DATA REPOSITORY: The thermochronological record of tectonic and surface process interaction at the Yakutat–North American collision zone in southeast Alaska

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New Thermochronological Data

METHODS

U-Th/He analysis

Rock samples were crushed, sieved and washed to extract a grain size that ranges from 60 to 250 µm. Apatite and zircons were separated using standard magnetic and heavyliquid separation techniques. Clear crystals without inclusions, cracks, or other defects were selected under a binocular microscope at nominal magnification of 100x. Grain diameters range from 80 to 150 µm for apatite, and 75 to 125 µm for zircons. Aliquots of multiple apatite grains and single zircon grains were analyzed for ^{4}He in the noble gas laboratory at Lehigh University. Apatite and zircon grains were heated in a resistance furnace at 1100°C for 15 minutes and 1350°C for 60 minutes, respectively, and analyzed for ^{4}He by isotope dilution utilizing a ^{3}He spike and quadrupole mass spectrometry. After helium analysis, the samples were sent to the University of Arizona at Tucson for uranium, thorium, and samarium measurements using isotope-dilution ICP-MS. The analytical error of isotope measurements using mass spectrometry is small (1–2 %). Because intra-sample error (analytical reproducibility) is much larger than the analytical error, the error reported for each sample reflects that of the error in sample replication. The errors in Table 1 are calculated as the simple standard deviation of the sample age population. Analytical details of individual samples are presented in the data repository (Tables DR1 and DR2).

$^{40}Ar/^{39}Ar$ analysis

Potassium feldspar was separated from two coarse-grained granitic rocks of the Wrangellia composite terrane. After crushing we handpicked 8-22 mg of pure K-feldspar grains under the binocular microscope and packed them in pure copper foil for neutron irradiation at the McMaster reactor. Argon analysis was carried out in the noble-gas laboratory at Lehigh University. The argon gas was extracted by stepwise heating of the sample packages using a double-vacuum resistance furnace. Each sample was heated in 58 steps ranging from 400 to 1500 °C, and varying durations of 15 minutes to 2 hours. Isotope ratios were measured with a VG 3600 noble-gas mass spectrometer using an electron-multiplier detector. Standard step-heating analytical data are given in Table DR4.

Figure DR1 shows the age spectra for samples EUT-35 and EUT-2 as well as the results from inverse modeling of the age spectra for thermal history, using kinetics and domain structures derived from each sample's ^{39}Ar release during stepheating analysis (Table DR5). Modeling of the sample's gas release indicates the presence of several diffusion domains that have slow-cooling closure temperatures ranging from 165 to 290˚C (EUT-2) or 210 to 335˚C (EUT-35). Despite small discordance overall the age spectra are flat and indicate that relatively fast cooling through this temperature range occurred at about 130 Ma. The age spectra for both samples are remarkably free from any excess argon expressed early in gas release as is typical for most samples, and the earliest gas released gives ages as young as about 50 to 60 Ma (this age is hard to resolve any better given the uncertainties in the small gas fractions and the aymptotic approach of the age spectrum to the age axis>

This qualitative conclusion is supported by inverse modeling using the Arvert 4 code (Harrison et al., 2005; Zeitler, 2004). The inversions, which use a controlled-random-search algorithm and which permit reheating as well as cooling, are dominated by monotonic cooling with closure for most domains in the interval about 130 to 140 Ma (EUT-2) or about 125 Ma (EUT-35), at rates of ~20 ˚C/.y. (EUT-2) or possibly much more (EUT-35) (the slightly discordant nature of the age spectra preclude a more definitive statement about rate). The combination of this early closure to temperatures below about 200 ˚C, plus the later closure of the least retentive domains, suggest that the samples remained warm with little movement towards the surface for many tens of million years after initial rapid cooling.

Detrital zircon FT analysis

Detrital zircons were separated from sand samples of the Chitina and Copper River using standard magnetic and heavy liquid techniques. Zircon fission track dating has been carried in the same procedure as for the other detrital samples of southeast Alaska published in Enkelmann et al., (2008, 2009). For each sample we dated more than 100 single grains. Grain-age distributions were deconvolved into component age populations using binomial peak-fitting (table 2; Galbraith and Green, 1990; Brandon et al., 1992, 1996). Single grain ages are shown in age groups in figure 4 and age populations in figure 10.

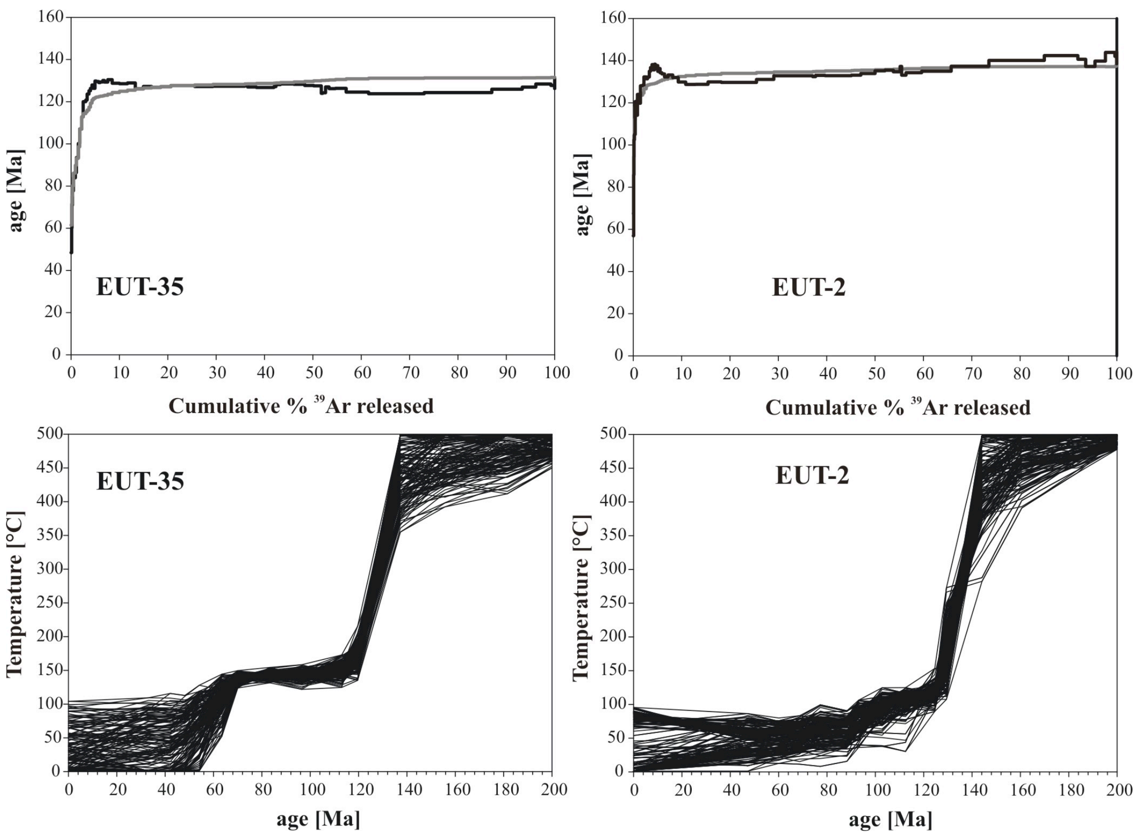

Figure DR1: Results of potassium-feldspar $^{40}Ar/^{39}Ar$ analysis, samples EUT-35 and EUT-2. Top panel: measured age spectra (dark) and mean of inversion models (gray). Bottom: Plot of thermal histories, showing bundles of 150 thermal histories (all histories converged to an acceptably grouped but not statistical fit (mean percent deviation) of 3.8% or better given the mildly discordant nature of the age spectra. The inversion for EUT-35 permitted only monotonic cooling; for EUT-2 mild reheating of 5˚C/m.y. was permitted.

Table DR1: Bedrock apatite U-Th/He dating.

Sample	4-He [mol]	238-U [mol]	235-U [mol]	232-Th [mol]	147-Sm [mol]	F_t-factor	Uncor. Age [Ma]	Corr. Age [Ma]	Mean ± stdev.
6EUT 1	2.763E-15	3.981E-13	2.945E-15	5.003E-13	5.838E-12	0.742	3.95	5.32	
6EUT 1	4.316E-15	6.039E-13	4.467E-15	9.842E-13	8.928E-12	0.781	3.83	4.90	
6EUT 1	2.296E-15	5.370E-13	3.972E-15	7.139E-13	6.294E-12	0.73	2.43	3.33	**4.5±1**
6EUT 2	3.182E-14	1.175E-12	8.687E-15	3.267E-12	3.032E-11	0.728	11.89	16.33	
6EUT 2	2.658E-14	1.119E-12	8.280E-15	3.600E-12	2.487E-11	0.72	9.96	13.84	
6EUT 2	1.942E-14	1.363E-12	1.008E-14	3.872E-12	3.334E-11	0.71	6.23	8.77	
6EUT 2	4.390E-14	2.402E-12	1.776E-14	7.276E-12	5.548E-11	0.771	7.83	10.16	
6EUT 2	3.529E-14	1.840E-12	1.361E-14	5.058E-12	4.323E-11	0.754	8.51	11.29	**12.1±3**
6EUT 3	1.028E-13	4.067E-12	3.008E-14	1.152E-11	1.015E-10	0.779	11.04	14.17	
6EUT 3	1.155E-13	2.447E-12	1.810E-14	7.180E-12	6.443E-11	0.778	20.27	26.05	
6EUT 3	2.463E-14	1.240E-12	9.174E-15	3.603E-12	3.216E-11	0.706	8.58	12.15	
6EUT 3	1.482E-13	2.243E-12	1.659E-14	5.764E-12	6.088E-11	0.723	29.66	41.02	

