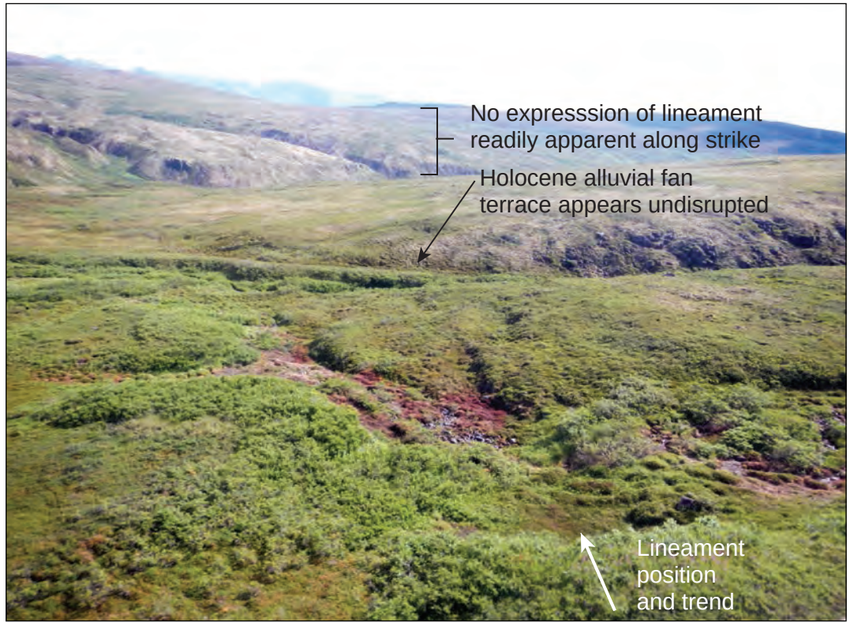
View looking north along 1- to 2-m-high east-facing scarps along southern portion of lineament group 8. Large arrows point along mapped lineament. Note the presence of solifluction lobes with an alcove or recession in between them that create an irregular and curving topographic scarp.

G)



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.

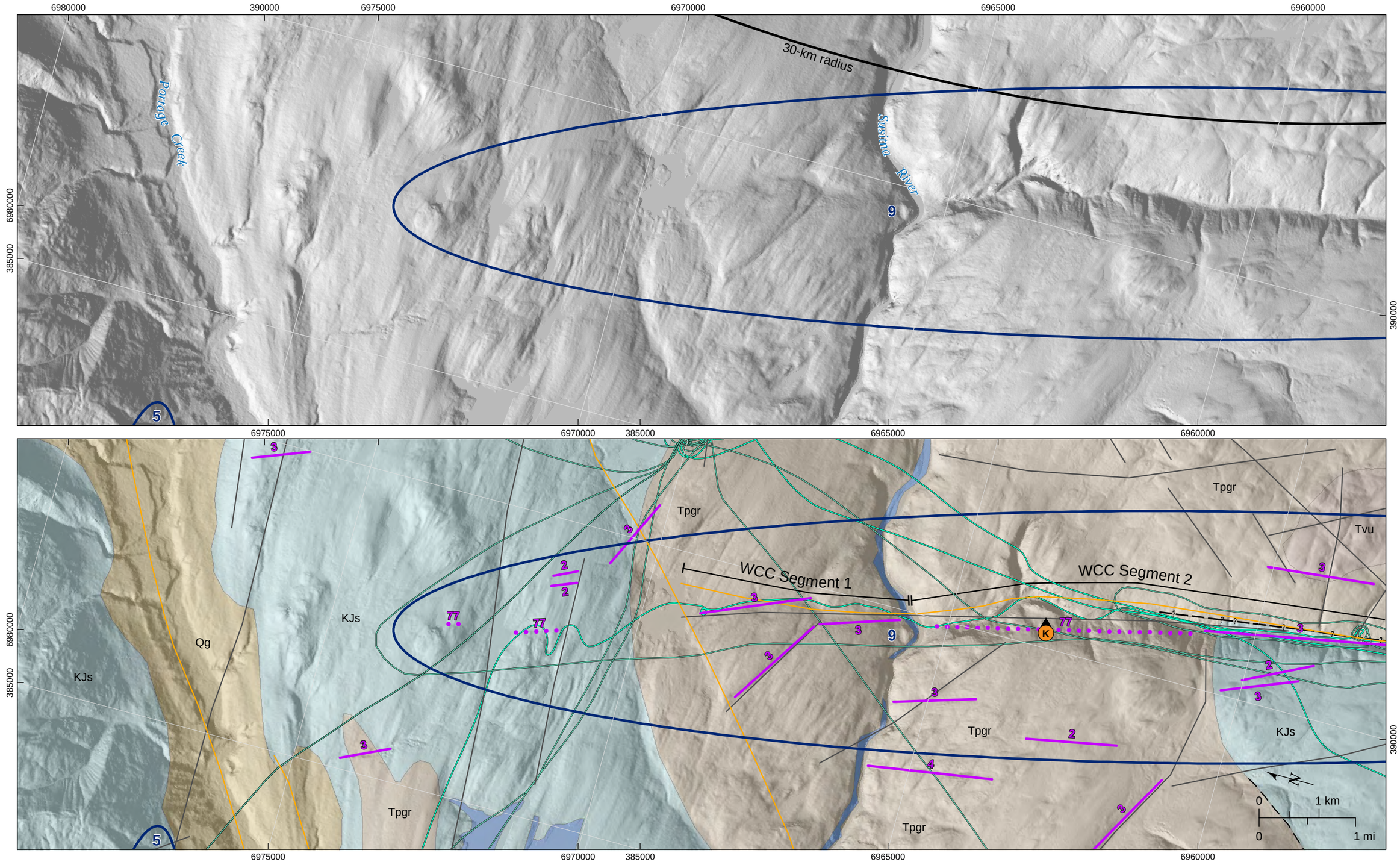
H)



