Supplemental Materials: *Bedrock ledges, colluvial wedges, and ridgetop water towers: Characterizing geomorphic and atmospheric controls on the 2023 Wrangell landslide to inform landslide assessment in Southeast Alaska*, USA, by J. Roering, M. Darrow, A. Patton, and A. Jacobs

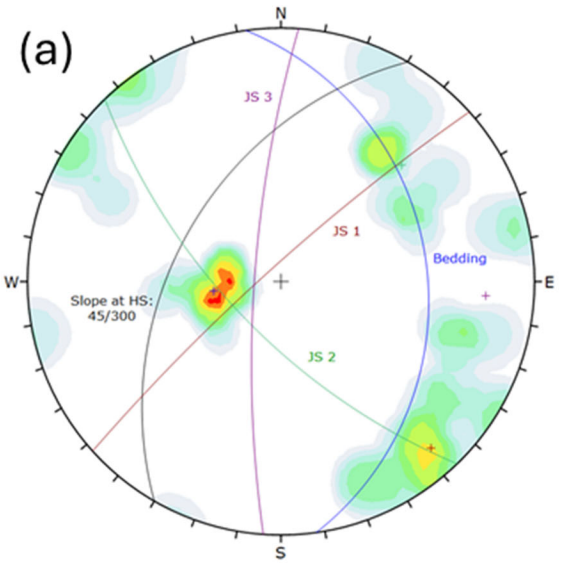
1 Bedrock strength measurements

We collected estimates of intact bedrock strength using two Rock Schmidt Rebound Hammers (N-type and L-type, with impact energies of 2.207 Nm and 0.735 Nm, respectively). We followed ASTM D5873-14 (ASTM 2014), with the exception that we did not use a grinding stone on the *in situ* rock faces (Fig. S1). Figure 8 shows the location of readings taken at the head of the landslide.

Figure S1. Image of Schmidt hammer readings being collected at the head of the MP11.2 landslide.

2 Bedrock structure measurements

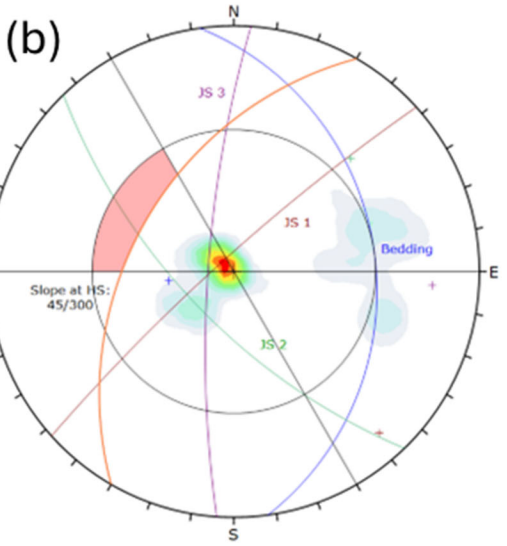
We obtained 35 bedrock and/or joint surface orientation measurements for kinematic analysis. Supplementary Figure S2 contains stereonets illustrating the overall orientations of bedding and three major joint sets, as well as the orientation of the head scarp area. We used 30° lateral limits, and assumed friction angles of 30° for sandstone and 15° for shale (González de Vallejo and Ferrer 2011). The preliminary kinematic analysis indicated that planar and wedge failures had low probability of occurrence. Flexural toppling in the shale, however, resulted in 27.3% of critical intersections, suggesting that this mode of failure is possible.



Color	Density Concentrations
	0.00 - 1.10
	1.10 - 2.20
	2.20 - 3.30
	3.30 - 4.40
	4.40 - 5.50
	5.50 - 6.60
	6.60 - 7.70
	7.70 - 8.80
	8.80 - 9.90
	9.90 - 11.00

Contour Data	Pole Vectors
Maximum Density	10.47%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Plot Mode	Pole Vectors
Vector Count	39 (39 Entries)
Hemisphere	Lower
Projection	Equal Angle



Color	Density Concentrations
	0.00 - 2.60
	2.60 - 5.20
	5.20 - 7.80
	7.80 - 10.40
	10.40 - 13.00
	13.00 - 15.60
	15.60 - 18.20
	18.20 - 20.80
	20.80 - 23.40
	23.40 - 26.00

