1 Table S1. Summary of FDL catchment size, and rock types and strengths. FDLs are listed

2 from the north to the south. For uniaxial compressive strength, corresponding sample

3 numbers shown in Figure S2 are in parentheses.

FDL ID	Catchment area (x10^3 m^2)	Rock Units	Uniaxial Compressive Strength, σ_c (MPa)
FDL-11	255	Dbp, Dbcp, Ds	52.8, 40.3 (106, 107)
FDL-7	742	Dwpg, Dsk, Dsc	26.2, 60.7 (102, 103)
FDL-B	121	SЄpm	77.3 (113)
FDL-A	801	SЄpm, Dcsp, Єgms	50.4 (112)
FDL-C	223	Dcsp, Єgms	---
FDL-D	605	Op, Dim, Dls, Dsp	34.3, 32.9, 15.2, 20.6, 45.8 (116, 117, 119, 121, 122)
FDL-5	346	Obpm, Dbcp	14.0 (111)
FDL-4	220	Obpm, Dbcp	34.6, 26.3 (108, 109)

1   Table S2. Rock units within the FDL catchments. '§' indicates descriptions abbreviated from

2   Spangler and Hubbard (in review); '*' indicates descriptions from Dillon et al. (1988)

Map Unit Symbol	Description
Dbp	§ Platy, brown to black phyllite
Dbcp	§ Platy to massive, black to green calcareous metasiltstone to metasandstone
Dsk	* Massive gray marble, dolomite, and carbonate conglomerate with minor politic, quartzose, and volcanic interlayers; contains fossils
Dsc	* Chlorite quartzite sandstone, conglomerate, and siltstone, limestone, and green and gray phyllite
Dwpg	* Tuffaceous purple and green phyllite and quartzite
Ds	§ Predominantly gray and black slate; subordinate phyllite
Dls	§ Platy to massive, dark gray to brown limestone with intermittent thin, platy black phyllite
Dsp	§ Predominantly dark gray to black and brown slate and phyllite, subordinate interbedded graphitic phyllite and thin limestone
Dcsp	§ Predominantly interbedded platy, purple and green-blue chloritic schist and phyllite, subordinate black to gray phyllite
Dim	§ Platy to massive, green to dark gray and black igneous and metamorphic calcium-rich rocks
SЄpm	§ Predominantly interbedded, platy, brown to dark gray-black phyllite, metasiltstone, metasandstone and greywacke, subordinate shale
Obpm	* Black, carbonaceous phyllite and crinoidal metalimestone
Op	§ Platy, black to gray phyllite
Єgms	§ Interbedded platy to massive, dark gray-brown to green greywacke, metasandstone and metasiltstone

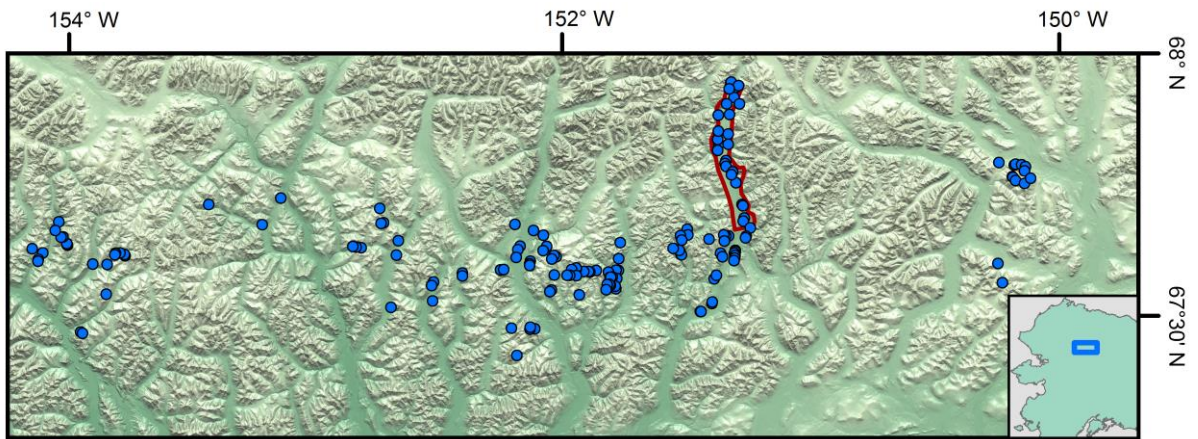
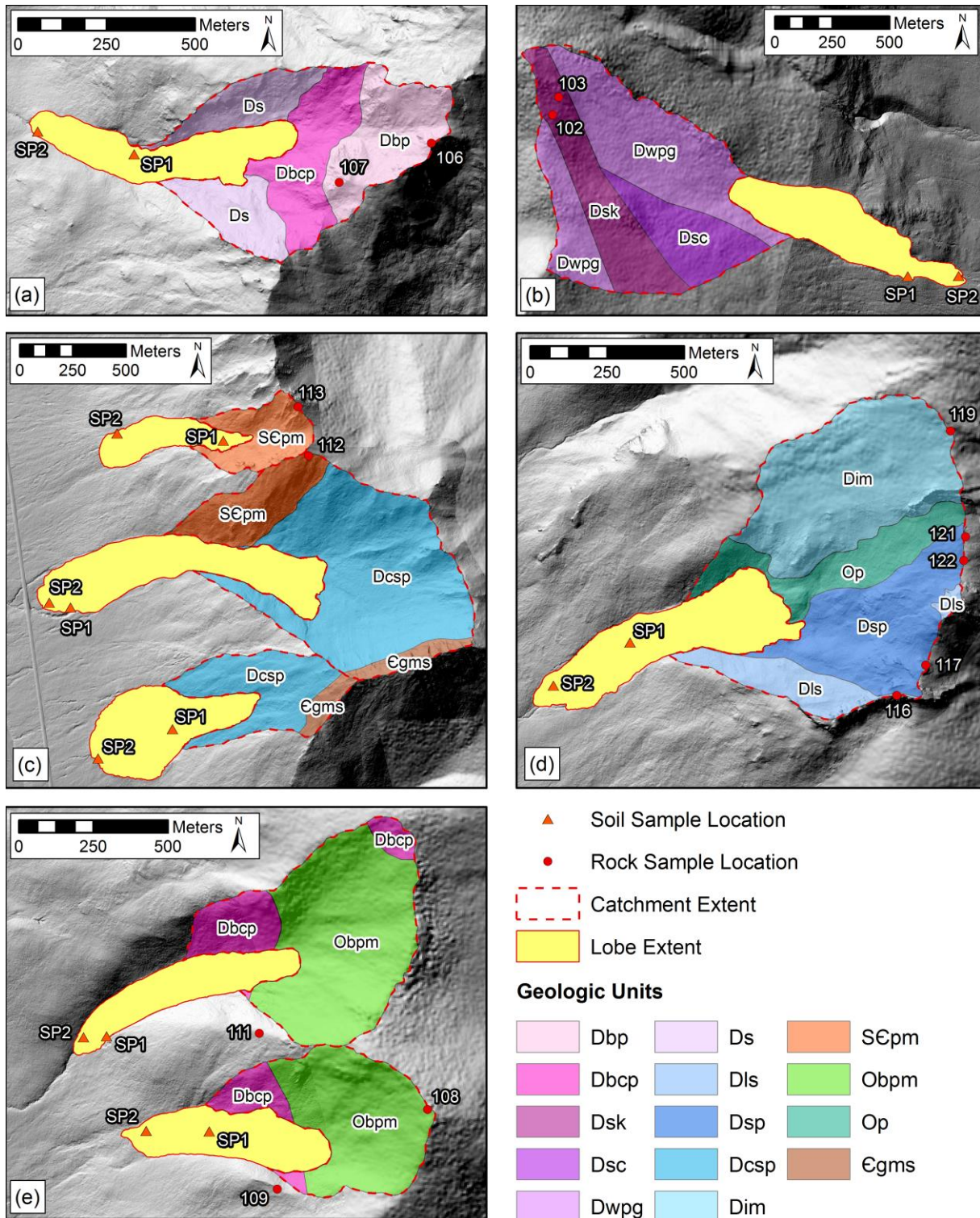
Table S3. Summary of FDL lobe and soil properties, and movement rates. FDLs are listed from the north to the south. USCS classifications

