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*Supplement of*

## **Frozen debris lobe morphology and movement: an overview of eight dynamic features, southern Brooks Range, Alaska**

**M. M. Darrow et al.**

*Correspondence to:* Margaret M. Darrow (mmdarrow@alaska.edu)

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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 <sup>3</sup> m <sup>2</sup> )	Rock Units	Uniaxial Compressive Strength, $\sigma_c$ (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	SCpm	77.3 (113)
FDL-A	801	SCpm, Dcsp, Egms	50.4 (112)
FDL-C	223	Dcsp, Egms	---
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)

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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
Dhcp	§ Platy to massive, black to green calcareous metasiltstone to metasandstone
Dsk	* Massive gray marble, dolomite, and carbonate conglomerate with minor polytic, 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
SCpm	§ 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
Egms	§ Interbedded platy to massive, dark gray-brown to green greywacke, metasandstone and metasiltstone

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1 Table S3. Summary of FDL lobe and soil properties, and movement rates. FDLs are listed from the north to the south. USCS classifications  
 2 are provided for soil types. For gravimetric moisture content ( $w$ ) and organic content ( $Org$ ), the averages from four samples tested are  
 3 presented. Rates and distances are calculated from August measurements.

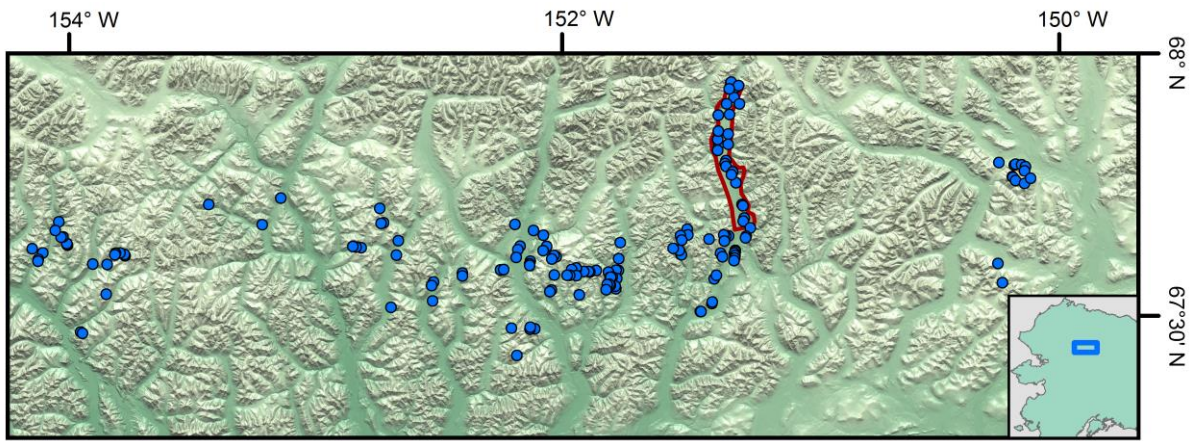
FDL ID	Lobe area ( $\times 10^3 \text{ m}^2$ )	Typical length (m)	Typical width (m)	Soil Type	$w$ (%)	$Org$ (%)	2013-2014 Rate ( $\text{m yr}^{-1}$ )	2014-2015 Rate ( $\text{m yr}^{-1}$ )	2015 Distance to Dalton Highway (m)
FDL-11	83	792	117	GM, SM	17.0	4.8	0.2	0.2	233.0
FDL-7	188	1109	173	GM, SM	9.2	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

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1 Table S4. FDL average movement rates calculated between data years. The beginning data  
 2 year was 1955. All rates are in  $\text{m yr}^{-1}$ . 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

