DR1. OFFSET MEASUREMENTS OF DISPLACED FEATURES ALONG THE DENALI FAULT AND ERROR CALCULATIONS

The Denali fault trace is marked by a red line in all the photos.

Black and white air photos were taken during August 1973 with an intended scale of 1:12,000. Colored air photos were taken during November 2002 with an intended scale of 1:6000. However, scales differ from photo to photo and within each photo. Scale can be calculated from given offset.

Generally, for each site there are two photos: an air photo on which the correlated features are marked and an oblique photo for a better impression of the site. In the air photo of site DFNM, the shadow of Noyes Mountain hides the site. Therefore, the air photo is not provided. For locations of faults and sampling sites see figure 1 and DR3.

Offset was measured in several ways:

1. Measuring tape. The error expresses the uncertainty in identifying the piercing point. The magnitude of the error is related to the size of the correlated element. For example: in order to correlate a 10 meter wide channel, a ±5 meter offset is attributed to the location of each point. The total uncertainty of ±7 meters which is attributed to the offset measurement is derived from the addition of uncertainties:

$$\sigma_{sum} = \sqrt{\sigma_i^2 + \sigma_j^2} \qquad (1)$$

2. GPS locations. A ±10 meter error is attributed to each measured point to account for the uncertainty in the GPS measurement. Therefore, a total uncertainty of ±14 meter is attributed the offset measurement (see eq. 1 above). Additional error is sometimes added and expresses the uncertainty in identifying the piercing point. The magnitude of the error is related to the size of the correlated element (as explained in 1 above).
3. Accurate determination of the air photo scale in the area of the offset. The error expresses the uncertainty in identifying the piercing point. The magnitude of the error is related to the size of the correlated element (as explained in 1 above).

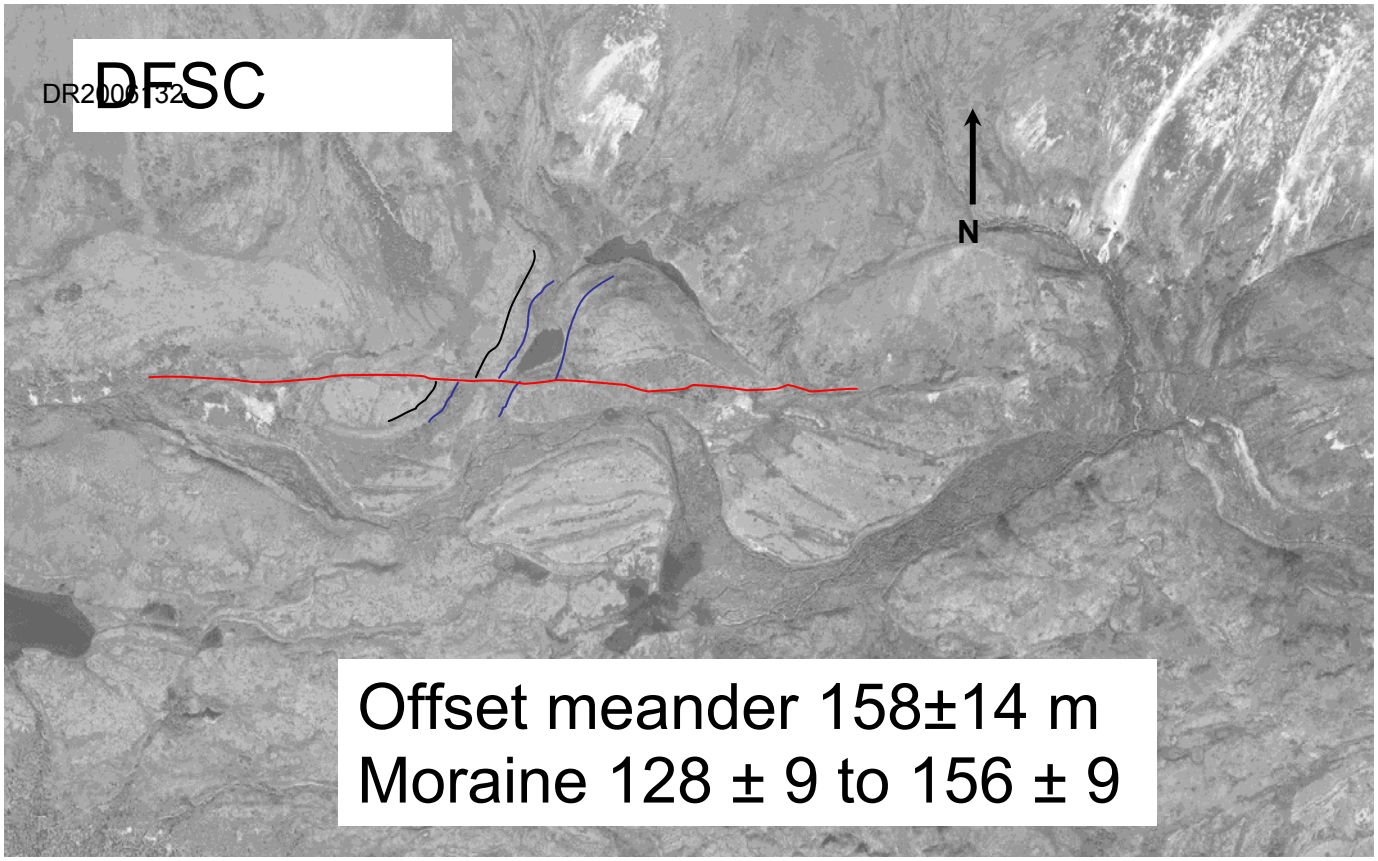
Uncertainties of average ages were calculated using the root mean square approach. This is a useful method for describing the reliability of an average (*Error analysis,* Taylor, 1997):