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

FUGRO Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 8 PHOTOGRAPHS	FIGURE A8-2.3

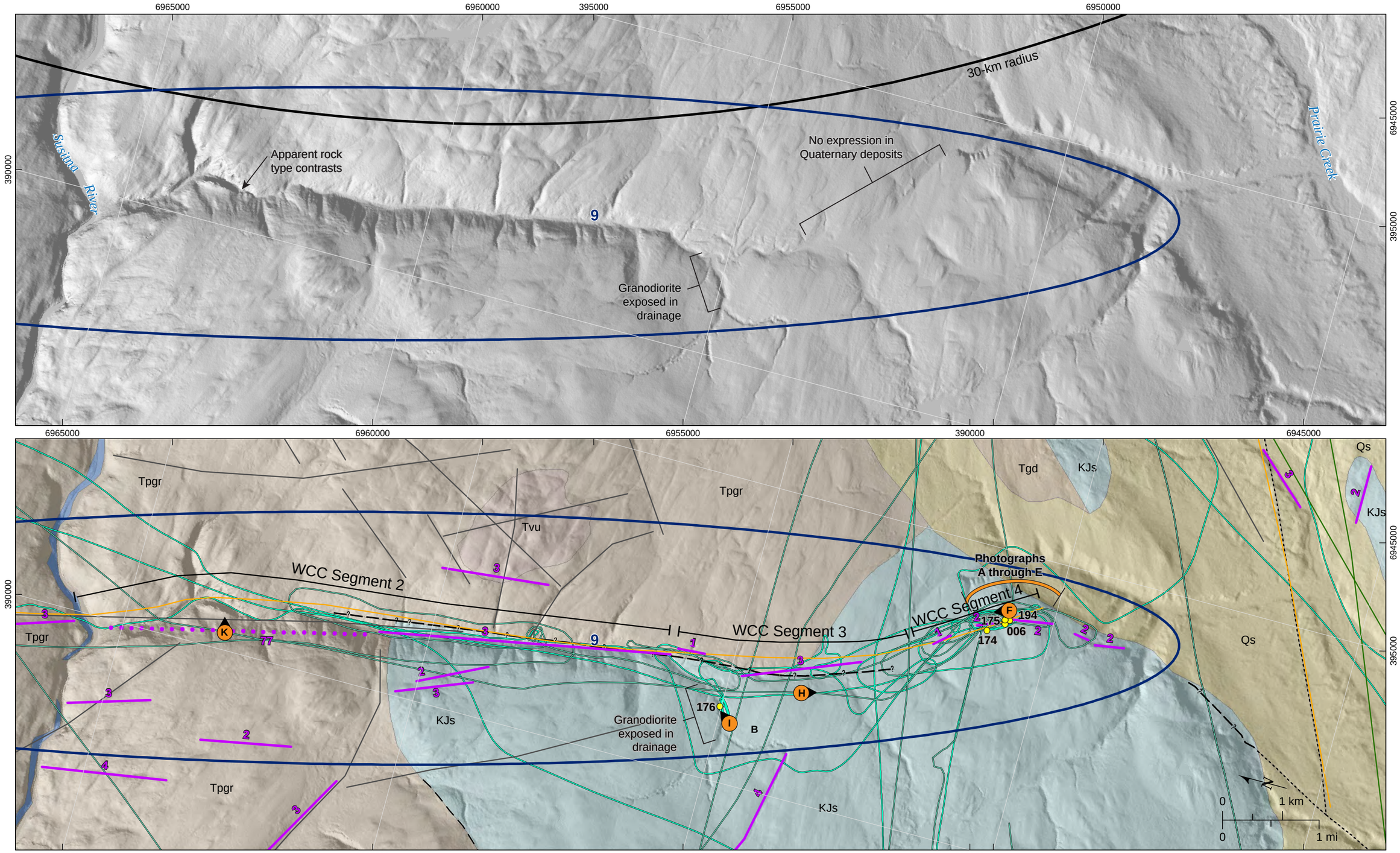
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Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.
2. Data frame has been rotated 75° west of north.
3. Geologic map by Wilson et al., 2009.