6EUT 4	1.973E-14	2.452E-12	1.813E-14	6.410E-12	6.416E-11	0.758	3.61	4.76	
6EUT 4	2.699E-14	2.843E-12	2.103E-14	7.254E-12	8.480E-11	0.77	4.24	5.51	
6EUT 4	2.992E-14	5.247E-12	3.881E-14	1.544E-11	1.119E-10	0.777	2.48	3.20	
6EUT 4	1.500E-14	1.941E-12	1.436E-14	5.286E-12	5.089E-11	0.717	3.41	4.76	**4.6±1**
6EUT 5	4.154E-15	4.153E-13	3.072E-15	6.902E-13	2.672E-11	0.779	4.54	5.83	
6EUT 5	5.109E-15	4.540E-13	3.358E-15	9.042E-13	2.944E-11	0.773	4.89	6.33	
6EUT 5	2.472E-15	3.038E-13	2.247E-15	7.037E-13	2.107E-11	0.716	3.35	4.68	
6EUT 5	3.418E-15	3.179E-13	2.351E-15	6.497E-13	1.957E-11	0.762	4.68	6.15	**5.8±0.7**
6EUT 9	9.284E-15	6.637E-13	4.909E-15	2.157E-12	2.268E-11	0.788	5.66	7.18	
6EUT 9	1.466E-14	8.338E-13	6.167E-15	3.571E-12	2.608E-11	0.807	6.38	7.91	
6EUT 9	1.890E-14	1.015E-12	7.504E-15	3.636E-12	4.099E-11	0.813	7.14	8.78	**8.0±0.8**
6EUT10	6.531E-15	9.617E-13	7.113E-15	2.367E-12	3.010E-11	0.813	3.06	3.76	
6EUT10	4.231E-15	6.200E-13	4.586E-15	1.670E-12	2.113E-11	0.77	2.96	3.84	
6EUT10	4.557E-15	6.471E-13	4.786E-15	2.249E-12	2.579E-11	0.761	2.74	3.60	
6EUT10	5.102E-15	5.118E-13	3.785E-15	1.197E-12	1.463E-11	0.793	4.60	5.80	**4.3±1**
6EUT11	6.879E-16	6.419E-14	4.748E-16	3.908E-13	6.862E-12	0.775	2.84	3.66	
6EUT11	4.011E-15	4.256E-13	3.148E-15	9.077E-13	2.390E-11	0.77	4.12	5.35	
6EUT11	2.068E-15	2.134E-13	1.579E-15	8.189E-13	2.564E-11	0.743	3.02	4.07	
6EUT11	2.290E-15	2.511E-13	1.857E-15	1.443E-12	2.436E-11	0.75	2.52	3.36	**4.1±0.9**
6EUT40	1.131E-14	7.890E-13	5.835E-15	9.906E-13	1.119E-11	0.748	8.17	10.93	
6EUT40	3.945E-15	4.393E-13	3.249E-15	5.665E-13	4.803E-12	0.716	5.15	7.20	
6EUT40	1.632E-14	1.182E-12	8.743E-15	1.407E-12	9.451E-12	0.774	8.14	10.52	
6EUT40	1.292E-14	7.475E-13	5.529E-15	1.514E-12	1.046E-11	0.811	8.73	10.77	**9.9±1.8**
6EUT41	1.849E-14	4.981E-13	3.684E-15	1.285E-12	3.797E-11	0.725	14.56	20.08	
6EUT41	1.956E-14	5.065E-13	3.746E-15	1.317E-12	3.730E-11	0.715	15.21	21.27	
6EUT41	4.403E-14	8.658E-13	6.404E-15	2.650E-12	7.875E-11	0.748	18.24	24.38	**21.9±2**
6EUT42	3.606E-14	7.322E-13	5.416E-15	2.309E-12	5.945E-11	0.732	17.90	24.45	
6EUT42	4.241E-14	9.070E-13	6.709E-15	2.459E-12	7.639E-11	0.814	17.70	21.75	
6EUT42	7.547E-14	1.296E-12	9.588E-15	3.930E-12	1.304E-10	0.795	20.48	25.76	**24.0±2**

Note: Apatite degassed in furnace at 1100°C for 15 minutes. Ft- alpha correction factor after Farley (1996), grain size weighted Ft factor for multiple grain aliquots.

Table DR2: Bedrock zircon U-Th/He dating.

Sample	4-He [mol]	238-U [mol]	235-U [mol]	232-Th [mol]	F_t-factor	Uncor. Age [Ma]	Corr. Age [Ma]	Mean ± stdev.
North of Chitina River								
6EUT 1	1.623E-13	1.455E-11	1.076E-13	4.082E-12	0.800	8.11	10.14	
6EUT 1	3.869E-13	2.233E-11	1.652E-13	7.322E-12	0.852	12.46	14.63	**12.4±3**
6EUT 2	1.781E-12	1.510E-11	1.117E-13	4.535E-12	0.770	84.82	110.2	
6EUT 2	1.308E-12	9.003E-12	6.659E-14	2.393E-12	0.752	105.08	139.7	
6EUT 2	1.147E-12	1.033E-11	7.641E-14	3.159E-12	0.719	79.80	111.0	**120±17**
6EUT 3	3.634E-12	3.978E-11	2.942E-13	7.991E-12	0.810	67.21	83.0	
6EUT 3	9.941E-13	9.502E-12	7.028E-14	3.093E-12	0.693	74.89	108.1	
6EUT 3	9.458E-13	5.896E-12	4.361E-14	2.157E-12	0.735	113.47	154.4	**115±36**
6EUT 4	2.364E-12	1.781E-11	1.318E-13	5.242E-12	0.756	95.43	126.2	
6EUT 4	1.303E-12	1.267E-11	9.373E-14	3.700E-12	0.756	74.15	98.1	
6EUT 4	1.388E-12	8.462E-12	6.259E-14	2.978E-12	0.774	116.30	150.3	**125±26**
6EUT 8	3.148E-15	2.849E-14	2.107E-16	6.723E-14	0.727	55.46	76.3	
6EUT 8	6.723E-13	4.206E-12	3.111E-14	1.456E-12	0.687	113.53	165.3	
6EUT 8	1.456E-13	1.388E-12	1.027E-14	5.617E-13	0.637	73.88	116.0	**119±45**

6EUT10	1.923E-12	1.750E-11	1.295E-13	6.162E-12	0.786	78.18	99.5	
6EUT10	1.633E-15	1.485E-14	1.099E-16	2.791E-14	0.679	59.39	87.5	
6EUT10	3.785E-13	3.293E-12	2.435E-14	1.296E-12	0.723	81.08	112.1	**100±12**
South side								
06STP4	8.938E-14	2.143E-11	1.585E-13	2.659E-12	0.796	3.14	3.94	
06STP4	5.788E-14	1.784E-11	1.319E-13	6.011E-12	0.774	2.33	3.01	**3.5±0.7**
07JBC05	9.309E-13	1.518E-11	1.123E-13	1.503E-12	0.787	46.23	58.74	
07JBC05	2.829E-13	4.380E-12	3.239E-14	2.603E-12	0.763	43.88	57.50	
07JBC05	3.270E-13	6.187E-12	4.576E-14	1.778E-12	0.771	38.27	49.64	**55.3±5**
06STP21	1.645E-13	4.471E-12	3.307E-14	9.069E-13	0.715	27.15	37.97	
06STP21	3.191E-14	1.757E-12	1.300E-14	4.599E-13	0.717	13.25	18.48	**28.2±14**
05STP33	1.580E-13	1.718E-11	1.271E-13	4.626E-12	0.784	6.70	8.55	
05STP33	2.263E-13	2.423E-11	1.792E-13	4.767E-12	0.769	6.92	8.99	**8.8±0.3**
98ASn106	1.171E-13	1.04E-11	7.66E-14	4.08E-12	0.725	8.02	11.06	
98ASn106	2.240E-13	2.86E-11	2.12E-13	7.01E-12	0.699	5.73	8.19	**9.6±2**

Note: Apatite degassed in furnace at 1100°C for 15 minutes. Ft- alpha correction factor after Farley (1996).