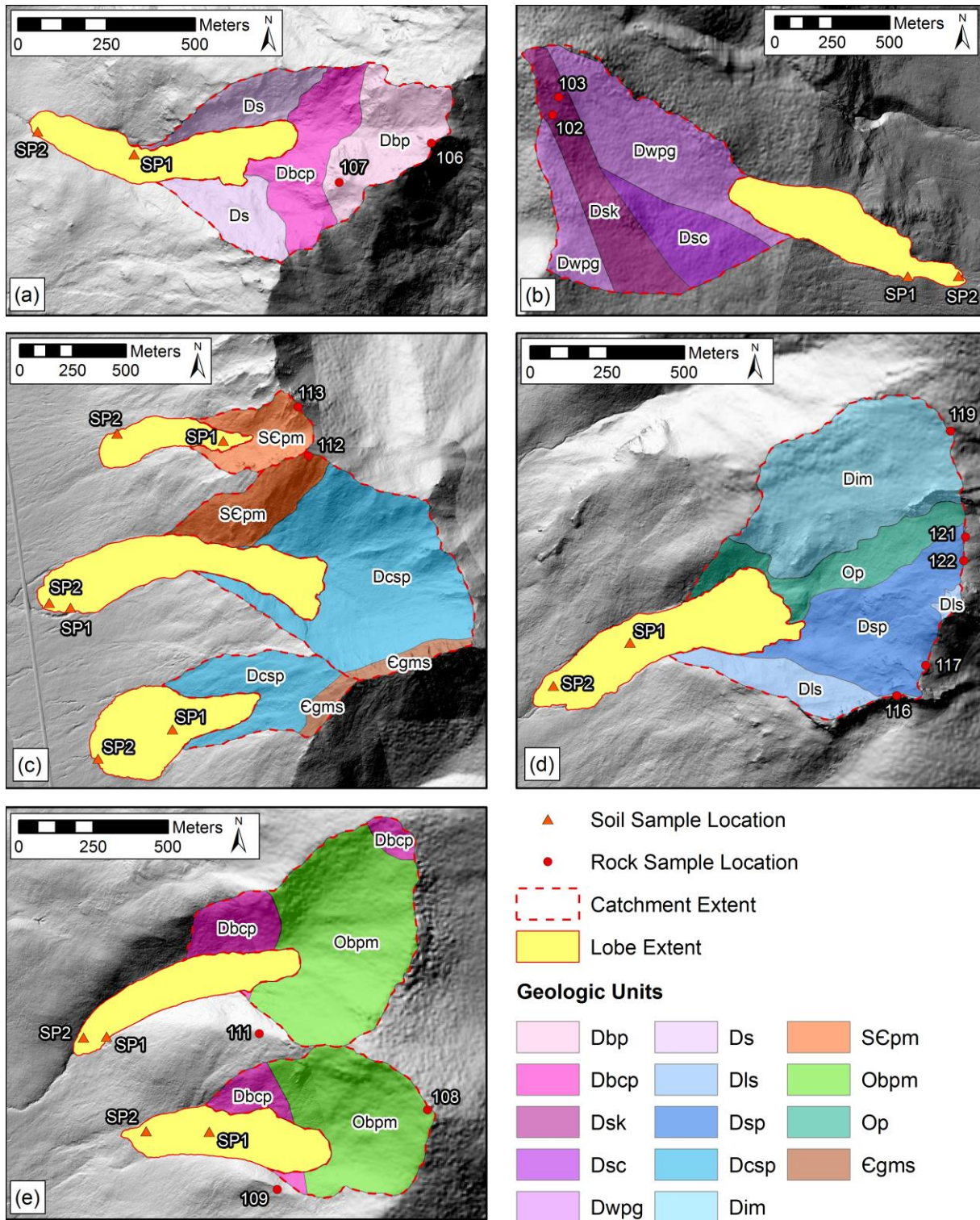
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2 Figure S1. Location of identified FDLs (blue dots) based on analysis of available high-  
3 resolution satellite imagery. The AOI for this project is indicated by the red polygon, and the  
4 inset displays the location of the FDLs within the State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

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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).)