$$\sigma_{\bar{m}} = \sqrt{\frac{1}{N}\Sigma\sigma_i^2} \qquad (2)$$

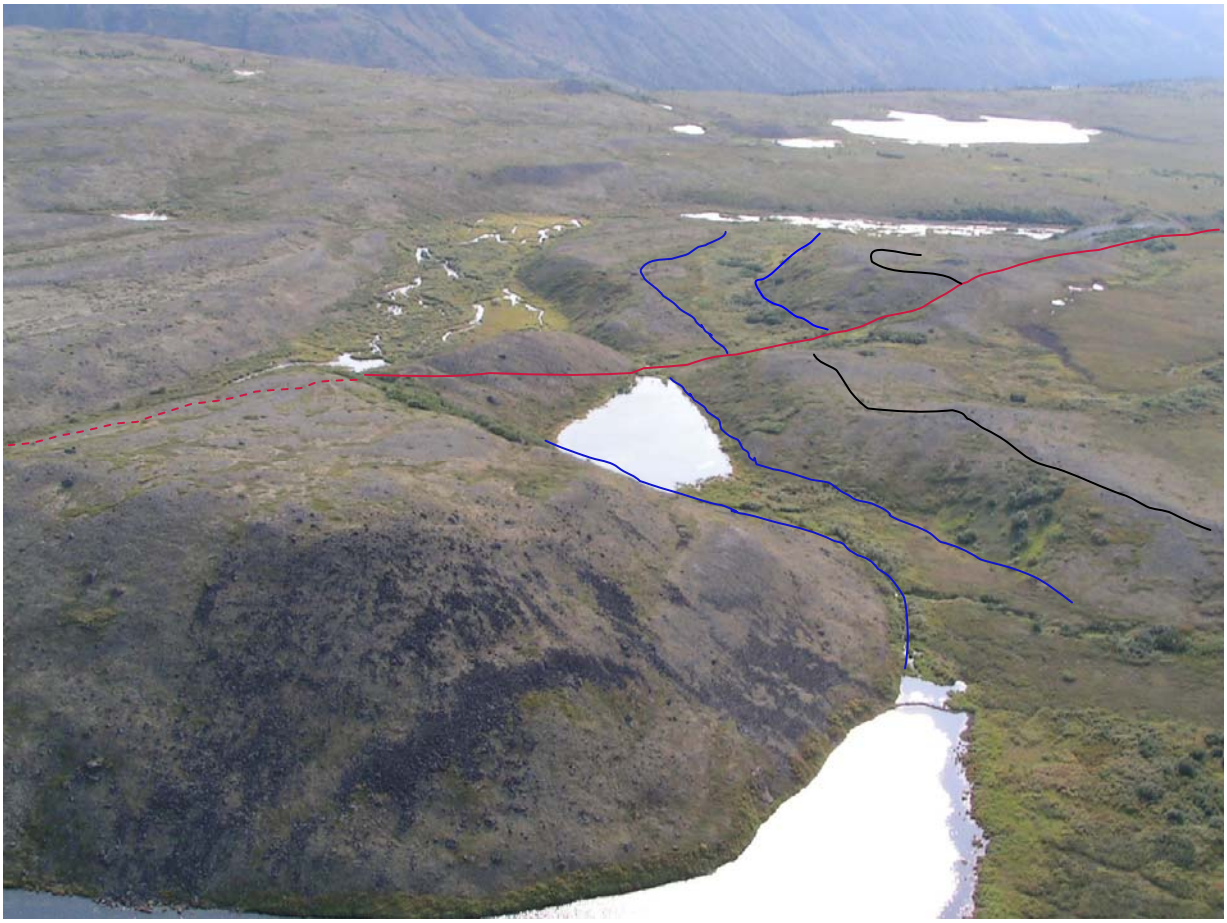
Uncertainties of slip rate were derived from the multiplication of uncertainties:

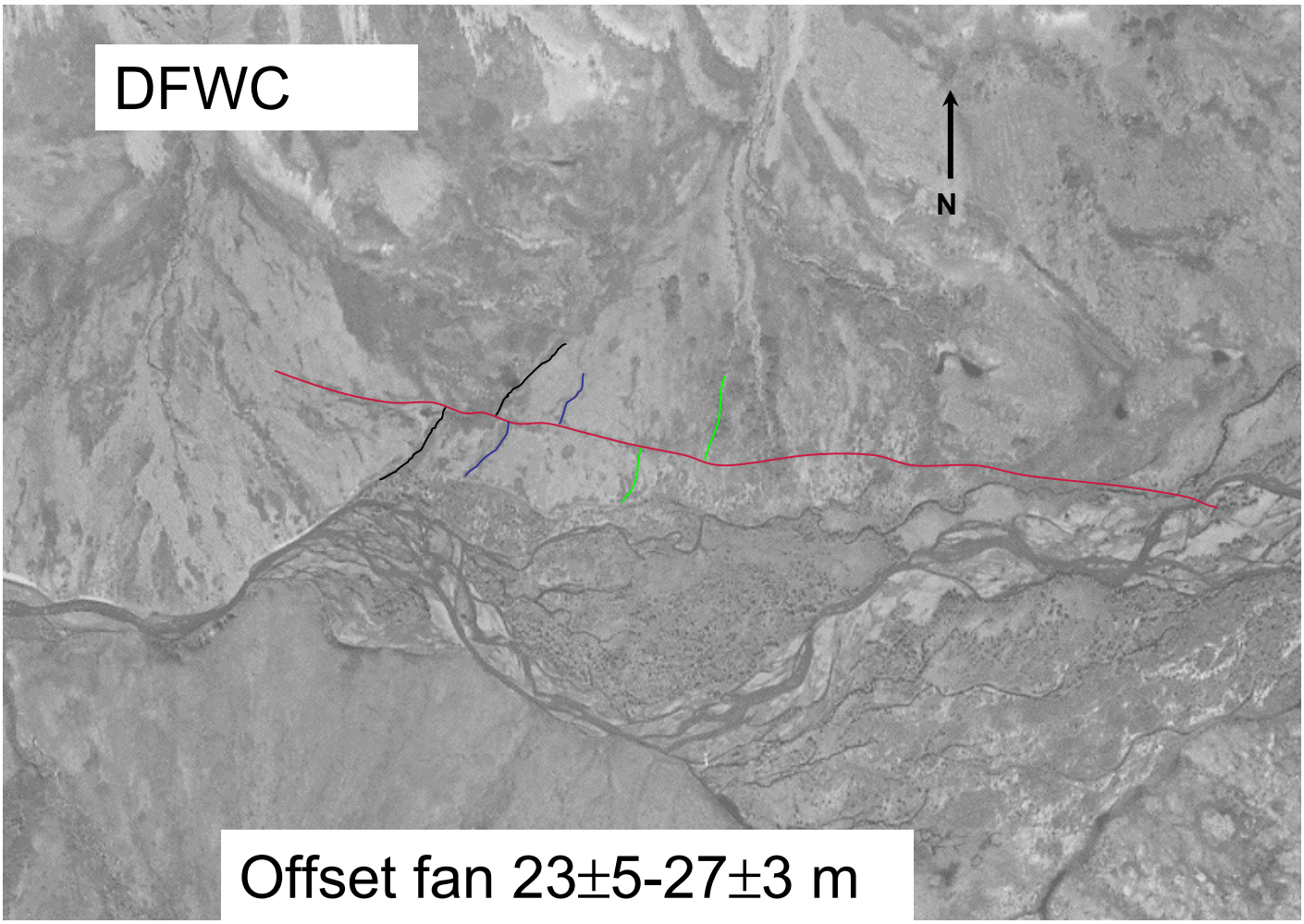
$$\sigma_S = S\sqrt{(\frac{\sigma_{age}}{age})^2 + (\frac{\sigma_{offset}}{offset})^2} \qquad (3)$$