Published Thermochronology

Table DR3: Published apatite and zircon thermochronolometric data.

sample	Lat	Long	Elevation [m]	Terrane Rock	Method	Age [Ma] ± 2σ
O'Sullivan & Currie, 1996					***bedrock sample***	
Mt. Logan	60.6005	-140.5025	5924	Chugach	aFT	36.0 ± 6
Mt. Logan					zFT	*43.8 ± 5*
Mt. Logan	60.6180	-140.6522	5645	Chugach	aFT	40.2 ± 9
Mt. Logan	60.6000	-140.5166	5540	Chugach	aFT	39.9 ± 6
Mt. Logan	60.6022	-140.4855	5371	Chugach	aFT	25.6 ± 5
Mt. Logan	60.5833	-140.4166	5330	Chugach	aFT	40.3 ± 5
Mt. Logan	60.6000	-140.5333	5230	Chugach	aFT	27.8 ± 4
Mt. Logan	60.6180	-140.5666	5050	Chugach	aFT	36.6 ± 6
Mt. Logan	60.6172	-140.6516	4660	Chugach	aFT	14.6 ± 3
Mt. Logan	60.6180	-140.6522	4400	Chugach	aFT	14.5 ± 3
Mt. Logan	60.6166	-140.0166	3335	Chugach	aFT	25.7 ± 5
Mt. Logan					zFT	*41.2 ± 4*
Mt. Logan	60.6175	-140.7169	3290	Chugach	aFT	9.0 ± 2
Mt. Logan	60.5000	-140.2666	2470	Chugach	aFT	3.7 ± 0.6
Mt. Logan	60.4333	-140.2666	1783	Chugach	aFT	4.0 ± 0.6
Mt. Upton	60.7666	-140.2333	2760	Wrangellia	zFT	98.7 ± 13
O'Sullivan et al., 1995						
68APR72	59.9303	-139.4288	808	Yakutat	aFT	9.5 ± 5
68APS57F	59.1833	-138.2047	732	Yakutat	aFT	2.4 ± 1
68APR77D	59.0200	-138.0017	571	Yakutat	aFT	1.3 ± 1
67APR42A	59.8222	-138.9358	617	Yakutat	aFT	2.8 ± 1
67APR42B	59.7761	-138.9164	712	Yakutat	aFT	3.1 ± 2
69APR54A	60.2647	-140.9044	3354	Chugach	aFT	3.2 ± 1
81APR5	60.2714	-139.4322	2332	Chugach	aFT	3.4 ± 3
69APR32A	60.3017	-139.6017	2499	Chugach	aFT	4.4 ± 2
69APR40A	60.1888	-139.5455	1524	Chugach	aFT	1.7 ± 1

67APR78A	60.0714	-139.3653	922	Chugach	aFT	3.5 ± 2	
80APR49A	59.8967	-138.9033	1250	Chugach	aFT	2.7 ±1	
78APR8	59.2011	-137.9641	600	Chugach	aFT	2.5 ± 0.7	
Spotila et al., 2004						**Aliquot age**	**Average age ± stdev**
99CH2	60.7203	-142.5435	754	Chugach	aHe	7.8	8.2 ± 0.8
					aHe	8.5	
					zHe	*27.6*	*26.0 ± 2.1*
					zHe	*24.3*	
01CH29	60.2926	-142.3558	1082	Yakutat	aHe	3.9	3.9 ± 0.4
01CH34	60.2134	-142.6270	579	Yakutat	aHe	3.9	NR
					aHe	12.4	
					zHe	*47.9*	*NR*
					zHe	*60.1*	
01CH38	60.3194	-143.1168	640	Yakutat	aHe	1.3	1.4 ± 0.2
					aHe	1.5	
01CH39	60.2625	-143.3121	297	Yakutat	aHe	2.3	2.2 ± 0.2
					aHe	2.0	
					zHe	*47.6*	*47.7 ± 7.6*
					zHe	*47.7*	
01CH41	60.0592	-141.9400	274	Yakutat	aHe	16.3	16.3
01CH43	60.1809	-141.1756	279	Yakutat	aHe	0.9	1.0 ± 0.5
				Yakataga Fm.	aHe	0.6	
					aHe	1.4	
					zHe	*74.3*	*NR*
					zHe	*50.8*	
01CH45	60.6572	-142.4146	1783	Chugach	aHe	9.0	9.7 ± 1.0
					aHe	9.8	
					aHe	10.3	
01CH47	60.7672	-142.6065	1494	Chugach	aHe	14.3	13.3 ± 1.3
					aHe	12.3	
01CH48	60.7911	-142.6368	1920	Chugach	aHe	16.0	16 ± 1.6
					aHe	11.9	
01CH49	60.6793	-142.5340	2012	Chugach	aHe	13.8	13.0 ± 1.3
					aHe	12.1	
01CH55	60.1866	-141.0804	1204	Yakutat	*zHe*	*30.1*	*NR*
					zHe	*33.4*	
01CH56	60.2482	-141.1171	1135	Yakutat	aHe	4.6	5.8 ± 0.6
					aHe	7.0	
02CH1	61.3408	-144.2049	1829	Chugach	aHe	31.5	28.7 ± 2.9
					aHe	25.8	
02CH2	61.3425	-144.1896	1524	Chugach	aHe	29.4	29.8 ± 3.0
					aHe	30.1	
02CH3	61.3231	-144.1405	1074	Chugach	aHe	36.5	36.5
02CH4	61.3344	-144.1521	1259	Chugach	aHe	28.0	27.9 ± 2.8
					aHe	27.7	
02CH19	60.9221	-142.4012	1402	Chugach	aHe	18.4	18.3 ± 1.8
					aHe	18.3	
02CH28	60.2573	-141.1584	1625	Yakutat	aHe	3.3	4.8 ± 1.5
					aHe	6.3	
02CH31	60.2855	-141.4542	1387	Yakutat	aHe	1.2	1.2 ± 0.1

					aHe	1.3	
02CH32	60.3435	-141.7640	1478	Yakutat	aHe	1.4	1.5 ± 0.2
					aHe	1.7	

Berger et al., 2008

01CH29	60.2926	-142.3558	1082	Yakutat	aHe	0.56	0.7 ± 0.11
				Kultieth Fm.	aHe	0.61	
					aHe	0.64	
					aHe	0.84	
					aHe	0.71	
					aHe	0.83	
01CH32	60.3434	-142.4418	442	Yakutat	aHe	0.66	0.58 ± 0.04
				Kultieth Fm.	aHe	0.55	
					aHe	0.55	
					aHe	0.57	
					aHe	0.59	
01CH34	60.2134	-142.6270	579	Yakutat	aHe	1.19	1.79 ± 0.59
				Poul Creek Fm.	aHe	2.70	
					aHe	1.37	
					aHe	1.44	
					aHe	2.27	
01CH36	60.3340	-142.6010	884	Yakutat	aHe	0.95	0.91 ± 0.04
				Kultieth Fm.	aHe	0.93	
					aHe	0.90	
					aHe	0.82	
					aHe	0.93	
					aHe	0.95	
01CH37	60.3026	-142.7810	221	Yakutat	aHe	0.98	1.02 ± 0.17
				Kultieth Fm.	aHe	1.26	
					aHe	0.84	
					aHe	2.37	
01CH38	60.3194	-143.1168	640	Yakutat	aHe	2.06	1.47 ± 0.43
				Kultieth Fm.	aHe	1.27	
					aHe	1.07	
01CH41	60.0592	-141.9400	274	Yakutat	aHe	8.21	1.96 ± 0.54
				Yakataga Fm.	aHe	27.20	
					aHe	1.28	
					aHe	2.59	
					aHe	2.00	
					aHe	4.44	
01CH54	60.1548	-141.9881	1707	Yakutat	aHe	2.79	2.86 ± 0.52
				Yakataga Fm.	aHe	2.69	
					aHe	2.27	
					aHe	3.70	
					aHe	8.96	
02CH31	60.2855	-141.4542	1387	Yakutat	aHe	0.71	0.71 ± 0.03
				Kultieth Fm.	aHe	0.67	
					aHe	0.70	
					aHe	0.74	
02CH33	60.3095	-141.2241	2432	Yakutat	aHe	1.66	1.34± 0.18
				Kultieth Fm.	aHe	1.19	

					aHe	1.19	
					aHe	1.40	
					aHe	1.27	
02CH34	60.4184	-141.7631	1798	Prince William	aHe	1.96	1.96
05STP1	60.4208	-143.5028	946	Yakutat	*zHe*	*13.61*	*12.9 ± 1.1*
					zHe	*12.09*	
05STP6	60.4608	-143.0588	1052	Prince William	aHe	0.86	0.76 ± 0.07
					aHe	0.73	
					aHe	0.70	
					aHe	1.82	
					zHe	*5.81*	*5.1 ± 1*
					zHe	*4.38*	
					zFT	*42.7*	*42.7 ± 4.4*
05STP10	60.8622	-143.3235	1804	Chugach	aHe	25.7	22.8 ± 1.8
					aHe	23.8	
					aHe	20.5	
					aHe	21.7	
					aHe	22.1	
05STP13	60.4608	-143.0588	816	Yakutat	aHe	0.82	0.72 ± 0.1
				Kultieth Fm.	aHe	0.85	
					aHe	0.78	
					aHe	0.62	
					aHe	0.67	
					aHe	0.59	
					zHe	*10.65*	*9.6 ± 1.4*
					zHe	*8.61*	
05STP18	60.4007	-142.5130	1250	Yakutat	aHe	0.76	0.85 ± 0.07
				Kultieth Fm.	aHe	0.94	
					aHe	0.81	
					aHe	0.90	
05STP19	60.4333	-142.4904	1156	Prince William	aHe	0.80	0.81 ± 0.03
					aHe	0.78	
					aHe	0.85	
					aHe	0.82	
05STP23	60.6012	-142.3409	1432	Chugach	aHe	7.86	6.86 ± 1.26
					aHe	8.05	
					aHe	7.74	
					aHe	5.42	
					aHe	5.21	
05STP36	60.5542	-141.7456	2171	Chugach	aHe	9.04	9.03 ± 0.5
					aHe	9.17	
					aHe	8.40	
					aHe	8.65	
					aHe	9.87	
					aHe	14.68	
06STP21	60.2950	-141.9651	1678	Yakutat	aHe	0.64	0.68 ± 0.08
				Poul Creek Fm.	aHe	0.82	
					aHe	0.66	
					aHe	0.60	
06STP41	60.7438	-141.9648	900	Chugach	aHe	16.8	16.9 ± 1.15
					aHe	18.4	
					aHe	15.6	

