GSA DATA REPOSITORY 2010096

Analytical methods

<u>Ti in quartz method for thermometry</u>

Ti in quartz standards

Due to the difficulty of ablating near-transparent minerals, and to ensure matrix matching between the standards and samples, Ti in quartz standards were made for calibration of Ti concentrations in quartz by laser ablation (LA-ICP-MS). A gel method was used to prepare homogenous standards at temperatures below the melting point of quartz (1770°C), obtainable by standard box furnaces (<1500°C). Gel preparation is based on methodology of Biggar and O'Hara (1969) and O'Hara (1970).

Tetra ethyl ortho silicate (TEOS) and ethanol (1:1) were added to a weighed Ti solution and mixed thoroughly to homogenize the solution. Ammonium hydroxide was added, sealed and left at room temperature overnight to precipitate a gel. The gel was dried at 75°C for several hours and subsequently at 100°C overnight. Dry gels were transferred to a platinum crucible and heated slowly. The temperature was increased every two hours to 200°C, 300°C and 500°C before annealing at 900°C overnight and 1000°C for 8 hours followed by further annealing 1200°C for 24 hours. Titanium concentrations of quartz standard were confirmed by solution inductively coupled plasma mass spectrometry (ICP-MS). Standards with 1.7, 4.4 and 9.6 ppm Ti were prepared by this method and used to calibrate the laser analyses.

Laser ablation analysis of Ti

Titanium in quartz analyses were performed using a New Wave 213nm laser combined with Thermo X Series II inductively coupled plasma mass spectrometry (LA-ICP-MS) at the University of Victoria using helium as the transport gas. Quartz was ablated using short line scans to help prevent cracking of the crystals using a scan rate of 12 μm/s, 10 Hz pulse frequency and a 55 μm spot size and a laser output energy of ~0.12 mJ (producing a fluence of ~5.5 J/cm^2). These analytical conditions maintained the integrity of friable crystals and avoided burning through 75 μm 'thick' section of the samples while yielding sufficient material for accurate and precise Ti analysis. Line scans were approximately 50 to 100 μm, over which compositional variations were not apparent.

Using these conditions the detection limit was 0.2 ppm (10 s.d. of background), and the precision was ±0.3 ppm 2 s.e. (standard error of the deviation of measured standards from the calibration).

Whole rock and mineral analyses

Major elements

Bulk rock samples were jaw crushed and ground in an agate mill at University of Victoria or by agate mortar at Duke University. Major elements were analysed by Direct Current Plasma (DCP) at Duke University following the methodology of Klein et al. (1991) and high Si samples that gave low totals were duplicated by XRF at Washington State University (WSU), analytical details can be found in Johnson et al. (1999). Samples analysed by XRF gave totals of 98-100% with higher Si contents, where DCP analyses had given low totals associated with undissolved silica. Therefore XRF major element data for duplicates is presented in this study.

Trace element analyses

Trace element analyses were performed on the same powders as major element analyses. 100 mg of sample was digested with HF-HNO_3 dried down and redigested in 8N HNO_3. Subsequently they were redried and then diluted by a factor of 1:1000 in 2% HNO3 solution. Trace elements were analyzed using a Thermo X Series II inductively coupled plasma mass spectrometry (ICP-MS) following the approach of Eggins et al., (1997) at the University of Victoria. BIR-1 was routinely measured to monitor for drift, and DNC-1, W2-A, BCR-2, BHVO-2 rock standards were analyzed for calibration at the start and end of analytical sessions (Data Repository Item, Table DR4).

Strontium isotope analyses

The $^{87}Sr/^{86}Sr$ of fault breccias and basalts were measured on leached versions of the same whole rock powders used for elemental analysis. Powders were leached with 5% HCl prior to digestion to remove any calcite that may have precipitated from seawater subsequent to the high-temperature alteration event. Strontium was separated by standard cation exchange techniques (Weis et al., 2006) and measured using a Triton thermal ionization mass spectrometry at the Pacific Centre for Isotopic and Geochemical Research, University of British Columbia. The NBS 987 standard gave

$^{87}Sr/^{86}Sr$ = 0.710238 ± 0.000012 (2 s.d., n= 3) and BCR-2 measured $^{87}Sr/^{86}Sr$ = 0.705006 ±10 (2 s.d.) and the Sr blank was 13 pg.