where S is the slip rate.

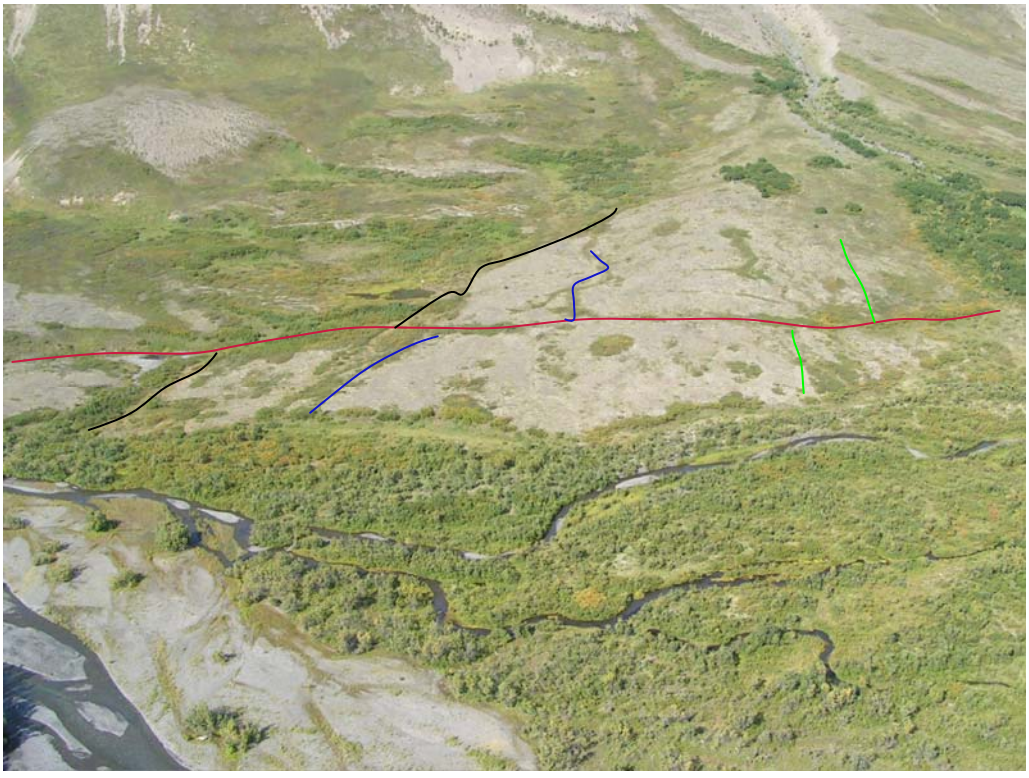


Meander – offset is measured by correlating the meander's banks (blue lines). The error expresses the uncertainty in identifying the exact location of the slope-river valley contact. Moraine – offset is measured by correlating the moraine's crest (black line). The uncertainty in the measurement is expressed both by the range of measured offsets (there were two possibilities of crest identification) and by the uncertainty on the location of each piercing point. Offset was measured both by GPS locations of piercing points and measuring tape.





Alluvial fan – offset is measured by correlating eastern edge of the fan (green line), the western edge of the fan (black line) and a small channel within the fan (blue line). The uncertainty in the measurement is expressed both by the range of measured offsets and by the uncertainty on the location of each piercing point. Offset measurement was done by measuring tape.