06STP44	60.7536	-141.9265	1732	Chugach	aHe	21.9	20.7 ± 1.2
					aHe	19.5	
06STP46	60.7601	-141.8869	2428	Chugach	aHe	26.1	27.8 ± 2.79
					aHe	25.5	
					aHe	31.7	
06STP72	60.0652	-142.4314	0	Yakutat	aHe	2.13	2.98 ± 0.77
				Yakataga Fm.	aHe	3.99	
					aHe	2.82	
					aHe	5.05	
06STP74	60.2011	-142.8231	216	Yakutat	aHe	1.02	1.04 ± 0.03
				Yakataga Fm.	aHe	1.07	
					aHe	1.06	
					aHe	0.99	
06STP81	60.2140	-142.2416	1954	Yakutat	aHe	1.08	1.29 ± 0.29
				Poul Creek Fm.	aHe	0.99	
					aHe	1.33	
					aHe	3.75	
					aHe	1.74	

Berger & Spotila, 2008

05STP1	60.4200	-143.5028	946	Yakutat	aHe	0.45	0.53 ± 0.07
				Kultieth Fm.	aHe	0.67	
					aHe	0.55	
					aHe	0.54	
					aHe	0.50	
					aHe	0.45	
05STP2	60.3931	-143.5422	620	Yakutat	aHe	0.39	0.44 ± 0.03
				Kultieth Fm.	aHe	0.43	
					aHe	0.46	
					aHe	0.47	
					aHe	0.47	
05STP3	60.4332	-143.5044	1252	Yakutat	aHe	0.64	0.53 ± 0.1
				Kultieth Fm.	aHe	0.65	
					aHe	0.39	
					aHe	0.44	
					aHe	0.55	
05STP4	60.3896	-143.6997	394	Yakutat	aHe	0.86	0.74 ± 0.07
				Kultieth Fm.	aHe	0.73	
					aHe	0.72	
					aHe	0.78	
					aHe	0.62	
					aHe	0.75	
05STP7	60.8838	-143.7637	1140	Chugach	aHe	25.9	25.1 ± 0.87
					aHe	25.3	
					aHe	25.4	
					aHe	23.6	
05STP11	60.5428	-143.4165	1448	Prince William	aHe	17.3	1.78 ± 0.83
					aHe	2.86	
					aHe	1.64	
					aHe	0.84	
05STP15	60.2306	-143.9758	488	Yakutat	aHe	1.76	1.8 ± 0.11

				Poul Creek Fm.	aHe	22.80	
					aHe	1.72	
					aHe	2.47	
					aHe	1.99	
					aHe	1.74	
					aHe	2.71	
05STP26	60.6469	-143.7903	2208	Chugach	aHe	2.14	2.28 ± 0.16
					aHe	2.06	
					aHe	2.35	
					aHe	2.23	
					aHe	2.54	
					aHe	2.36	
05STP27	60.4996	-143.7248	1704	Yakutat	aHe	0.63	0.63 ± 0.11
				Kultieth Fm.	aHe	0.74	
					aHe	0.76	
					aHe	0.46	
					aHe	0.57	
05STP33	60.6441	-143.7239	2758	Chugach	aHe	1.79	1.66 ± 0.09
					aHe	1.53	
					aHe	1.60	
					aHe	1.58	
					aHe	1.70	
					aHe	1.74	
06STP1	60.1686	-140.5297	1189	Yakutat	aHe	1.65	1.55
				Poul Creek/	aHe	5.54	
				Yakataga	aHe	1.45	
					aHe	4.82	
					aHe	8.78	
06STP3	60.1643	-140.3476	1713	Yakutat	aHe	7.41	7.21 ± 1.16
				Poul Creek Fm	aHe	8.41	
					aHe	148	
					aHe	5.30	
					aHe	122	
					aHe	7.72	
					aHe	13.5	
06STP4	60.2369	-140.4611	1676	Prince William	aHe	1.44	0.56 ± 0.08
					aHe	0.59	
					aHe	0.44	
					aHe	1.80	
					aHe	0.64	
06STP50	60.4488	-143.9837	875	Yakutat	aHe	1.02	1.09 ± 0.09
				Kultieth Fm.	aHe	1.23	
					aHe	1.00	
					aHe	1.09	
06STP71	60.1333	-140.7119	853	Yakutat	aHe	5.35	3.95 ± 1.06
				Yakataga Fm.	aHe	3.73	
					aHe	8.47	
					aHe	2.78	
					aHe	8.08	
01CH22	60.9104	-144.3150	1532	Chugach	aHe	20.1	18.9 ± 1.2
					aHe	17.7	
01CH25	60.6940	-144.3774	320	Chugach	aHe	9.92	10.7 ± 1.31

					aHe	9.71	
					aHe	10.5	
					aHe	10.2	
					aHe	19.7	
					aHe	13.3	
01CH26	60.4990	-144.4772	884	Chugach	aHe	1.79	2.02 ± 0.14
					aHe	2.04	
					aHe	2.19	
					aHe	2.06	
02CH28	60.2573	-141.1584	1625	Yakutat	aHe	2.19	0.74 ± 0.14
				Kultieth Fm.	aHe	0.55	
					aHe	0.87	
					aHe	0.81	

McAleer et al., 2009

03PH305A	59.1281	-138.0839	88	Yakutat	aHe	2.65	1.82 ± 0.49
				tonalite	aHe	1.35	
					aHe	1.72	
					aHe	1.66	
					aHe	2.25	
					aHe	1.27	
					zHe	*2.28*	*2.45 ± 0.17*
					zHe	*2.65*	
					zFT		*27.5 ± 1.5*
03PH306A	59.4272	-138.1097	67	Chugach	aHe	4.72	5.11 ± 0.65
					aHe	4.24	
					aHe	5.67	
					aHe	5.81	
03PH307A	59.4378	-138.2490	243	Chugach	aHe	2.01	2.34 ± 0.33
					aHe	2.66	
					zHe	*12.20*	*13.0 ± 0.79*
					zHe	*13.80*	
					zFT		*16.5 ± 0.8*
03PH308A	59.4214	-138.4510	453	Yakutat	*zHe*	*2.34*	*2.6 ± 0.26*
				tonalite	*zHe*	*2.85*	
					zFT		*18.8 ± 1.2*
03PH309A	59.4044	-138.6967	741	Yakutat	aHe	2.39	2.56 ± 0.17
				gneiss	aHe	2.72	
					aHe	7.05	
					aHe	10.50	
03PH310A	59.9417	-139.2331	926	Yakutat	aHe	1.55	1.67 ± 0.12
				diorite	aHe	1.64	
					aHe	1.83	
03PH311A	60.0225	-139.2058	1610	Chugach	aHe	0.73	0.89 ± 0.11
					aHe	0.97	
					aHe	0.97	
					zHe	*1.86*	1.96 ± 0.09
					zHe	*2.05*	
					zFT		4.5 ± 0.3
69APR31B	60.2867	-139.1983	1829	Wrangellia	aHe	3.99	3.62 ± 0.34

					aHe	3.79	
					aHe	3.88	
					aHe	3.16	
					aHe	3.27	
69APR32A	60.3017	-139.6017	2499	Chugach	aHe	1.75	1.9 ± 0.14
					aHe	2.04	
80APR49A	59.8967	-138.9033	1250	Chugach	aHe	1.22	1.13 ± 0.08
					aHe	1.14	
					aHe	1.03	
89SR29	58.8958	-136.9125	0	Wrangellia	aHe	9.45	9.09 ± 0.44
					aHe	9.53	
					aHe	8.42	
					aHe	8.95	
95APo13	59.6006	-138.5422	914	Chugach	aHe	1.40	1.45 ± 0.04
					aHe	1.49	
					aHe	1.47	
95APo21	59.8144	-138.9167	0	Chugach	aHe	2.05	2.5 ± 0.51
					aHe	2.24	
					aHe	3.21	
MGB1	58.7573	-136.2563	0	Wrangellia	aHe	3.76	4.34 ± 0.88
					aHe	4.16	
					aHe	5.81	
					aHe	3.61	
MGB2	58.8959	-136.6648	0	Wrangellia	aHe	2.11	2.5 ± 0.3
					aHe	2.74	
					aHe	2.25	
					aHe	2.36	
					aHe	2.56	
					aHe	3.00	
MGB3	58.9718	-136.9458	0	Wrangellia	aHe	17.9	17.9 ± 0.25
					aHe	18.2	
					aHe	17.6	
MGB4	58.8899	-136.9171	232	Wrangellia	aHe	7.83	6.21 ± 1.15
					aHe	5.70	
					aHe	6.85	
					aHe	5.69	
					aHe	4.25	
					aHe	6.95	
MGB5	58.8941	-136.9230	128	Wrangellia	aHe	5.91	5.9 ± 0.42
					aHe	5.67	
					aHe	5.45	
					aHe	6.56	
MGB6	58.8982	-136.9256	0	Wrangellia	aHe	8.97	8.14 ± 1.44
					aHe	9.79	
					aHe	5.95	
					aHe	7.85	
MGB7	58.8484	-137.1213	0	Chugach	aHe	2.15	2.31 ± 0.16
					aHe	2.47	
MGB8	58.7254	-136.4105	0	Wrangellia	aHe	2.32	2.15 ± 0.17
					aHe	1.97	
					zHe	*25.9*	*25.4 ± 0.44*
					zHe	*25.0*	