Electron microprobe analyses

Chlorite, plagioclase and epidote compositions were measured by wavelength-dispersive-spectrometry using a Cameca SX-50 electron microprobe at University of British Columbia using standard operating conditions of 15 vK, 20 nA beam current with 10 nA for chlorite, 20s counting times and spot size of 5 μm for plagioclase and epidote and 10 μm for chlorite (Data Repository Item Table DR5). A series of natural and synthetic standards were used for data reduction by the methodology of Pouchou and Pichoir (1985).

References:

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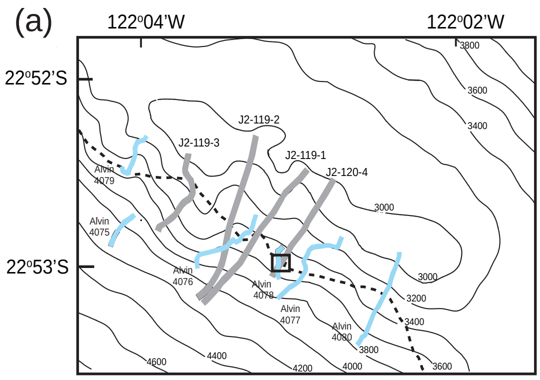
DR1 (a) Location map shows contours at 200 m intervals and Jason (grey) and Alvin (blue) dive tracks. Dashed line marks lava-dike transition. Box shows location of study area (b).
(b) Sample locations in relation to fault strands and lava-dike transition. Photographs and photomicrographs show relationship between outcrops, samples and petrography. Photomicrographs illustrate inter-growth of quartz and chlorite in matrix and veins. Samples prefixes 4078 and 021005 correpond to Alvin and Jason dive samples respectively.