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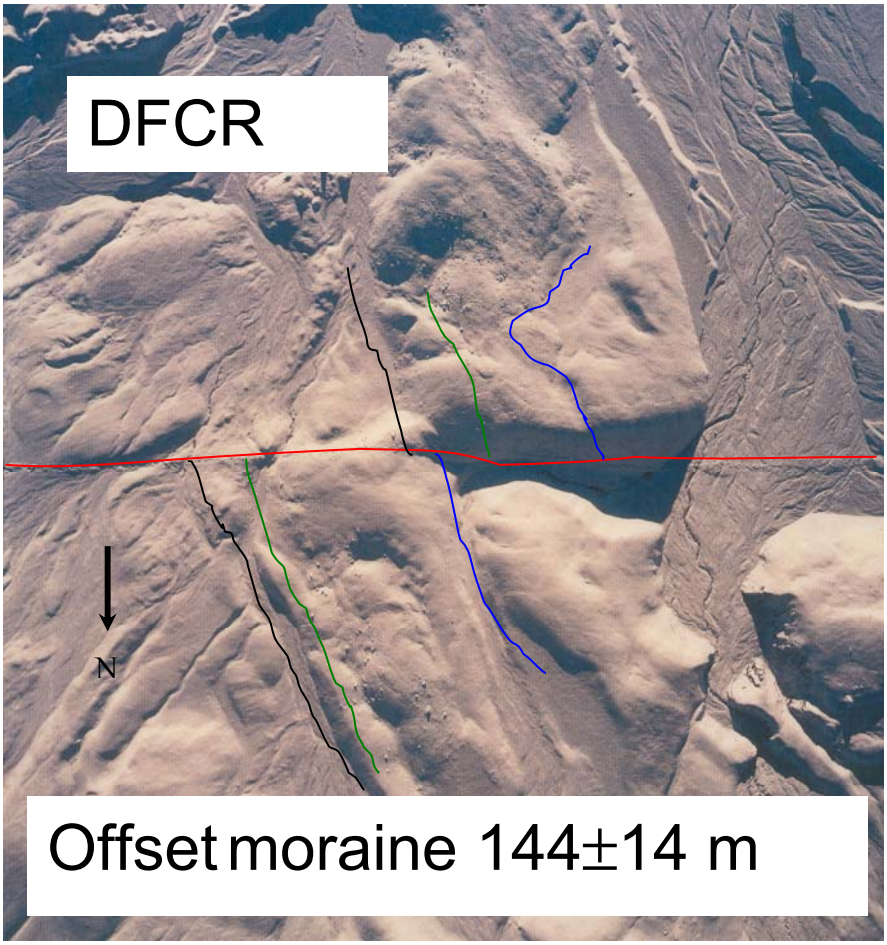
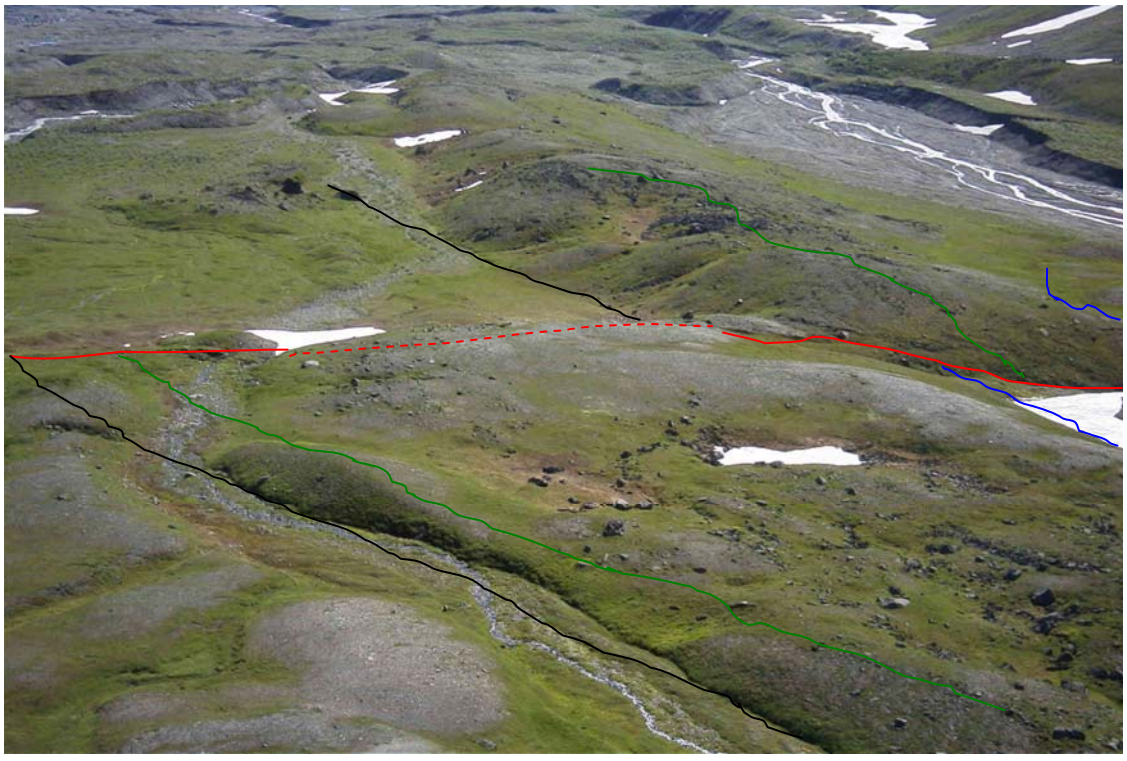


Measurement of offset along this moraine is based on three measured features: a channel flowing within the moraine (blue lines) which is offset 139±7 meters, the eastern moraine crest (green lines) which is offset 135±17 meters, and the eastern moraine boundary (black lines) which is offset 157±14 meters. The similarity in offset of the three measured elements provides confidence in the offset determination. The errors express the uncertainty in determining the exact location of the piercing point. The average offset is 144±14 meters. The red dashed line in the bottom photo indicates the trace of the fault hidden by the moraine. Offsets were measured both by GPS and a measuring tape.