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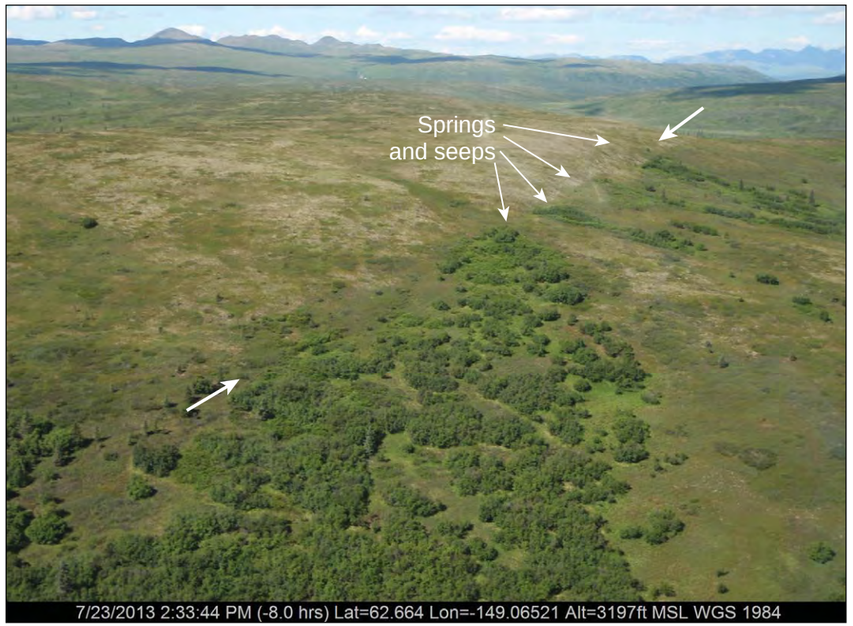


Notes: 1. See Figures A0.2, A0.3, A0.4, and A0.5 for explanation.
2. Data frame has been rotated 75° west of north.
3. Geology by Wilson et al., 2009.

Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 9 MAP DATA	FIGURE A9-2.1

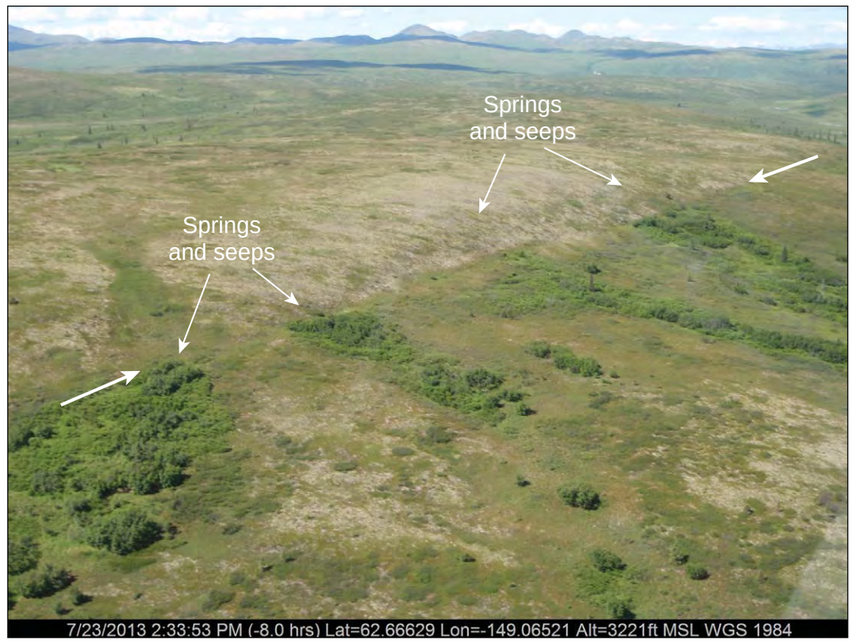
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A)



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.

B)



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

C)



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

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fwla-wc-file1/project/Projects/79_2000/79_218900_Alaska_Railbelt/05_Graphics/May 2015 CSSE with SFR Final Rep 14-33

D)



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

E)



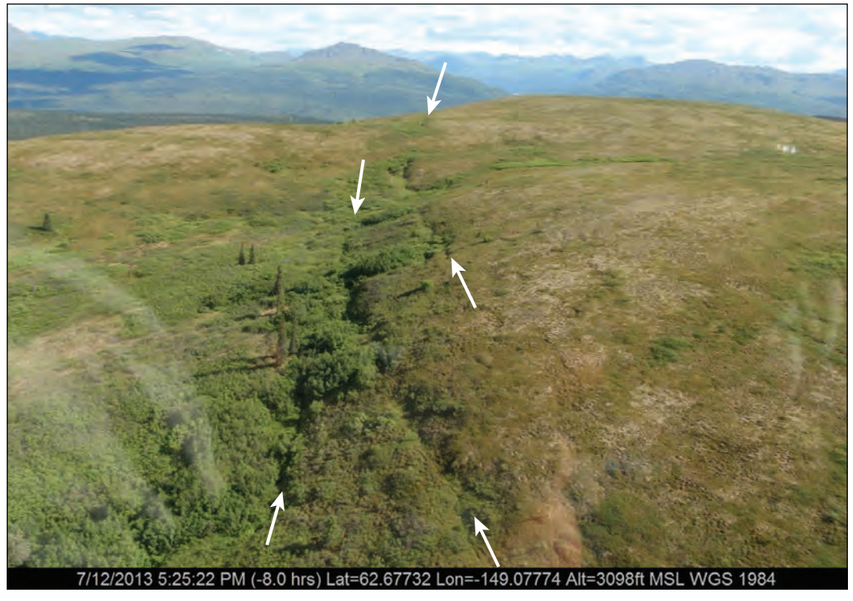
Photograph 5 of 5 with view looking northwest. Note that lineament expression has died out and brackets bound the location of its projection.

F)



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

G)



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

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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.