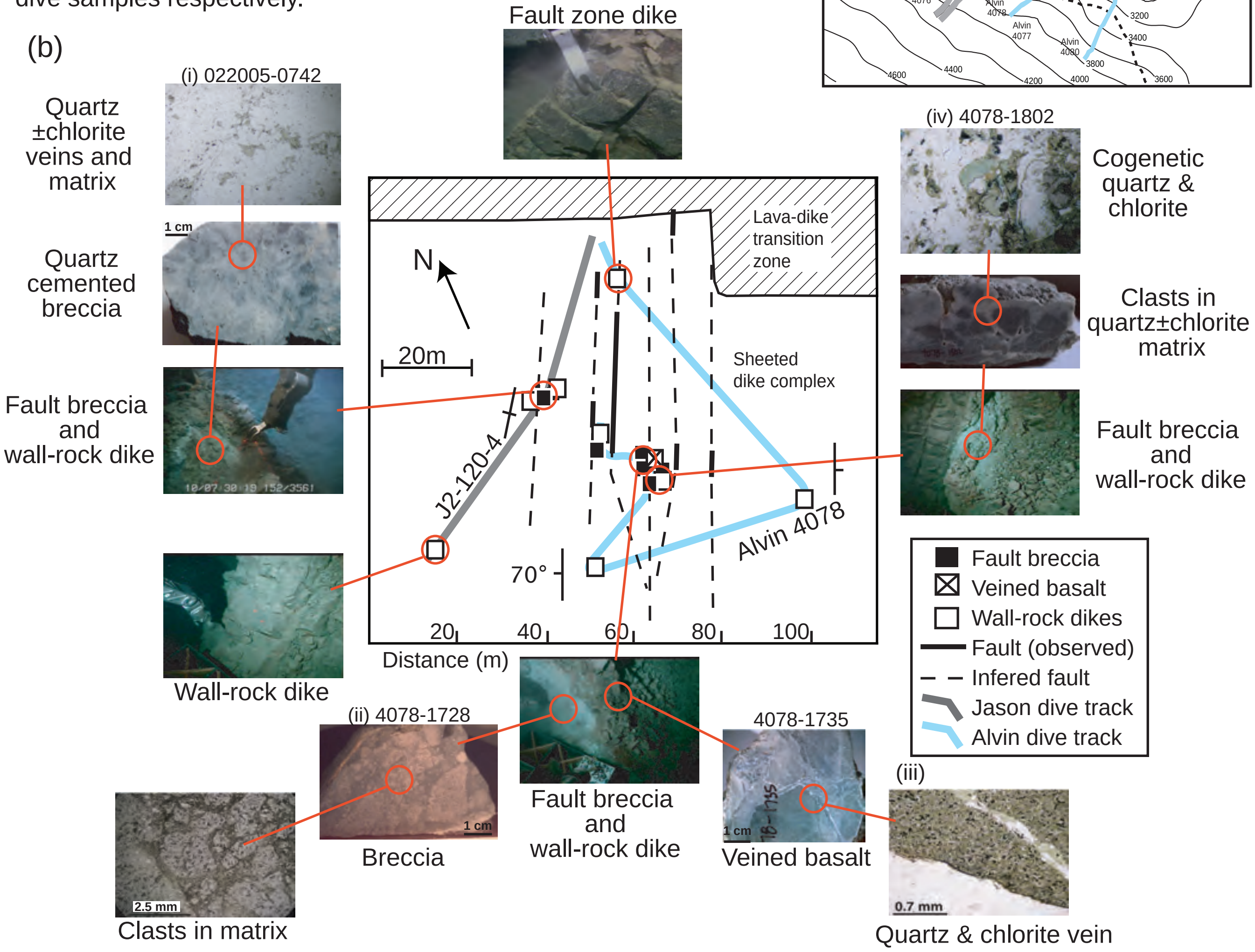


Table DR1. Titanium conentrations in quartz and results of Ti-quartz thermometry for Ti activities of 1 and 0.7.

Sample	Quartz Lithology	Ti ppm	Temperature (°C)	
			$a(TiO_2)=1$	$a(TiO_2)=0.7$
4078-1728	vein	0.73	373	421
	vein	1.85	421	476
	vein	1.30	402	454
	vein	1.70	417	471
	vein	2.12	429	485
	vein	1.60	413	467
	vein	2.19	431	487
	vein	1.72	417	472
	vein	0.60	364	410
4078-1735	vein	1.14	395	446
	vein	2.06	427	483
	vein	2.11	429	485
	vein	0.29	332	373
	vein	1.45	408	461
	vein	2.15	430	486
	vein	1.48	409	462
	groundmass	1.86	422	477
	vein	1.68	416	470
4078-1742A	vein	0.37	342	385
	vein	0.45	351	395
	vein	0.39	344	387
	vein	1.35	404	456
	vein	0.30	333	374
	vein	1.49	409	463
	vein	0.61	365	411
	vein	1.68	416	470
	vein	0.27	329	369
	vein	0.25	325	366
	vein	0.32	336	378
	vein	1.14	395	446
	vein	1.09	393	444
4078-1742B	vein	0.76	375	423
	groundmass	1.86	422	477
	groundmass	2.18	431	487
	vein	2.44	437	495
	vein	0.56	361	406
	vein	0.70	371	418
	vein	1.41	407	459
	vein	0.45	351	395
	vein	<d.l.		
	vein	<d.l.		

	groundmass	<d.l.		
	groundmass	<d.l.		
4078-1802	vein	1.90	423	478
	vein	1.20	398	449
	vein	0.60	364	410
	vein	1.04	391	441
	vein	1.22	399	450
	vein	1.64	415	469
	vein	1.75	418	473
	vein	0.97	387	437
	vein	1.55	412	465
021005-0742	vein	1.20	398	449
	vein	0.66	368	415
	vein	0.25	325	366
	vein	1.78	419	474
	vein	1.17	397	448
	vein	1.18	397	448
	vein	2.12	429	485
	vein	2.00	426	481
	vein	1.85	421	476
	vein	<d.l.		
	vein	0.36	341	383
Mean		1.25	392	411
Standard deviation		0.64	33	35

The detection limit is 0.2 ppm, which equates to 316 and 331 ^{o}C for $a(TiO_2)$ of 1 and 0.7 respectively.

Table DR2. Petrography, major, trace element and Sr isotopes.