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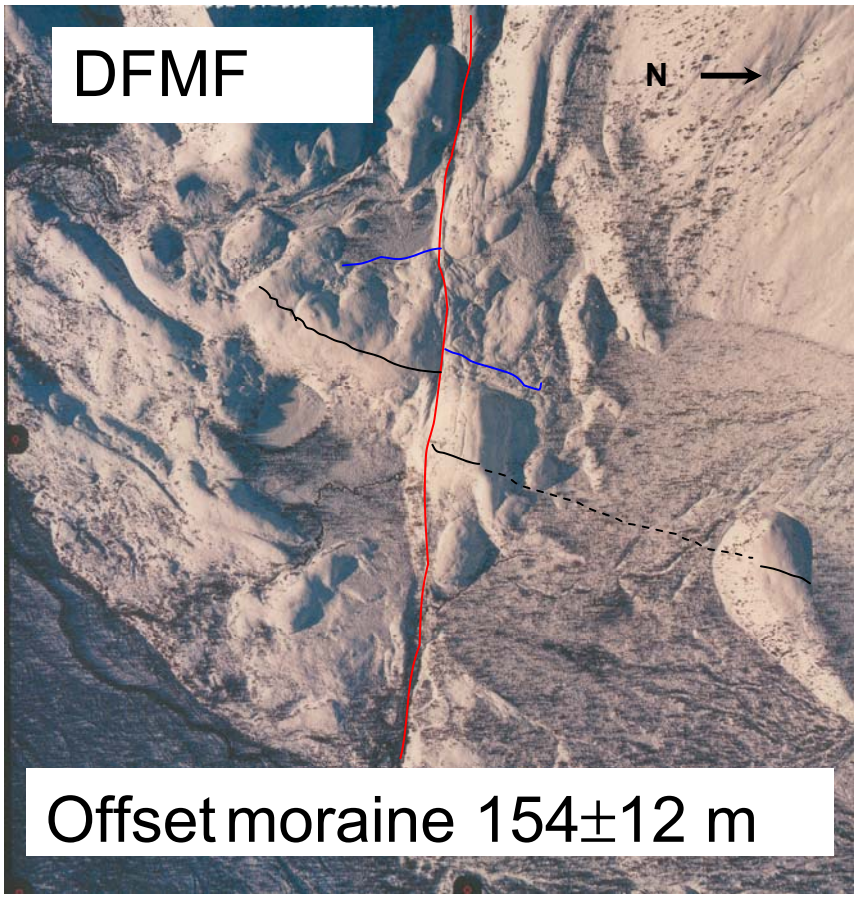