MGB9	58.6066	-136.4647	0	Wrangellia	aHe	3.84	4.18 ± 0.7
					aHe	3.25	
					aHe	4.89	
					aHe	3.74	
					aHe	5.30	
					aHe	4.07	
MGB10	58.3315	-136.2065	0	Wrangellia	aHe	5.88	5.5 ± 0.35
					aHe	11.10	
					aHe	5.51	
					aHe	5.67	
					aHe	4.94	
MGB11	58.2800	-136.7756	0	Chugach	aHe	2.52	2.83 ± 0.31
					aHe	3.13	
MGB12	58.3979	-137.0723	0	Yakutat sandstone	aHe	1.61	0.93 ± 0.51
					aHe	0.77	
					aHe	4.66	
					aHe	2.54	
					aHe	0.40	
					zHe	*25.0*	
Meigs et al., 2008						**Age population**	**Apparent age**
01CH49	60.6793	-142.5340	2012	Chugach	aFT		13.3 ± 1.3
99CH2	60.7203	-142.5435	754	Chugach	aFT		13.8 ± 1.4
					zFT	28.2 (34%)	
					zFT	39.6 (66%)	
01CH45	60.6572	-142.4146	1783	Chugach	aFT		14.5 ± 1.3
01CH47	60.7672	-142.6065	1494	Chugach	aFT		27.3 ± 2.6
01CH53	60.4181	-142.5119	1326	Yakutat Kultieth Fm.	aFT		3.4 ± 1.1
					zFT	26.4 (34%)	
					zFT	41.9 (49%)	
					zFT	68.4 (17%)	
02CH31	60.2855	-141.4542	1387	Yakutat Kultieth Fm.	aFT		3.8 ± 0.9
					zFT	34.4 (59%)	
					zFT	53.4 (41%)	
01CH39	60.2625	-143.3121	297	Yakutat	aFT		4.0 ± 1.2
01CH48	60.7911	-142.6368	1920	Chugach	aFT		5.0 ± 2.1
					zFT	30.7 (16%)	
					zFT	57.5 (73%)	
					zFT	123 (23%)	
01CH29	60.2926	-142.3558	1082	Yakutat	aFT		5.5 ± 1.8
01CH43	60.1809	-141.1756	279	Yakutat	aFT		5.7 ± 2.1
01CH36	60.3340	-142.6010	883	Yakutat	aFT		5.8 ± 2.2
					zFT	41.2 (71%)	
					zFT	66.8 (29%)	
01CH32	60.3434	-142.4418	442	Yakutat	aFT		6.2 ± 2.0
01CH55	60.1866	-141.0804	1204	Yakutat	aFT		28.7 ± 3.8
					zFT	29.9 (55%)	
					zFT	40.8 (45%)	
01CH34	60.2134	-142.6270	579	Yakutat	aFT	6.3	NR

					zFT	34.1 (36%)	
					zFT	51.0 (48%)	
					zFT	100 (17%)	
01CH41	60.0592	-141.9400	274	Yakutat	aFT	31.5	NR
					zFT	38.0 (68%)	NR
					zFT	114 (32%)	
Perry et al., 2009						**Age population**	
05-09	60.1675	-142.6414		Yakutat	zFT	16.9 (40%)	NR
				Yakataga Fm.	zFT	32.4 (30%)	
					zFT	67.8 (30%)	
05-10	60.1683	-142.6291		Yakutat	zFT	15.8 (44%)	NR
				Yakataga Fm.	zFT	32.8 (40%)	
					zFT	72.5 (17%)	
05-11	60.1683	-142.6291		Yakutat	zFT	15.1 (37%)	NR
				Yakataga Fm.	zFT	29.8 (49%)	
					zFT	71.9 (14%)	
05-12	60.0542	-143.7861		Yakutat	zFT	21.3 (39%)	NR
				Yakataga Fm.	zFT	34.8 (49%)	
					zFT	76.8 (12%)	
05-07	60.3344	-142.6194		Yakutat	zFT	29.0 (39%)	NR
				Poul Creek Fm.	zFT	42.0 (50%)	
					zFT	67.2 (11%)	
05-08	60.3458	-142.6208		Yakutat	zFT	37.5 (96%)	NR
				Poul Creek Fm.	zFT	65.8 (4%)	
05-13	60.2833	-143.3208		Yakutat	zFT	24.4 (36%)	NR
				Poul Creek Fm.	zFT	38.9 (64%)	
					zFT	32.6 (59%)	NR
					zFT	54.7 (41%)	
05-01	60.2625	-143.0833		Yakutat	zFT	31.4 (78%)	NR
				Kultieth Fm.	zFT	57.6 (22%)	
05-03	60.3219	-143.1181		Yakutat	zFT	28.1 (34%)	NR
				Kultieth Fm.	zFT	43.5 (59%)	
					zFT	97.0 (6.6%)	
05-04	60.3181	-143.1211		Yakutat	zFT	30.8 (41%)	NR
				Kultieth Fm.	zFT	44.1 (59%)	
05-06	60.3344	-142.6164		Yakutat	zFT	22.3 (13%)	
				Kultieth Fm.	zFT	37.5 (82%)	
					zFT	80.2 (5%)	
05-17	60.7388	-143.4194		Yakutat	zFT	30.1 (80%)	NR
				Kultieth Fm.	zFT	45.3 (20%)	
Enkelmann et al., 2008					***Detrital samples***		
UT23	60.9250	-141.9831	1400	Wrangellia	zFT	92 (48%)	
					zFT	119 (52%)	

UT22	60.8839	-142.1931	1107	Chugach	zFT	30.4 (28%)
					zFT	42.1 (66%)
					zFT	82.8 (6%)
UT24	60.8839	-141.9075	1059	Chugach	zFT	32.9 (10%)
					zFT	77.2 (57%)
					zFT	102 (33%)
UT21	60.8014	-142.3014	1086	Chugach	zFT	13.1 (4%)
					zFT	28.2 (20%)
					zFT	42 (76%)
UT44	60.7375	-141.9533	837	Chugach	zFT	8.2 (5%)
					zFT	21.5 (48%)
					zFT	34.5 (47%)
UT46	60.8339	-142.7833	412	Chugach	zFT	13.5 (9%)
					zFT	21.7 (85%)
					zFT	35.6 (6%)
UT47	60.8336	-142.7458	426	Chugach	zFT	10.7 (4%)
					zFT	17.4 (12%)
					zFT	27.1 (49%)
					zFT	35.2 (35%)
YA1	60.1228	-142.3507	78	Yakutat	zFT	6.3 (4%)
					zFT	17.9 (17%)
					zFT	37.3 (62%)
					zFT	81.8 (17%)
YA2	60.0722	-142.1369	70	Yakutat	zFT	5.2 (12%)
					zFT	10.7 (32%)
					zFT	24.8 (40%)
					zFT	60 (16%)
YA3	60.22	-142.5324	91	Yakutat	zFT	9.9 (2%)
					zFT	25.1 (21%)
					zFT	40.8 (55%)
					zFT	62.2 (16%)
					zFT	122 (7%)
Enkelmann et al., 2009						
YA9	60.2674	-143.3254	73	Yakutat	zFT	23.3 (15%)
					zFT	45.4 (50%)
					zFT	71.1 (28%)
					zFT	114 (7%)
YA8	60.2131	-143.1809	6	Yakutat	zFT	14.2 (4%)
					zFT	30.2 (62%)
					zFT	54.5 (34%)
YA10	60.2607	-143.0315	59	Yakutat	zFT	24.7 (10%)
					zFT	34.4 (32%)
					zFT	52.4 (47%)
					zFT	77 (11%)
YA12	60.29	-142.7062	149	Yakutat	zFT	8.7 (3%)
					zFT	32.3 (14%)
					zFT	45.3 (44%)
					zFT	68.3 (31%)
					zFT	107 (8%)

YA11	60.2836	-142.6508	219	Yakutat	zFT	18.9 (4%)
					zFT	34.4 (37%)
					zFT	61.1 (37%)
					zFT	116 (7%)
YA7	60.3377	-142.3269	606	Yakutat	zFT	9.9 (2%)
					zFT	25.1 (21%)
					zFT	40.8 (55%)
					zFT	62.2 (16%)
					zFT	122 (7%)
YA4	60.0542	-141.9464	10	Yakutat	zFT	5.8 (6%)
					zFT	13.8 (15%)
					zFT	22.9 (30%)
					zFT	49.2 (35%)
					zFT	106 (14%)
YA6	60.0425	-141.8145	10	Yakutat	zFT	10.8 (13%)
					zFT	22.9 (27%)
					zFT	46.3 (48%)
					zFT	92.4 (12%)
YA5	60.0009	-141.6784	10	Yakutat	zFT	12.2 (19%)
					zFT	20.8 (25%)
					zFT	39.3 (22)
					zFT	63.9 (34%)
IB6	60.0707	-141.4795	10	Yakutat	zFT	10.4 (21%)
					zFT	18.5 (22%)
					zFT	32.2 (30%)
					zFT	52.9 (18%)
					zFT	88.5 (9%)
IB7	60.1714	-141.1521	12	Yakutat	zFT	6.1 (3%)
					zFT	17.1 (5%)
					zFT	35 (25%)
					zFT	52.3 (46%)
					zFT	81.4 (21%)
IB5	59.9743	-141.2178	16	Yakutat	zFT	6.3 (17%)
					zFT	14.7 (19%)
					zFT	30.7 (22%)
					zFT	45.6 (26%)
					zFT	86.6 (17%)
IB1	59.8057	-140.8638	39	Chug./Yakutat	zFT	3.1 (24%)
					zFT	24.1 (33%)
					zFT	63.7 (43%)
IB4	59.7622	-140.3954	9	Chug./Yakutat	zFT	2.6 (41%)
					zFT	56.2 (59%)
IB3	59.9128	-139.9944	76	Chug./Yakutat	zFT	2.1 (38%)
					zFT	14.2 (22%)
					zFT	55.5 (40%)
IB2	59.9181	-139.8986	70	Chug./Yakutat	zFT	2.6 (8%)
					zFT	47.5 (60%)
					zFT	83.4 (32%)

Note: underlined numbers were excluded from the original authors to calculate the average age. aFT: apatite fission track, zFT: zircon fission track, aHe: apatite U-Th/He, zHe: zircon U-Th/He. General zircon analysis are in italics.