Sample	Rock type	Location						Petrography								
		Depth (mbsl)	Longitude	Latitude	X	Y	Depth below ldt	cpx altern	% cpx altern	fsp altern	gm altern	% gm altern	clasts	matrix	veins	patches
4078-1709	basalt	3561	-112.052482	-22.884384	4834	5455	82	amph	20-30%	amph, fsp2	amph, sulph	20%				
4078-1718	fault breccia	3562	-112.052482	-22.884411	4834	5452	83						fsp2, chl, ampl	amph, fsp, chl,	qtz, chl	
4078-1718B																
4078-1720	fault breccia	3562	-112.052482	-22.884411	4834	5452	83						cpx, amph, fsp	chl, fsp, cpx, ar	sulphide vein, (	chl
4078-1728	fault breccia	3559	-112.052404	-22.884474	4842	5445	80						cpx, amph, fsp	amph, qtz, chl,	amph, chl, qtz	chl/amph patch
4078-1735	veined basalt	3559	-112.052404	-22.884474	4842	5445	80	amph	100%	amph, fsp2	sulphides, chl/a	80-100%			qtz, chl, chl/sm, with titanite, ep	
4078-1735B																
4078-1742	fault breccia	3660	-112.052404	-22.884474	4842	5445	81						qtz, chl, sulphi	qtz, chl, sulphi	qtz, with titanite	
4078-1742B																
4078-1759	basalt	3558	-112.052405	-22.88451	4842	5441	79	v.fine gr	-	v.fine gr	amph, fsp, sulp	50%			1) amph, 2) amph, qtz, sulph	
4078-1800	fault breccia	3558	-112.052405	-22.88451	4842	5441	79						fsp, amph, ep,	chl, qtz, epidote, talc, +/- ampl		1) chl, 2) sulphi
4078-1800B													chl/qtz, amph	qtz, chl	qtz, chl	
4078-1802	fault breccia	3558	-112.052405	-22.88451	4842	5441	79						amph, fsp, chl,	fsp, qtz, chl, an	qtz	chl
4078-1802B																
4078-1807	basalt	3558	-112.052405	-22.88451	4842	5441	79	amph	70-80%	amph, fsp2	amph, chl, sulp	60-70%			chl, qtz	qtz, chl
4078-1817	basalt	3560	-112.05262	-22.884617	4820	5429	81	amph	20-30%	amph, fsp2	amph, amph/ch	20-30%			chl (core), qtz,	chl, chl/amph
4078-1833	basalt	3547	-112.052113	-22.884657	4872	5425	68	amph	10%	amph, fsp2, chl	amph, chl/ampl	5%			1) chl/amph, qtz 2) amph	
4078-1833	basalt	3547	-112.052113	-22.884657	4872	5425	68									
4078-1903	basalt	3523	-112.052304	-22.884123	4852	5484	44	v.fine gr	-	freshish	fsp, amph, preh	-			fine sulph, qtz, amph	
4078-1951	basalt	3379	-112.052127	-22.882715	4869	5640	-100	amph	50-60%	fsp2, amph	amph, chl	40-50%			chl, chl/amph, (	chl
4078-2020	basalt	3333	-112.051984	-22.883059	4884	5602	-146	amph	20%	amph, fsp2	-	-				
021005-0708	basalt	3593	-112.05294	-22.884462	4787	5446	114	amph	30-40%	amph, fsp2	amph, chl, sulp	40-60%			qtz, chl, talc, amph, titanite	
021005-0730	fault breccia	3561	-112.052588	-22.884274	4823	5467	82						fsp, amph, sulp	amph, chl, ep,	amph	chl, sulphide
021005-0730B	fault breccia	3561	-112.052588	-22.884274	4823	5467	82									
021005-0731	basalt	3561	-112.052588	-22.884274	4823	5467	82	amph	30-40%	amph, fsp2	amph, chl, chl/s	40-50%			qtz, chl	
021005-0731B	basalt	3561	-112.052588	-22.884274	4823	5467	82									
021005-0741	basalt	3561	-112.052588	-22.884274	4823	5467	82	amph	60-70%	amph, fsp2	chl, amph/chl, a	40-50%				
021005-0741B																
021005-0741C																
021005-0742	fault breccia	3557	-112.052549	-22.884275	4827	5467	78						amph, fsp, chl,	qtz, chl, sulphi	qtz, titanite, epidote	
021005-0817	basalt	3479	-112.052085	-22.883528	4874	5550	0	amph	10%	amph, fsp2	amph	20-30%				
021005-0817B																
021005-0834	basalt	3458	-112.052095	-22.883501	4873	5553	-21	amph	30-40%	fsp2, amph	v. fine gr.	-			amph, sulph	
021005-0839	basalt	3457	-112.052134	-22.883537	4869	5549	-22	amph	<5%	amph, fsp2	amph, sulph,	20-30%				