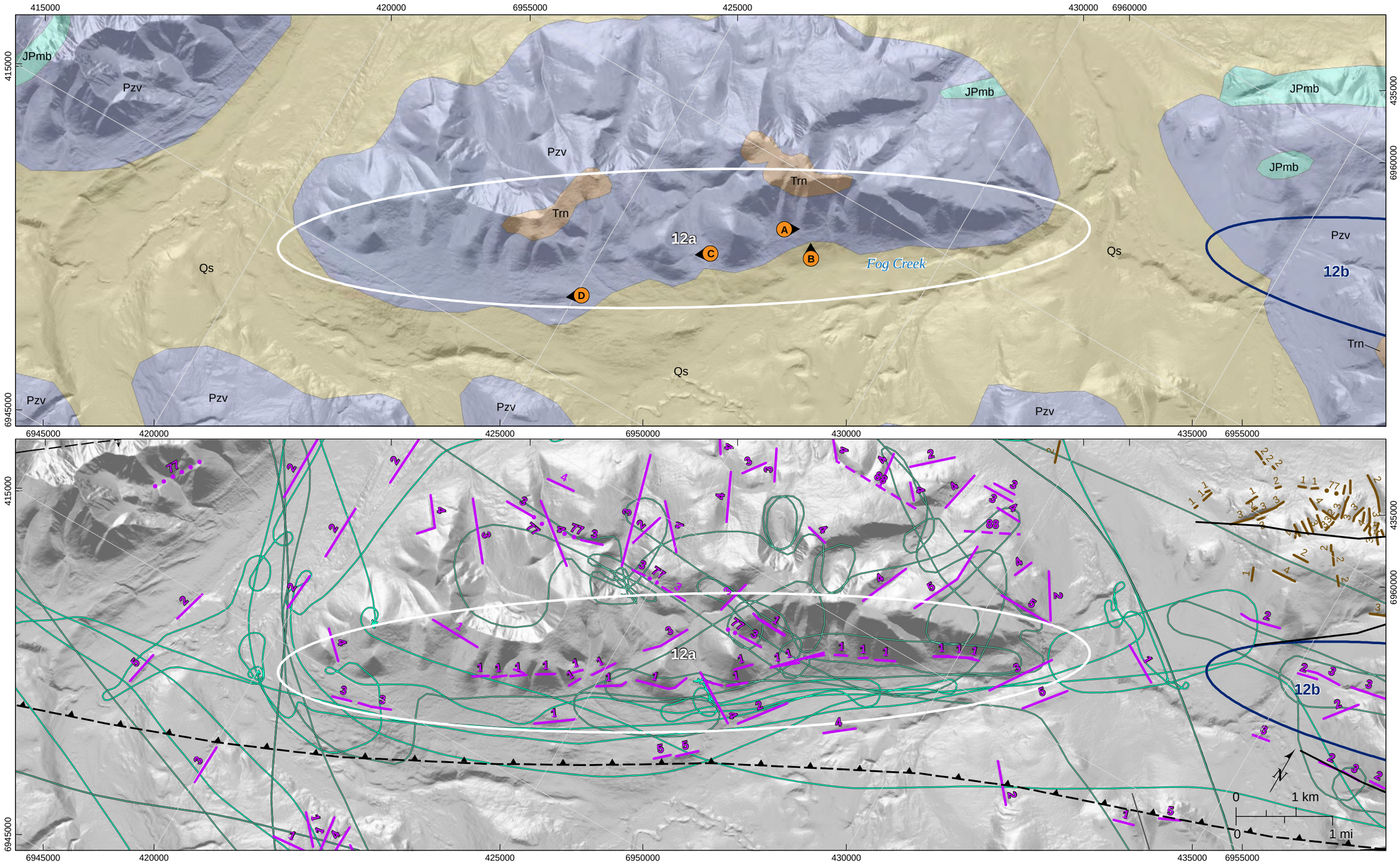
J)



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

TUGRO Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 9 PHOTOGRAPHS	FIGURE A9-2.4

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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.

FUGRO Date 10/18/13	STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY	SUSITNA-WATANA HYDROELECTRIC PROJECT LINEAMENT GROUP 12a MAP DATA	FIGURE A12a.1

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