are provided for soil types. For gravimetric moisture content (w) and organic content (Org), the averages from four samples tested are

presented. Rates and distances are calculated from August measurements.

FDL ID	Lobe area ($\times 10^3$ m^2)	Typical length (m)	Typical width (m)	Soil Type	w (%)	Org (%)	2013-2014 Rate (m yr^{-1})	2014-2015 Rate (m yr^{-1})	2015 Distance to Dalton Highway (m)
FDL-11	83	792	117	GM, SM	17.0	4.8	0.2	0.2	233.0
FDL-7	188	1109	173	GM, SM	9.2	1.4	8.6	11.2	N/A
FDL-B	89	743	157	SM	14.9	2.2	1.6	2.0	425.6
FDL-A	286	1378	241	SM	14.9	2.2	4.6	5.2	39.2
FDL-C	210	845	398	GM, ML	28.4	4.5	0.9	0.9	200.4
FDL-D	144	881	174	SM	23.2	6.2	14.5	13.3	414.7
FDL-5	93	830	120	SM, SP-SM	41.2	7.6	1.9	2.4	973.7
FDL-4	100	707	159	GM, SM	25.1	5.0	1.0	1.2	1049.2

1   Table S4. FDL average movement rates calculated between data years. The beginning data
2   year was 1955. All rates are in m yr^{-1}. The '---' indicates lack of data for that lobe (see Table
3   1 for imagery limitations).

Year	FDL-11	FDL-7	FDL-B	FDL-A	FDL-C	FDL-D	FDL-5	FDL-4
1970	5.9	1.6	0.2	1.9	4.2	1.2	1.2	1.8
1978	9.4	3.0	2.3	2.2	1.6	0.5	---	---
1979	6.3	5.5	3.9	---	---	---	---	---
1981	---	---	---	---	---	2.1	0.0	0.1
1993	5.6	9.5	3.6	3.8	0.3	1.9	1.5	2.9
2007	---	6.3	3.4	---	---	---	---	---
2009	---	13.6	5.4	4.4	0.5	10.3	1.8	2.4
2011	0.1	8.4	1.8	4.2	0.0	32.1	7.7	5.0
2014	0.0	12.2	3.9	3.9	1.1	30.1	5.6	0.0

2 Figure S1. Location of identified FDLs (blue dots) based on analysis of available high-
3 resolution satellite imagery. The AOI for this project is indicated by the red polygon, and the
4 inset displays the location of the FDLs within the State of Alaska. Base map data from GINA
5 (2015) and ASGDC (2014).

2 Figure S2. Frozen debris lobe and catchment extents, including catchment geology, and rock

3 and soil sample locations. From north to south: (a) FDL-11; (b) FDL-7; (c) FDL-B, FDL-A,

4 FDL-C; (d) FDL-D; (e) FDL-5, FDL-4. Descriptions of rock units are in Table S2.

5 (Geologic unit data from Spangler and Hubbard (in review) and Dillon et al. (1988). Base

6 map data from Hubbard et al. (2011) and GINA (2001).)