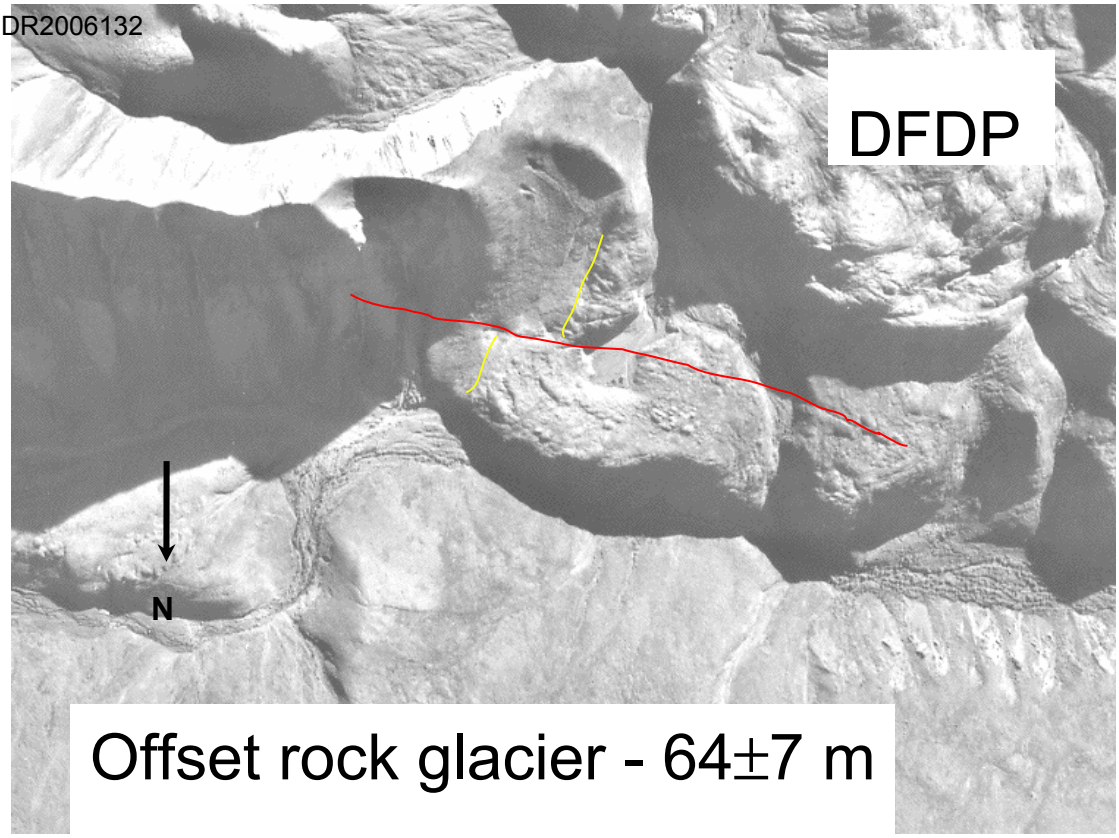
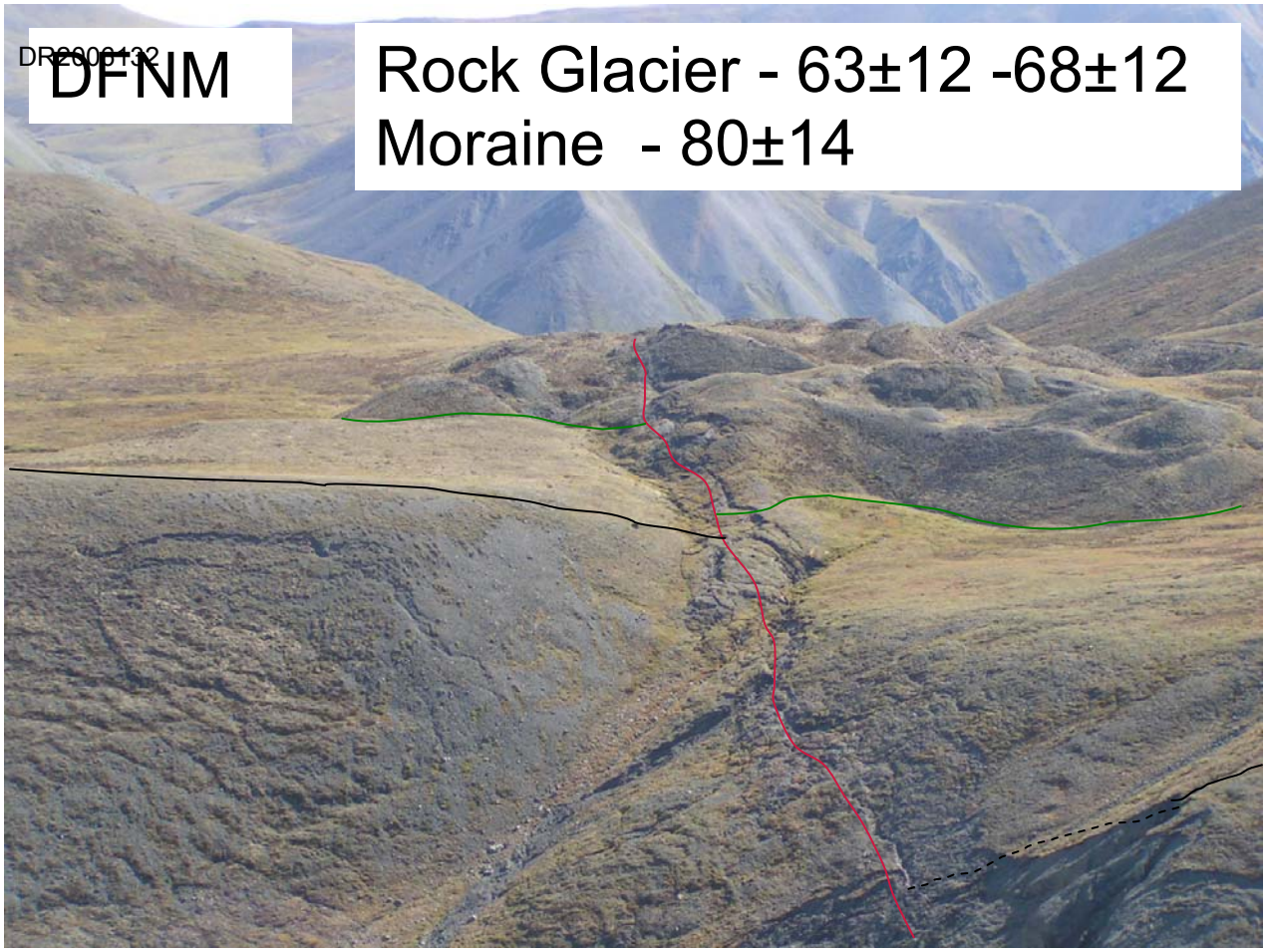