Data sources for major element data: MP - Pollock et al., 2009, NH - Hayman and Karson, 2009, XRF denotes samples analysed by XRF at WSU, all others are by DCP at Duke University.
Abbreviations: ldt - lava dike transition zone, amph- amphibole, chl-chlorite, sulph-sulphides, qtz-quartz, sm-smectite, chalco - chalcopyrite, cpx-clinopyroxene, fsp- feldspar, fsp2-secondary feldspar, chl/sm - chlorite smectite interlayers, amph/chl- amphibole chlor
B, C denote duplicates and triplicates

			Major elements													Trace elements														
% qtz	misc	% sulphides	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_3	LOI	Total	source	Sc	Ti	V	Cr	Co	Ni	Cu	Zn	Rb	Sr	Y	Zr	Cs	Ba	La
			50.7	1.3	13.6	11.1	0.2	8.1	12.2	2.5	0.1	-	1.2	99.9	NH	46	8275	319	169	42	63	59	78	0.045	90	29	81	0.002	1.95	1.73
10%		1-2%	59.0	1.5	11.7	14.0	0.2	9.0	1.9	2.5	0.1	-		99.7		34	8503	279	61	36	34	21	213	0.03	8	30	86	0.001	0.52	1.77
			-	-	-	-	-	-	-	-	-	-	-	-		34	8520	279	60	36	33	22	213	0.033	9	31	87	0.002	0.51	1.87
5%		1%	53.3	1.3	14.2	10.6	0.2	10.8	5.1	4.0	0.1	-	3.8	99.4		37	6836	263	200	38	66	125	91	0.046	54	21	67	0.002	0.95	1.36
30%	chalco + pyrite	1-2%	83.4	0.4	5.0	4.6	0.1	4.2	0.9	1.0	0.0	0.0		99.7	NH - XRF	12	2344	80	79	20	25	36	45	0.089	7	9	22	0.005	1.01	0.88
idote			55.4	1.6	12.6	12.9	0.1	8.1	2.4	3.8	0.1	-		97.1	NH	39	9369	307	111	42	50	12	67	0.074	21	36	99	0.007	0.64	1.97
			-	-	-	-	-	-	-	-	-	-	-	-		40	9401	309	111	42	50	12	68	0.076	21	36	99	0.007	0.63	1.95
80-100%	chalco + pyrite	5-20%	97.0	0.1	1.1	1.5	0.0	0.9	0.1	0.0	0.0	0.0		100.8	NH -XRF	7	1497	65	35	19	13	1525	28	0.029	2	7	16	0.002	0.43	0.32
			-	-	-	-	-	-	-	-	-	-	-	-		7	1500	66	35	19	13	1535	29	0.028	2	7	16	0.002	0.43	0.32
			51.7	1.8	13.4	13.7	0.3	6.6	10.0	3.1	0.1	-	1.9	100.7	NH	43	10750	374	57	44	40	62	104	0.075	96	40	112	0.004	3.33	2.70
ides	pyrite	10%	72.4	0.8	8.0	9.7	0.1	6.2	1.1	1.0	0.2	-	3.9	99.4		20	4512	149	121	40	41	4	47	0.065	4	16	49	0.006	0.28	1.14
50%	pyrite	1-5%	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20-80%	pyrite	1-5%	92.9	0.1	2.0	1.4	0.0	1.2	0.2	0.3	0.0	0.0		98.2	NH-XRF	3	603	23	27	6	9	40	121	0.046	6	2	7	0.002	1.00	0.18
			-	-	-	-	-	-	-	-	-	-	-	-		3	607	23	28	7	8	41	122	0.046	6	2	7	0.002	0.99	0.18
			51.1	1.4	14.1	11.3	0.2	8.8	9.8	2.4	0.0	-	3.7	99.2		38	7733	285	146	36	54	19	42	0.065	74	26	85	0.008	1.39	1.59
			51.1	1.5	14.1	11.9	0.2	8.7	10.6	2.4	0.1	-	2.1	100.5	MP	41	8411	309	146	38	53	84	49	0.036	79	27	78	0.003	1.62	1.48
			50.9	1.4	13.9	11.6	0.2	8.6	10.5	2.5	0.0	-	1.9	99.7	NH	43	8414	313	130	41	58	85	99	0.052	84	30	72	0.006	2.31	2.02
			-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			51.3	1.8	13.6	13.8	0.3	6.8	10.0	3.1	0.1	-	1.2	100.6	MP	42	10509	364	56	40	36	58	91	0.054	89	34	109	0.003	2.62	1.88
			49.7	1.6	15.0	11.2	0.2	8.3	9.9	2.6	0.1	-	2.7	98.4		38	8628	279	212	34	76	72	94	0.191	102	27	100	0.006	5.22	2.53
			50.8	1.3	14.7	10.7	0.2	8.3	11.4	2.8	0.1	-	2.1	100.2	MP	41	7385	287	227	38	76	61	78	0.132	95	23	74	0.011	2.60	1.35