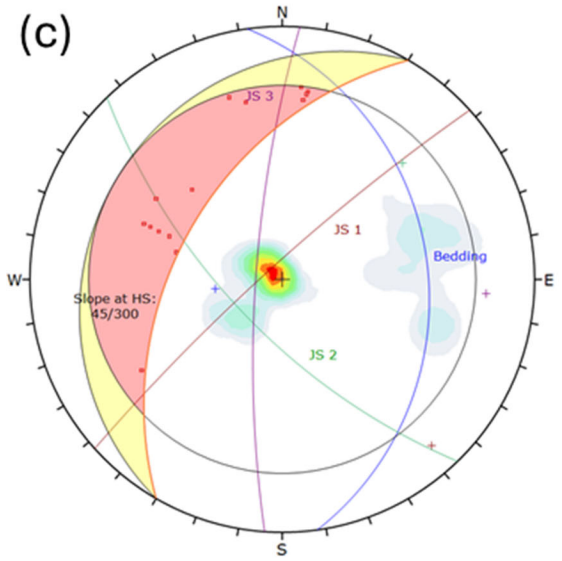
Contour Data	Dip Vectors
Maximum Density	25.21%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	45
Slope Dip Direction	300
Friction Angle	30°
Lateral Limits	30°

	Critical	Total	%
Planar Sliding (All)	0	39	0.00%

Plot Mode	Dip Vectors
Vector Count	39 (39 Entries)
Hemisphere	Lower
Projection	Equal Angle

Symbol	Feature
▪	Critical Intersection



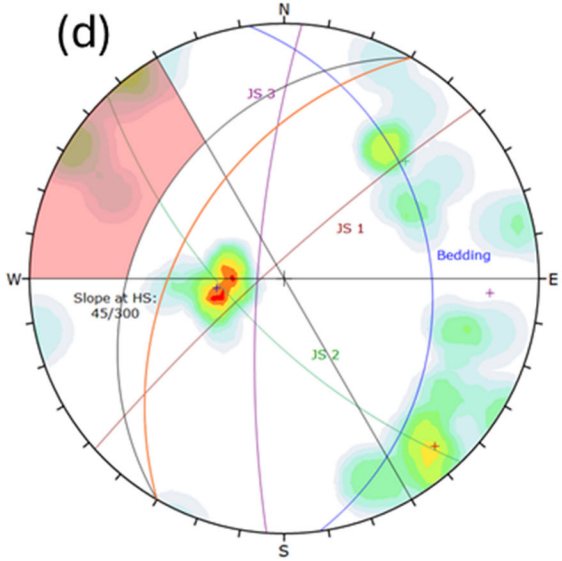
Color	Density Concentrations
	0.00 - 2.60
	2.60 - 5.20
	5.20 - 7.80
	7.80 - 10.40
	10.40 - 13.00
	13.00 - 15.60
	15.60 - 18.20
	18.20 - 20.80
	20.80 - 23.40
	23.40 - 26.00

Contour Data	Dip Vectors
Maximum Density	25.21%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	45
Slope Dip Direction	300
Friction Angle	15°

	Critical	Total	%
Wedge Sliding	14	741	1.89%

Plot Mode	Dip Vectors
Vector Count	39 (39 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	741
Hemisphere	Lower
Projection	Equal Angle



Color	Density Concentrations
	0.00 - 1.10
	1.10 - 2.20
	2.20 - 3.30
	3.30 - 4.40
	4.40 - 5.50
	5.50 - 6.60
	6.60 - 7.70
	7.70 - 8.80
	8.80 - 9.90
	9.90 - 11.00

Contour Data	Pole Vectors
Maximum Density	10.47%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Flexural Toppling
Slope Dip	45
Slope Dip Direction	300
Friction Angle	15°
Lateral Limits	30°

	Critical	Total	%
Flexural Toppling (All)	4	39	10.26%
Flexural Toppling (Set 2: JS 1)	3	11	27.27%

Plot Mode	Pole Vectors
Vector Count	39 (39 Entries)
Hemisphere	Lower
Projection	Equal Angle

Figure S2. Bedrock structure and kinematic analysis. a) MP11.2 landslide bedrock orientation (all orientations in dip/dip direction): slope at the head scarp is 45/300, bedding is 30/82, JS 1 83/318, JS 2 67/226, JS 3 78/274, b) Kinematic analysis of planar sliding failure using a friction angle of 30° for sandstone. The percent of critical intersections is 0%, c) Kinematic analysis of wedge failure using lateral limits of 30° and a friction angle of 15° for shale. The percent of critical intersections is 1.89%, d) Kinematic analysis of flexural toppling using 30° lateral limits and a friction angle of 15° for shale in bedding. The percent of critical intersections is 27.3%. In all cases, estimates of shear strength obtained from González de Vallejo and Ferrer (2011)