Measurement of offset along this moraine is based on two measured features: a channel flowing along the western edge of the moraine (blue lines) which is offset 171±4 meters, and the moraine crest (black lines) which is offset 136±17 meters. The errors express the uncertainty in determining the exact location of the piercing point. The average offset is 154±12 meters. Dashed black line in upper photo marks the interpolation of the moraine crest where it was washed out by a landslide. Offsets were measured both by GPS and a measuring tape.



Offset was determined by the measured displacement of the eastern boundary (yellow lines) of this inactive rock glacier. Error expresses the uncertainty in determining the piercing point. Offset was measured with a measuring tape.



Two offset features were measured and dated at this site. The offset of the inactive rock glacier (green lines) was measured three times and the measurements range between 63±12 meters and 68±12 meters. The offset was determined by the measured displacement of the western boundary of the rock glacier using GPS locations and a measuring tape. The offset of the moraine (black lines) was determined by the measured displacement of the moraine's crest. The eroded part of the moraine crest is extrapolated and marked with a dashed black line.

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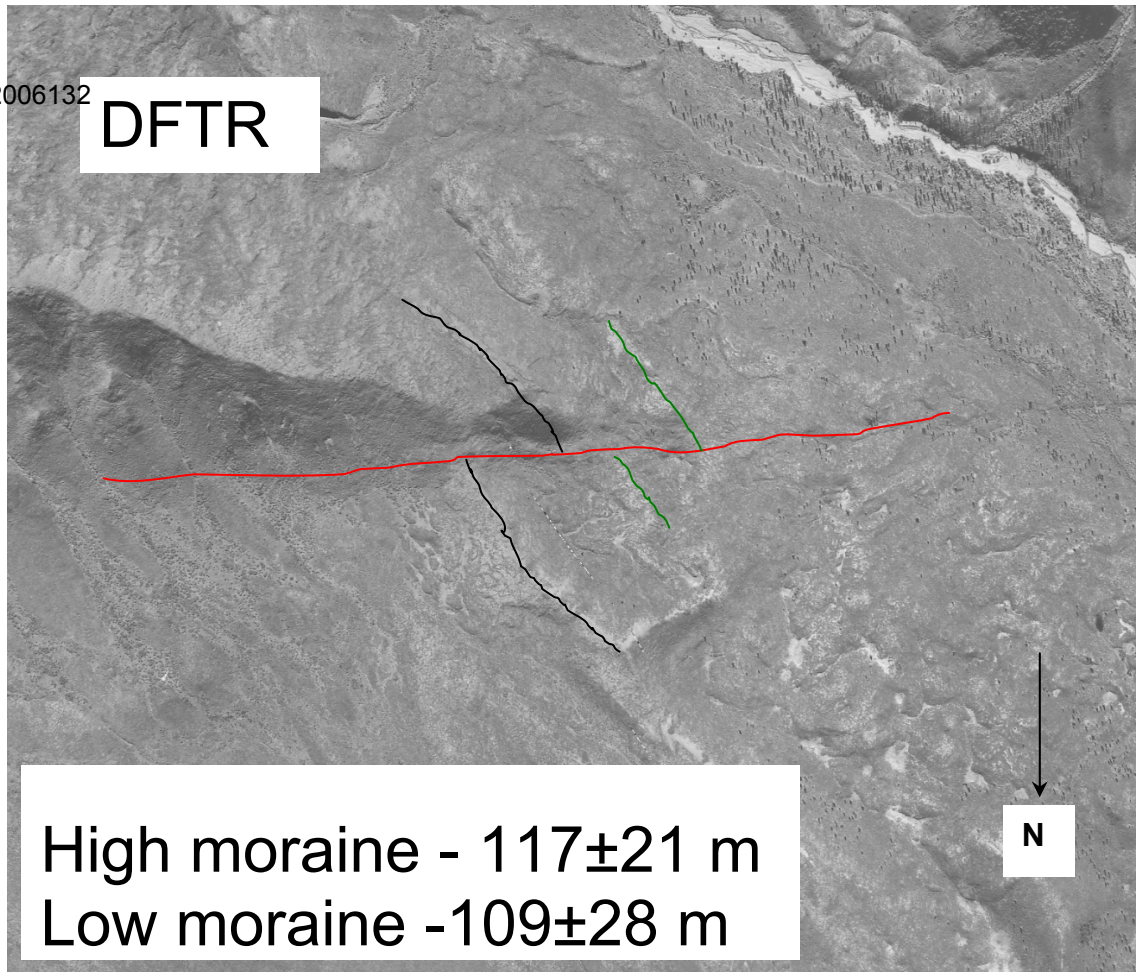
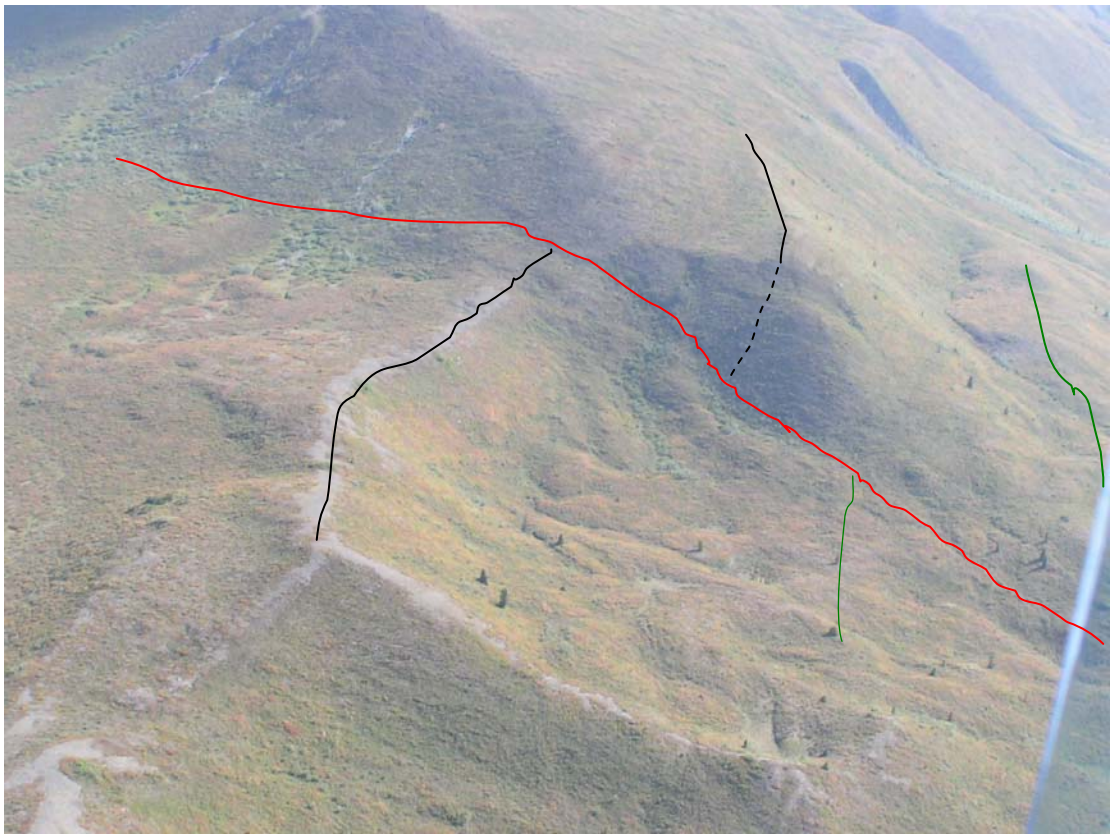


Two offset moraines were measured and dated at this site. The offset of both moraines was determined by the displacement of their crests. South of the fault, the high moraine crest (black lines) is eroded and the large error reflects the uncertainty in extrapolating the crest orientation to the fault trace (dashed line). The crest of the low moraine (green lines) is not well defined and the large error reflects the uncertainty in determining the piercing point. Offset was determined by GPS locations and on the air photo after determining the scale of the air photo in the field.



DR2. SNOW COVER MEASUREMENT STATIONS

Snow cover stations around the Alaska Range considered for snow cover calculations. Data taken from (http://www.ncdc.noaa.gov/oa/climate/stationlocator.html):

Delta Junction
Dry Creek
Healy
Tok
McKinley Park
Big Delta

To evaluate the effect of snow cover on age calculations, measurements for the past 10-50 years were obtained form the above 6 stations located around the study area (http://www.ncdc.noaa.gov/oa/climate/stationlocator.html). At each station, the number of months that have snowfall and the average monthly snow cover were determined.