			-	-	-	-	-	-	-	-	-	-	-	-																
			50.3	1.3	15.1	10.5	0.2	8.4	11.4	2.5	0.0	-	1.5	99.8	MP	41	7539	285	293	35	73	10	35	0.069	83	25	74	0.001	1.98	1.39
<5%	pyrite	1-5%	51.5	1.4	14.3	11.5	0.2	10.7	7.2	3.1	0.1	-	3.4	100.1		40	7705	286	202	40	66	96	108	0.112	66	28	80	0.006	1.67	1.84
			51.1	1.3	14.3	11.1	0.2	10.4	6.9	3.2	0.2	-	3.6	98.7		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			50.4	1.4	14.3	10.9	0.2	8.6	11.0	2.6	0.1	-	1.8	99.3		42	7873	293	212	39	64	72	59	0.052	89	26	81	0.004	1.86	1.62
			51.0	1.3	14.2	10.7	0.2	8.7	11.3	2.5	0.0	-	2.0	99.9	MP	42	8001	298	215	39	65	72	59	0.053	90	26	84	0.004	1.91	1.55
			50.4	1.3	15.0	10.4	0.2	9.8	9.4	2.6	0.0	-	2.7	99.1		38	7037	265	288	34	65	11	55	0.051	70	25	70	0.004	1.59	1.52
																41	7555	286	304	37	69	12	61	0.062	74	27	76	0.005	1.62	1.73
																39	7090	268	290	34	65	12	55	0.052	71	25	70	0.004	1.57	1.50
60-100%	chalco + pyrite	2-10%	90.7	0.2	2.1	3.1	0.0	1.9	0.2	0.1	0.0	0.0	1.3	98.3	NH-XRF	4	729	38	20	12	8	336	15	0.026	2	4	5	0.001	0.57	0.15
			50.3	1.4	14.2	11.6	0.2	7.9	10.9	2.9	0.1	-	1.7	99.5		43	8565	320	130	40	57	63	90	0.084	96	31	83	0.004	2.71	1.99
			-	-	-	-	-	-	-	-	-	-	-	-		44	8707	325	132	41	57	63	91	0.085	98	31	84	0.004	2.77	1.99
			51.0	1.1	15.5	9.9	0.2	8.7	12.2	2.7	0.0	-	1.5	101.4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			50.2	1.5	14.0	11.7	0.2	7.6	10.9	2.9	0.1	-	1.4	98.9		44	9274	338	127	43	53	68	94	0.315	102	37	96	0.010	2.84	2.73
		Standards																												
		AGV-1	58.9	1.0	17.3	6.6	0.1	1.5	4.8	4.3	3.3			98.0	BIR-1	43	5650	319	386	52	167	121	68	0.19	109	16	15	0.005	6.21	0.59
		AGV-1	58.8	1.0	17.2	6.6	0.1	1.5	4.8	4.3	3.2			97.7	2 s.d.	1	60	3	4	1	2	1	1	0.01	1	0	0	0.000	0.07	0.01
		AII-92(29-1)	49.9	1.7	15.6	10.8	0.2	7.4	10.9	3.0	0.2			99.6																
ite intergrowth, v.fine gr - ve		BHVO-1a	49.9	2.7	13.6	12.2	0.2	7.2	11.3	2.2	0.8			100.0	WA-2	35	6225	260	87	43	69	106	75	19.89	197	22	90	0.856	163.83	10.32
		BHVO-1a	50.1	2.7	13.6	12.2	0.2	7.2	11.3	2.2	0.8			100.2	WA-2	35	6269	262	87	43	69	106	75	20.13	197	22	89	0.872	163.99	10.35
		BIR-1	48.0	0.9	15.6	11.4	0.2	9.6	13.1	1.8	0.0			100.6																
		BIR-1	48.3	1.0	15.5	11.6	0.2	9.9	13.5	1.8	0.0			101.8	DNC-1	32	2837	149	282	57	262	96	63	3.63	146	18	36	0.202	100.53	3.64
		DNC-1	47.7	0.5	18.6	10.0	0.2	10.2	11.3	1.9	0.4			100.9	DNC-1	32	2872	151	284	58	263	98	64	3.70	148	18	36	0.203	100.87	3.63
		DNC-1	47.6	0.5	18.6	10.1	0.2	10.2	11.3	1.9	0.5			100.9																
		G-2	69.0	0.5	15.4	2.7	0.0	0.8	2.0	4.1	4.3			98.7	BCR-2	33	13415	410	15	37	12	25	130	47.49	344	37	192	1.122	688.07	25.02
		G-2	69.0	0.5	15.4	2.7	0.0	0.8	2.0	4.1	4.1			98.5	BCR-2	33	13591	411	15	37	12	25	131	47.99	344	37	192	1.122	681.70	24.83
		W-2a	53.0	1.1	15.3	10.8	0.2	6.4	10.9	2.2	0.9			100.8																
		W-2a	52.4	1.1	15.2	10.8	0.2	6.4	10.8	2.2	0.8			99.9																
		688	47.9	1.1	17.3	10.2	0.2	8.4	11.9	2.1	0.2			99.3																
		688	48.3	1.1	17.2	10.4	0.2	8.5	12.0	2.1	0.4			100.1																

Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Pb	Th	U	$^{87}Sr/^{86}Sr$	2sd
5.93	1.10	6.32	2.48	1.01	3.33	0.67	4.52	1.02	2.92	0.46	2.97	0.45	2.16	0.33	0.06	0.03	0.702498	0.000007
6.54	1.24	6.99	2.67	1.03	3.58	0.71	4.78	1.08	3.09	0.48	3.09	0.46	2.29	0.15	0.07	0.17	-	-
6.79	1.28	7.16	2.73	1.04	3.68	0.72	4.87	1.11	3.15	0.49	3.14	0.47	2.32	0.16	0.07	0.18		
4.59	0.85	4.79	1.89	0.82	2.56	0.51	3.48	0.79	2.26	0.35	2.30	0.34	1.79	0.14	0.06	0.07	0.704370	0.000008
2.60	0.44	2.32	0.82	0.32	1.09	0.21	1.38	0.31	0.88	0.13	0.86	0.13	0.61	0.07	0.02	0.12	0.70503	0.000009
7.76	1.51	8.57	3.26	1.05	4.40	0.86	5.77	1.29	3.68	0.57	3.67	0.54	2.64	0.60	0.08	0.05	0.704559	0.000009
7.76	1.50	8.55	3.30	1.05	4.35	0.86	5.73	1.29	3.66	0.57	3.66	0.54	2.66	0.60	0.08	0.05		
1.17	0.22	1.27	0.50	0.18	0.72	0.15	0.99	0.23	0.65	0.10	0.66	0.10	0.43	0.24	0.01	0.11	0.704604	0.000007
1.17	0.22	1.27	0.51	0.18	0.73	0.15	0.99	0.23	0.65	0.10	0.68	0.10	0.44	0.24	0.01	0.11		
9.19	1.70	9.54	3.60	1.26	4.82	0.95	6.35	1.43	4.06	0.63	4.11	0.62	2.91	0.48	0.09	0.04	0.702620	0.000007
3.61	0.65	3.55	1.38	0.66	1.88	0.38	2.52	0.57	1.61	0.25	1.60	0.24	1.25	0.10	0.06	0.18	0.705171	0.000032
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.53	0.09	0.49	0.18	0.07	0.25	0.05	0.34	0.08	0.22	0.04	0.23	0.03	0.19	0.03	0.01	0.08	0.702989	0.000007
0.53	0.09	0.48	0.18	0.07	0.25	0.05	0.33	0.08	0.22	0.03	0.23	0.03	0.18	0.03	0.01	0.08		
5.55	1.04	5.88	2.28	0.91	3.07	0.61	4.11	0.93	2.65	0.41	2.65	0.40	2.19	0.13	0.06	0.03	0.702671	0.000009
5.11	0.96	5.52	2.23	0.97	3.09	0.62	4.27	0.97	2.77	0.44	2.83	0.43	2.09	0.26	0.06	0.03	-	-
6.84	1.26	7.15	2.76	1.09	3.69	0.73	4.84	1.08	3.04	0.47	3.03	0.46	2.07	0.12	0.06	0.03	0.702749	0.000010
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.702783	0.000008
6.54	1.23	7.06	2.82	1.12	3.83	0.78	5.24	1.20	3.46	0.54	3.54	0.54	2.84	0.22	0.08	0.04	0.702577	0.000009
7.59	1.31	7.04	2.54	0.97	3.20	0.64	4.24	0.96	2.76	0.43	2.80	0.43	2.41	0.66	0.17	0.08	0.702744	0.000008