Table DR4: *^{40}Ar/^{49}Ar Analytical Data for K-Feldspar Samples EUT-2 and EUT-35*

Step	Temp. (°C)	Time (m)	36Ar(a) (cps)	39Ar(k) (cps)	40Ar(r) (cps)	Age (Ma)	±2σ (Ma)	40Ar* (%)	39Ar(k) (%)
6EUT02 K-feldspar (10.60 mg)			J = 0.0020397	0.0000102 monitor GA1550 biotite (98.79	0.543 Ma)				
1	400	15	1706	2061	32397	56.95	20.06	6.04	0.09
2	430	15	601	1261	30129	85.85	14.52	14.50	0.06
3	460	15	806	2320	66469	102.45	7.50	21.81	0.10
4	490	15	531	3352	98480	105.00	4.72	38.54	0.15
5	520	15	953	6548	221964	120.62	3.02	44.07	0.29
6	520	15	173	3641	116513	114.06	3.13	69.49	0.16
7	550	15	1054	8615	300555	124.02	3.24	49.10	0.39
8	550	15	307	5406	181958	119.79	2.64	66.67	0.24
9	580	15	1117	10260	370121	128.08	2.27	52.84	0.46
10	580	15	309	5521	199598	128.37	2.51	68.54	0.25
11	610	15	1045	10735	400408	132.28	2.48	56.44	0.48
12	610	15	243	5997	222065	131.37	2.39	75.51	0.27
13	635	15	627	8673	323331	132.22	2.87	63.55	0.39
14	635	15	159	5239	199504	134.95	2.09	80.87	0.23
15	660	15	319	6818	263174	136.73	2.03	73.58	0.31
16	660	15	105	4113	160440	138.13	2.21	83.74	0.18
17	690	15	368	7166	274308	135.63	1.99	71.58	0.32
18	690	15	88	4248	165992	138.33	1.76	86.36	0.19
19	720	15	325	6806	264351	137.55	2.14	73.32	0.31
20	720	15	116	4129	160550	137.69	2.23	82.34	0.19
21	750	15	339	6782	258144	134.89	3.07	71.99	0.30
22	750	15	118	4073	156628	136.23	2.69	81.80	0.18
23	790	15	504	8230	311638	134.22	1.86	67.63	0.37
24	830	15	845	12372	466593	133.70	1.90	65.11	0.55
25	870	15	1032	15733	586869	132.29	1.79	65.78	0.71
26	910	15	1578	22079	829421	133.19	2.56	63.98	0.99
27	940	15	1276	25166	936289	131.96	1.59	71.25	1.13
28	970	15	1539	34482	1261621	129.85	1.92	73.47	1.55
29	995	15	2074	45963	1666342	128.71	1.96	73.08	2.06
30	1015	15	2345	57155	2072971	128.76	1.06	74.90	2.56
31	1030	15	2365	61504	2251354	129.91	1.31	76.27	2.76
32	1030	45	5717	161756	5910057	129.67	1.69	77.73	7.25
33	1030	45	2629	80370	2969393	131.08	1.28	79.22	3.60
34	1030	120	5256	178701	6694349	132.84	1.46	81.12	8.01
35	1040	15	414	14549	543203	132.40	1.45	81.57	0.65
36	1040	45	1297	41959	1573774	132.99	1.36	80.37	1.88
37	1040	120	3618	122569	4593198	132.88	1.73	81.07	5.50
38	1055	15	311	11286	423680	133.11	1.26	82.14	0.51
39	1055	45	855	31492	1182138	133.10	2.08	82.34	1.41
40	1055	120	1718	65872	2487441	133.86	1.01	83.01	2.95
41	1055	120	1070	45868	1749422	135.16	1.60	84.65	2.06
42	1055	120	859	38403	1467532	135.41	1.70	85.20	1.72
43	1055	120	676	31720	1205647	134.71	1.96	85.73	1.42

44	1085	15	130	5836	226200	137.26	1.99	85.43	0.26
45	1115	15	669	21403	803375	133.09	1.91	80.21	0.96
46	1140	15	2667	71244	2698717	134.27	1.10	77.36	3.19
47	1155	15	4892	137110	5221730	134.96	2.89	78.28	6.15
48	1175	15	4779	174298	6759580	137.34	1.39	82.67	7.81
49	1200	15	4439	255275	10104437	140.07	1.54	88.46	11.45
50	1230	15	2058	154467	6218915	142.38	1.10	91.04	6.93
51	1260	15	515	34789	1382922	140.65	1.75	90.03	1.56
52	1300	15	734	43656	1691395	137.22	1.86	88.58	1.96
53	1350	15	839	50299	1986547	139.77	1.33	88.85	2.26
54	1450	15	632	42215	1718449	143.90	1.50	90.15	1.89
55	1500	15	152	7233	290353	141.99	2.42	86.58	0.32
56	1500	15	57	1034	42168	144.12	13.12	71.29	0.05
57	1500	15	42	311	12156	138.35	41.78	49.38	0.01
58	1500	15	32	260	10426	141.79	50.76	52.42	0.01

Step	Temp (°C)	Time (m)	36Ar(a) (cps)	39Ar(k) (cps)	40Ar(r) (cps)	Age (Ma)	2σ (Ma)	40Ar* (%)	39Ar(k) (%)
6EUT-35 K-feldspar (21.96mg)			J = 0.0020397	0.0000102	monitor GA1550 biotite (98.79				0.543 Ma)
1	400	15	14144	11370	151674	48.43	22.37	3.50	0.12
2	430	15	3417	7494	124599	60.16	12.05	10.98	0.08
3	460	15	1593	9615	189157	70.98	3.65	28.66	0.10
4	490	15	1398	19717	425605	77.73	1.55	50.72	0.20
5	520	15	1141	38142	890152	83.90	1.41	72.46	0.39
6	520	15	103	21652	520492	86.36	0.65	94.40	0.22
7	550	15	466	39398	1027818	93.53	1.16	88.12	0.40
8	550	15	127	27438	768163	100.19	0.74	95.25	0.28
9	580	15	749	41973	1257716	107.03	2.80	84.97	0.43
10	580	15	123	29754	941244	112.80	1.52	96.20	0.30
11	610	15	1038	52284	1763234	120.01	2.58	85.13	0.53
12	610	15	75	27261	925643	120.81	0.90	97.59	0.28
13	635	15	327	38291	1331575	123.63	1.02	93.18	0.39
14	635	15	62	28642	1009206	125.21	2.00	98.14	0.29
15	660	15	150	31249	1111172	126.32	1.37	96.09	0.32
16	660	15	59	24822	894458	127.95	1.05	98.03	0.25
17	690	15	384	35818	1273848	126.34	0.89	91.76	0.37
18	690	15	46	26013	951353	129.80	1.15	98.53	0.27
19	720	15	678	49040	1790085	129.56	1.50	89.87	0.50
20	720	15	49	31121	1131603	129.07	1.42	98.67	0.32
21	750	15	423	52175	1901236	129.34	0.91	93.77	0.53
22	750	15	52	32927	1207092	130.09	0.93	98.66	0.34
23	790	15	528	66760	2432366	129.32	0.80	93.90	0.68
24	830	15	606	92136	3387569	130.46	0.72	94.92	0.94
25	870	15	895	145757	5285576	128.74	0.97	95.17	1.49
26	910	15	1555	164544	5957362	128.54	1.53	92.78	1.68
27	940	15	1325	157387	5715319	128.91	1.07	93.53	1.60
28	970	15	1174	164514	5842434	126.16	1.41	94.33	1.68
29	995	15	1297	164197	5882018	127.23	1.56	93.82	1.67

30	1015	15	1756	186465	6657201	126.81	1.13	92.71	1.90
31	1030	15	2154	207051	7408752	127.09	1.32	92.03	2.11
32	1030	45	4605	482268	17337015	127.66	0.59	92.66	4.92
33	1030	45	3653	369487	13235309	127.22	1.21	92.40	3.77
34	1030	120	5815	648907	23268095	127.34	0.90	93.06	6.61
35	1040	15	458	54102	1954879	128.29	0.99	93.46	0.55
36	1040	45	1365	180129	6438991	126.96	0.88	94.04	1.84
37	1040	120	2472	357987	12774044	126.75	0.93	94.53	3.65
38	1055	12	256	35869	1284047	127.14	1.12	94.37	0.37
39	1055	45	634	95616	3450175	128.12	0.94	94.78	0.97
40	1055	120	1751	274403	9925418	128.42	1.21	94.98	2.80
41	1055	120	1384	215331	7779068	128.27	0.89	94.94	2.19
42	1055	120	1160	178489	6419721	127.72	1.39	94.87	1.82
43	1055	120	1137	160342	5757875	127.53	1.46	94.42	1.63
44	1085	15	308	26892	937656	123.95	1.79	91.10	0.27
45	1115	15	713	55377	1935603	124.24	0.85	90.12	0.56
46	1140	15	864	71727	2564643	127.00	1.37	90.89	0.73
47	1155	15	1717	134732	4786372	126.21	1.53	90.35	1.37
48	1175	15	2816	218183	7758072	126.32	1.23	90.25	2.22
49	1200	15	5695	453975	15908191	124.55	0.68	90.37	4.63
50	1230	15	13750	1123183	39101429	123.76	0.93	90.53	11.45
51	1260	15	14680	1365333	47748713	124.31	0.68	91.61	13.91
52	1300	15	7905	621903	22038512	125.90	0.64	90.36	6.34
53	1350	15	3123	272859	9750648	126.93	1.00	91.29	2.78
54	1450	15	3857	315689	11414640	128.38	0.94	90.86	3.22
55	1500	15	821	69155	2487332	127.72	1.11	91.05	0.70
56	1500	15	124	4243	150596	126.09	3.62	80.40	0.04
57	1500	15	48	723	26623	130.60	19.25	65.39	0.01
58	1500	30	41	171	6333	131.29	81.05	34.29	0.00