DR3. SAMPLING SITES AND COSMOGENIC MODEL AGES ALONG THE DENALI FAULT

Name	Elevation (m)	Latitude[§]	Longitude[§]	Measured ^{10}Be (10^5 atoms g^{-1} quartz)	Offset (m)[#]	Age (ky)[**]	
						=0 mm ky^{-1} No snow	=1 mm ky^{-1} Snow cover
DFCR		**63º 12.623**	**144º 49.905**		**144±14**		
*DFCR-1	1369	7011097	06v0609183	2.04±0.04		11.70±1.24	12.80±1.36
*DFCR-2	1367	7010997	06v0609200	1.82±0.06		10.47±1.11	11.45±1.21
*DFCR-3	1352	7010921	06v0609212	2.04±0.07		11.73±1.24	12.84±1.36
*DFCR-4	1328	7010598	06v0608957	1.73±0.03		10.26±1.09	11.21±1.19
*DFCR-5	1326	7010558	06v0608942	1.91±0.06		11.34±1.20	12.40±1.31
*DFCR-6	1318	7010406	06v0608891	1.84±0.06		11.02±1.17	12.05±1.28
*DFCR-7	1336	7010773	06v0609180	1.74±0.03		10.25±1.09	11.20±1.19
DFCR-8	1223	7010673	06v0609024	1.73±0.06		11.18±1.18	12.23±1.30
DFCR-9	1224	7010679	06v0609012	1.72±0.06		11.08±1.17	12.12±1.28
*DFCRSD-1†	1369	7011097	06v0609183	1.89±0.06		10.84±1.15	11.86±1.26
*DFCRSD-2†	1336	7010773	06v0609180	1.85±0.06		10.91±1.16	11.93±1.26
DFMF		**63º 09.246**	**144º 35.411**		**154±12**		
DFMF-1	1173	7004851	06v0621381	1.96±0.06		13.16±1.39	14.42±1.53
DFMF-2	1170	7004826	06v0621417	1.91±0.06		12.88±1.36	14.11±1.50
DFMF-3	1162	7004596	06v0621048	1.84±0.06		12.39±1.30	13.57±1.43
DFMF-4	1153	7004603	06v0621116	2.09±0.07		14.18±1.49	15.56±1.63
DFMF-5	1165	7004720	06v0621202	1.73±0.06		11.59±1.22	12.68±1.33
DFMFSD-1†	1173	7004851	06v0621381	1.54±0.05		10.35±1.09	11.32±1.19
DFMFSD-2†	1165	7004720	06v0621202	1.62±0.06		10.87±1.14	11.89±1.25
DFSC		**63º 27.777**	**148º 38.888**				
*DFSC1	919	7038189	06v0418067	1.79±0.04	158±14	14.87±1.58	16.32±1.73
*DFSC2	926	7038177	06v0418079	1.94±0.04	158±14	16.04±1.70	17.63±1.87
*DFSC3	927	7038169	06v0418076	1.82±0.06	158±14	15.01±1.59	16.48±1.75
DFSC7	892	7038031	06v0417844	1.88±0.07	128±9-156±9	15.95±1.70	17.53±1.86
DFSC8	886	7037798	06v0417663	1.84±0.06	128±9-156±9	14.95±1.58	16.41±1.74
DFWC		**63º 29.382**	**148º 05.064**		**23±5-28±3**		
DFWC-1	1030	7040410	06v0445993	0.28±0.02		2.10±0.22	2.28±0.24
DFWC-2	1010	7040322	06v0445954	0.31±0.03		2.38±0.35	2.58±0.27
DFNM		**62º 37.132**	**143º 01.905**				
DFNM-1†	1618	6944570	07v0395755	2.13±0.07	80±14	10.06±1.06	10.99±1.16
DFNM-2†	1621	6944581	07v0395736	2.43±0.11	80±14	11.52±1.27	12.60±1.34
DFNM-1R	1618	6944570	07v0395755	2.57±0.08	80±14	12.18±1.28	13.34±1.41
DFNM-RG†	1612	6944523	07v0395738	1.96±0.06	63±12-68±12	9.25±0.97	10.10±1.07
DFDP		**62º 40.457**	**143º 09.359**		**64±7**		
DFDP-1†	1441	6950943	07v0389590	1.89±0.08		10.23±1.11	11.18±1.19
DFDP-2	1430	6950970	07v0389621	1.46±0.05		7.97±0.84	8.69±0.92
DFDP-3†	1424	6950922	07v0389737	2.56±0.09		14.09±1.49	15.45±1.64
DFDP-4	1441	6950943	07v0389590	2.26±0.09		12.27±1.30	13.43±1.42
DFTR		**62º 40.515**	**142º 48.401**				
DFTR-6†	1261	6950513	07v0407476	2.08±0.09	117±21	13.04±1.43	14.29±1.51
DFTR-7	1261	6950513	07v0407476	2.29±0.07	117±21	14.32±1.52	15.71±1.67
DFTR-8†	1302	6950003	07v0407355	2.65±0.08	117±21	16.05±1.69	17.64±1.87
DFTR-9	1203	6950169	07v0407107	1.40±0.05	109±28	9.20±0.98	10.04±1.06
DFTR-10†	1203	6950169	07v0407107	1.65±0.07	109±28	10.81±1.17	11.82±1.25
DFTR-11†	1201	6950570	07v0407225	2.00±0.07	109±28	13.15±1.40	14.42±1.53
DFTR-12	1201	6950570	07v0407225	1.51±0.05	109±28	9.89±1.05	10.80±1.15

*Locations taken using NAD 83. All other locations were taken using NAD 27 Alaska

† Amalgamation of hundreds of small clasts (~1 cm) from the surface around the sampled boulders. Boulder sample thickness did not exceed 5 cm.

[§]Latitude/longitude (bold) given for central location of site. UTM location (plain) given for each individual sample.

[#]Single (bold) offset is given when only one offset feature is measured at the site. When multiple offset features are measured at the site, offsets are given in plain writing with samples.

[**]Ages calculated using a ^{10}Be sea-level and high-latitude production of 5.31 atoms g^{-1} quartz yr^{-1}(Schaller et al., 2001). 2.6% of production at sea-level and high latitude is by muons. Latitude/ Elevation scaling was done using Lal (1991) for neutrons and Granger and Smith (2000) for muons. Ages with snow cover assume 1 meter of snow over 8 months. (rock) = 2.7 gr cm^3. (snow) = 0.2 gr cm^3.

References

Granger, D.E., & Smith, A.L. Dating buried sediments using radioactive decay and muogenic production of ^{26}Al and ^{10}Be: *Nuclear Instruments and Methods in Physics Research*, **172**, 822-826 (2000).

Lal, D. Cosmic ray labeling of erosion surfaces: *In situ* production rates and erosion models: *Earth and Planetary Science Letters*, **104**, 424-439 (1991).

Schaller, M., von Blanckenberg, F., Hovius, N., and Kubik, P.W., 2001, Large-scale erosion rates from in situ-produced cosmogenic nuclides in European river sediments: Earth and Planetary Science Letters, v. 188, p. 441-458.