Notes: Both samples were 37Ar-dead (so no Ca-based corrections were applied)
Data were reduced using ArArCalc (by Anthony Koppers)
Sensitivity: ~1.13e-19 mol/cps. Discrimination (1 amu): 1.000564

Table DR5: *Kinetic and Diffusion-Domain Data, and Inversion-Model Parameters for K-Feldspar Samples EUT-2 and EUT-35*

```
SAMPLE INFO:   LU1433 EUT2 Kspar
(Best fit is   2.51, worst fit is   3.09)

          CRS ITERATIONS:  4000
   MODEL DURATION (m.y.):    200.0
              TIME NODES:    15
CONSTRAINING BRACKETS tT:     4
   TIME    TMIN   TMAX
  200.0   450.0   500.0
  190.0     0.0   500.0
   20.0     0.0   500.0
    0.0     0.0   500.0
MAX MONTE-CARLO HEATING RATE:   5.0   MAX MONTE-CARLO COOLING RATE:  50.0
        MAX CRS HEATING RATE:   5.0           MAX CRS COOLING RATE: 200.0
    CRS AMPLIFICATION FACTOR:   1.30
      SUBSET SIZE, POOL SIZE:   15   150
           FITTING CRITERION:   1.00
              FITTING OPTION:   1  (mean percent)
          DIFFUSION GEOMETRY:   2  (infinite-slab)
              RESTART OPTION:   0  (new start from Monte-Carlo histories)
DISCRETIZATION DELTA-TEMPERATURE:   5.0
           LOVERA SERIES CUT-OFF:   1.0e-04
      FLAG TO WRITE FULL REPORTS:   1

DOMAIN INFO
-----------
Domains:  8
      E        D0       frac.   Tc (10˚C/m.y.)
 1  39.14  1.30950e+20  0.016       135
 2  39.14  4.32617e+18  0.019       164
 3  39.14  8.37730e+15  0.025       231
 4  39.14  3.27419e+15  0.110       243
 5  39.14  2.09461e+15  0.070       248
 6  39.14  1.06931e+15  0.050       257
 7  39.14  8.18661e+14  0.110       261
 8  39.14  1.08169e+14  0.600       290

Goal Age Spectrum
-----------------
Goal spectrum steps:  58
      f39     age    error  skip?
  1  0.001    57.0   10.0   0
  2  0.001    85.8    7.3   1
  3  0.003   102.5    3.7   1
  4  0.004   105.0    2.4   1
  5  0.007   120.6    1.5   1
  6  0.009   114.1    1.6   1
  7  0.012   124.0    1.6   1
  8  0.015   119.8    1.3   1
  9  0.019   128.1    1.1   1
 10  0.022   128.4    1.3   1
 11  0.027   132.3    1.2   1
 12  0.029   131.4    1.2   1
 13  0.033   132.2    1.4   1
 14  0.036   134.9    1.0   1
 15  0.039   136.7    1.0   1
```

16	0.041	138.1	1.1	1
17	0.044	135.6	1.0	1
18	0.046	138.3	0.9	1
19	0.049	137.6	1.1	1
20	0.051	137.7	1.1	1
21	0.054	134.9	1.5	1
22	0.055	136.2	1.3	1
23	0.059	134.2	0.9	1
24	0.065	133.7	1.0	1
25	0.072	132.3	0.9	1
26	0.082	133.2	1.3	1
27	0.093	132.0	0.8	1
28	0.108	129.8	1.0	1
29	0.129	128.7	1.0	1
30	0.155	128.8	0.5	1
31	0.182	129.9	0.7	1
32	0.255	129.7	0.8	1
33	0.291	131.1	0.6	1
34	0.371	132.8	0.7	1
35	0.377	132.4	0.7	1
36	0.396	133.0	0.7	1
37	0.451	132.9	0.9	1
38	0.456	133.1	0.6	1
39	0.470	133.1	1.0	1
40	0.500	133.9	0.5	1
41	0.520	135.2	0.8	1
42	0.538	135.4	0.9	1
43	0.552	134.7	1.0	1
44	0.555	137.3	1.0	1
45	0.564	133.1	1.0	1
46	0.596	134.3	0.6	1
47	0.658	135.0	1.4	0
48	0.736	137.3	0.7	0
49	0.850	140.1	0.8	0
50	0.919	142.4	0.5	0
51	0.935	140.7	0.9	0
52	0.955	137.2	0.9	0
53	0.977	139.8	0.7	0
54	0.996	143.9	0.8	0
55	0.999	142.0	1.2	0
56	1.000	144.1	6.6	0
57	1.000	138.3	20.9	0
58	1.000	141.8	25.4	0

Heating Schedule Actually Used

Heating Steps: 58

	Temp. (C)	Time
1	426.3	10.0
2	438.1	10.0
3	468.1	10.0
4	492.7	10.0
5	529.9	10.0
6	522.1	10.0
7	561.5	10.0
8	557.1	10.0
9	598.7	10.0
10	601.3	10.0
11	664.8	10.0
12	661.1	10.0

13	688.9	10.0
14	677.2	10.0
15	699.1	10.0
16	684.5	10.0
17	723.9	10.0
18	713.7	10.0
19	753.1	10.0
20	742.9	10.0
21	780.9	10.0
22	763.3	10.0
23	813.0	10.0
24	848.0	10.0
25	878.7	10.0
26	918.1	10.0
27	944.4	10.0
28	986.7	10.0
29	1030.5	10.0
30	1071.4	10.0
31	1099.1	10.0
32	1237.8	10.0
33	1194.0	10.0
34	1331.3	10.0
35	1072.9	10.0
36	1201.3	10.0
37	1356.1	10.0
38	1107.9	10.0
39	1224.7	10.0
40	1329.8	10.0
41	1306.4	10.0
42	1300.6	10.0
43	1288.9	10.0
44	1131.2	10.0
45	1248.0	10.0
46	1434.9	10.0
47	1586.8	10.0
48	1703.6	10.0
49	1890.4	10.0
50	1913.8	10.0
51	1691.9	10.0
52	1785.3	10.0
53	1925.5	10.0
54	2205.8	10.0
55	2252.5	10.0
56	1505.0	10.0
57	1505.0	10.0
58	1505.0	10.0

===

SAMPLE INFO: LU1341 EUT35 Kspar
(Best fit is 3.68, worst fit is 3.23)

CRS ITERATIONS: 4000
MODEL DURATION (m.y.): 200.0
TIME NODES: 15
CONSTRAINING BRACKETS tT: 4

TIME	TMIN	TMAX
200.0	450.0	500.0
190.0	0.0	500.0
20.0	0.0	500.0
0.0	0.0	500.0

```
MAX MONTE-CARLO HEATING RATE:   5.0   MAX MONTE-CARLO COOLING RATE:   5.0
        MAX CRS HEATING RATE:   0.0           MAX CRS COOLING RATE: 500.0
    CRS AMPLIFICATION FACTOR:   1.40
      SUBSET SIZE, POOL SIZE:   15   150
           FITTING CRITERION:   1.00
              FITTING OPTION:   1  (mean percent)
          DIFFUSION GEOMETRY:   2  (infinite-slab)
              RESTART OPTION:   0  (new start from Monte-Carlo histories)
DISCRETIZATION DELTA-TEMPERATURE:   5.0
           LOVERA SERIES CUT-OFF:   1.0e-04
      FLAG TO WRITE FULL REPORTS:   1

DOMAIN INFO
-----------
Domains:  9
      E        D0       frac.   Tc (10˚C/m.y.)
 1  44.80  9.10131e+21  0.010       156
 2  44.80  6.01318e+20  0.020       179
 3  44.80  1.84121e+19  0.025       211
 4  44.80  1.50350e+18  0.025       237
 5  44.80  6.36948e+16  0.050       275
 6  44.80  2.67365e+16  0.150       286
 7  44.80  1.88410e+16  0.050       291
 8  44.80  1.74222e+16  0.020       292
 9  44.80  9.75223e+14  0.650       334

Goal Age Spectrum
-----------------
Goal spectrum steps:  58
      f39     age    error  skip?
  1  0.001    48.4   11.2   0
  2  0.002    60.2    6.0   1
  3  0.003    71.0    1.8   1
  4  0.005    77.7    0.8   1
  5  0.009    83.9    0.7   1
  6  0.011    86.4    0.3   1
  7  0.015    93.5    0.6   1
  8  0.018   100.2    0.4   1
  9  0.022   107.0    1.4   1
 10  0.025   112.8    0.8   1
 11  0.030   120.0    1.3   1
 12  0.033   120.8    0.4   1
 13  0.037   123.6    0.5   1
 14  0.040   125.2    1.0   1
 15  0.043   126.3    0.7   1
 16  0.046   128.0    0.5   1
 17  0.049   126.3    0.4   1
 18  0.052   129.8    0.6   1
 19  0.057   129.6    0.7   1
 20  0.060   129.1    0.7   1
 21  0.066   129.3    0.5   1
 22  0.069   130.1    0.5   1
 23  0.076   129.3    0.4   1
 24  0.085   130.5    0.4   1
 25  0.100   128.7    0.5   1
 26  0.117   128.5    0.8   1
 27  0.133   128.9    0.5   1
 28  0.150   126.2    0.7   1
 29  0.166   127.2    0.8   1
 30  0.185   126.8    0.6   1
```

31	0.206	127.1	0.7	1
32	0.256	127.7	0.3	1
33	0.293	127.2	0.6	1
34	0.359	127.3	0.5	1
35	0.365	128.3	0.5	1
36	0.383	127.0	0.4	1
37	0.420	126.8	0.5	1
38	0.423	127.1	0.6	1
39	0.433	128.1	0.5	1
40	0.461	128.4	0.6	1
41	0.483	128.3	0.4	1
42	0.501	127.7	0.7	1
43	0.518	127.5	0.7	1
44	0.520	124.0	0.9	1
45	0.526	124.2	0.4	1
46	0.533	127.0	0.7	1
47	0.547	126.2	0.8	1
48	0.569	126.3	0.6	0
49	0.615	124.5	0.3	0
50	0.730	123.8	0.5	0
51	0.869	124.3	0.3	0
52	0.932	125.9	0.3	0
53	0.960	126.9	0.5	0
54	0.992	128.4	0.5	0
55	0.999	127.7	0.6	0
56	1.000	126.1	1.8	0
57	1.000	130.6	9.6	0
58	1.000	131.3	40.5	0

Heating Schedule Actually Used

Heating Steps: 58

	Temp. (C)	Time
1	442.1	10.0
2	455.1	10.0
3	471.9	10.0
4	502.6	10.0
5	536.7	10.0
6	531.9	10.0
7	562.4	10.0
8	568.1	10.0
9	602.4	10.0
10	604.6	10.0
11	637.1	10.0
12	627.6	10.0
13	654.6	10.0
14	662.6	10.0
15	687.4	10.0
16	690.3	10.0
17	716.6	10.0
18	707.9	10.0
19	745.8	10.0
20	734.1	10.0
21	766.3	10.0
22	753.1	10.0
23	802.8	10.0
24	843.6	10.0
25	902.8	10.0
26	937.1	10.0
27	960.4	10.0

28	988.2	10.0
29	1010.1	10.0
30	1036.4	10.0
31	1059.7	10.0
32	1154.6	10.0
33	1156.1	10.0
34	1243.7	10.0
35	1049.5	10.0
36	1151.7	10.0
37	1239.3	10.0
38	1061.2	10.0
39	1131.2	10.0
40	1253.9	10.0
41	1256.8	10.0
42	1259.7	10.0
43	1259.7	10.0
44	1107.9	10.0
45	1178.0	10.0
46	1201.3	10.0
47	1271.4	10.0
48	1341.5	10.0
49	1458.3	10.0
50	1639.3	10.0
51	1767.8	10.0
52	1750.3	10.0
53	1715.2	10.0
54	1925.5	10.0
55	2252.5	10.0
56	1505.0	10.0
57	1505.0	10.0
58	1505.0	10.0

3D thermo-mechanical numerical models

Three-dimensional, coupled thermal-mechanical numerical models were constructed to study orogen scale kinematics and dynamics during the evolution of the St. Elias Orogen, southern Alaska (Hooks, 2009; Koons and others, 2010). These models allow for the testing of the influence of boundary, surface, and geometric characteristics on the evolution of plate corner within a continuum mechanics framework. The model geometry encompasses an area of dimensions 890 km (north-south= Y) by 640 km (east-west =X) with a thickness of 20 km (=Z) (fig. DR2). An isotropic conductive-advective thermal model (thermal conductivity (k) = 2.6 $Wm^{-1}C^{-1}$; radiogenic volumetric heat source (A_v) = 0.37 μWm^{-3}) and Mohr-Coulomb (~upper 15 km; ϕ = 30; cohesion = 44 MPa) and thermally-defined plastic yield condition (~lower 5 km; yield strength = 100 MPa) mechanical models are used to define the thermal and mechanical constitutive models. The models include no initial weaknesses; faults and shear zones develop as the model evolves as a function of partitioning and focusing of strain.

The initial velocity conditions are imposed on the base of the model over an area corresponding to the spatial extent of the Yakutat terrane (south of the Chugach-St. Elias Fault and west of the Fairweather Fault) consistent with its observed motions (~50 mm/yr; Fletcher and others, 2008). All margins of the model, except the surface, have fixed velocity conditions. The top and bottom (-20 km) of the model are conditioned with fixed temperatures of 0 and 400 °C, respectively (fig. DR2).

The modeling path first develops a reference Tectonic Model in the absence of topography or erosion; then the natural topography (Topographic Model*)* and an erosion scheme (Erosion Model*)* are successively applied as initial boundary conditions. The present topography, including bathymetry, was derived from a global 1-minute DEM sampled at the model discretization (~10 km spacing; Smith and Sandwell, 1997). The presence of anomalous topography has been shown to alter the stress state of the crust and can lead to feedback between uplift and localization of strain (Koons and others, 2002). To emphasize the influence of erosion, vigorous erosional conditions are applied based upon the spatial extent of current glaciations and are based on the assumption that glacial erosion maintains a near constant elevation during exhumation (Hallet and others, 1996; Meigs and Sauber, 2000). The erosion model employed for this study maintains the model nodes at a constant elevation (fixed between 500 and 1000 m) within the defined zone of erosion during the model run. Material passing through the model surface at these zones is essentially removed from the model system.

Hooks (2009) shows that the resultant deformation patterns produced by the model are relatively insensitive to the initial surface boundary conditions (i.e. erosion and topography). This suggests that the strain patterns observed within the orogen are primarily controlled by the kinematics and tectonic geometry. As the models reproduce the uplift and strain patterns observed within southern Alaska (Hooks, 2009; Koons et al., 2010), it is assumed that the model kinematic conditions are aptly characterized.

Backward projections of particle paths are extracted from the model. This technique assumes that the velocity conditions have reached near steady-state conditions and define the flux of material through the orogen (Hooks, 2009). Three particle paths were extracted from three locations of exhumation (A, B, and C on Figure 7). Temperatures and velocity conditions were extrapolated from the model grid to yield the three-dimensional paths extrapolated to the depth reach near constant values. Times were calculated using the velocities along the paths.

Supplemental Model Figure

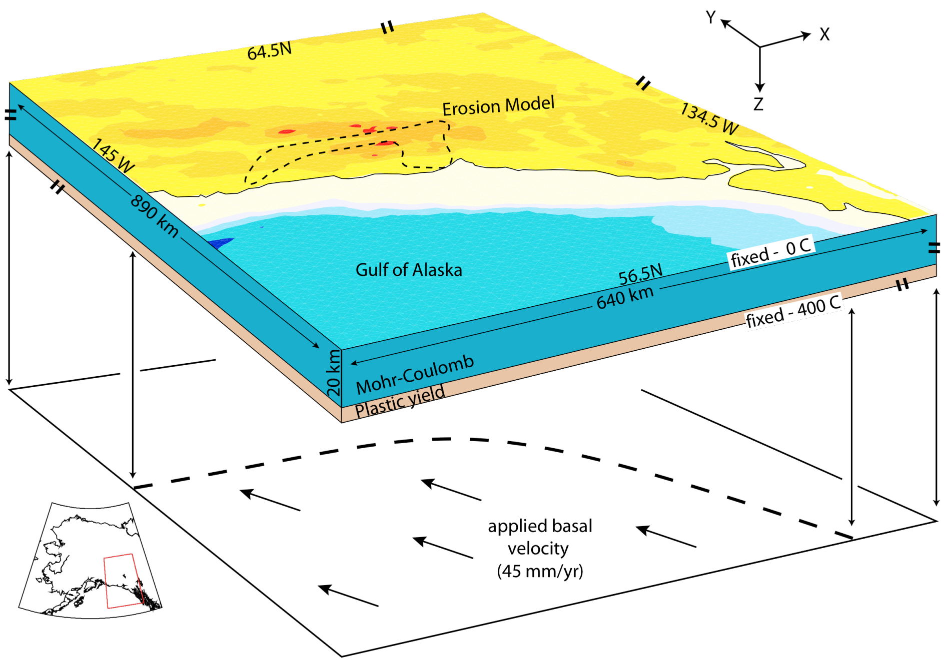

Figure DR2: Model diagram showing 3D geometry and boundary conditions for the numerical model (modified from Hooks, 2009). Not all model boundaries have fixed velocity conditions, except the model surface, which is free to deform. The model surface is conditioned with natural topography (color fill; 1000m contours) and an erosion model (see the dashed outline) that maintains a constant topography by removing material from the surface. A basal drag is applied to the model over the area of the Yakutat Terrane (see drop down plane) by giving the area the observed velocity of the Yakutat Terrane (~45 mm/yr). The model surface and base (~20 km depth) are given fixed temperatures of 0 C and 400 C, respectively.

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