4.47	0.83	4.80	1.94	0.83	2.73	0.54	3.72	0.85	2.42	0.38	2.44	0.37	1.97	0.21	0.07	0.03	-	-
4.91	0.94	5.50	2.20	0.92	2.99	0.60	4.04	0.92	2.60	0.40	2.63	0.40	1.98	0.08	0.07	0.03	0.702944	0.000008
6.30	1.17	6.58	2.53	0.96	3.35	0.66	4.45	1.00	2.84	0.44	2.82	0.42	2.11	0.18	0.07	0.06	0.703526	0.000008
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.54	1.04	5.89	2.29	0.96	3.13	0.62	4.16	0.95	2.69	0.42	2.72	0.41	2.11	0.18	0.06	0.03	0.702678	0.000008
5.39	1.01	5.73	2.28	0.97	3.09	0.62	4.16	0.94	2.69	0.42	2.73	0.41	2.18	0.18	0.06	0.03	-	-
5.21	0.97	5.53	2.17	0.88	2.97	0.59	4.01	0.90	2.57	0.40	2.61	0.39	1.89	0.24	0.06	0.03	-	-
5.93	1.11	6.28	2.45	0.95	3.31	0.66	4.41	0.99	2.84	0.44	2.82	0.43	2.02	0.25	0.07	0.03	-	-
5.19	0.97	5.52	2.19	0.87	2.96	0.59	3.99	0.91	2.59	0.40	2.61	0.39	1.89	0.24	0.06	0.03	-	-
0.54	0.10	0.59	0.25	0.10	0.40	0.08	0.56	0.13	0.38	0.06	0.36	0.06	0.15	0.15	0.01	0.27	-	-
6.59	1.22	6.88	2.67	1.04	3.64	0.72	4.82	1.09	3.10	0.48	3.10	0.47	2.23	0.37	0.08	0.03	0.702548	0.000009
6.60	1.22	6.90	2.69	1.05	3.65	0.73	4.88	1.10	3.14	0.48	3.13	0.47	2.25	0.37	0.08	0.03	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.702647	0.000008
9.34	1.71	9.50	3.55	1.27	4.68	0.91	5.97	1.33	3.76	0.58	3.68	0.55	2.48	0.35	0.09	0.06	0.702493	0.000007
1.84	0.37	2.34	1.10	0.50	1.70	0.36	2.50	0.58	1.65	0.26	1.66	0.25	0.56	3.59	0.04	0.01		
0.01	0.00	0.02	0.01	0.00	0.02	0.00	0.02	0.01	0.02	0.00	0.01	0.00	0.01	0.02	0.00	0.00		
22.78	2.98	12.81	3.32	1.10	3.61	0.62	3.76	0.80	2.18	0.33	2.07	0.31	2.32	7.72	2.11	0.47		
22.73	2.98	12.71	3.32	1.10	3.66	0.62	3.77	0.80	2.19	0.33	2.08	0.31	2.33	7.70	2.06	0.48		
8.08	1.11	4.97	1.46	0.60	1.97	0.39	2.73	0.65	1.91	0.30	1.98	0.31	0.96	6.67	0.24	0.05		
8.08	1.10	4.92	1.44	0.60	1.99	0.39	2.75	0.64	1.90	0.30	2.00	0.31	0.96	6.63	0.23	0.05		
53.68	6.90	28.93	6.76	2.04	6.83	1.09	6.37	1.34	3.65	0.55	3.45	0.52	4.80	10.50	5.82	1.58		
53.35	6.90	28.56	6.73	2.03	6.83	1.08	6.35	1.33	3.65	0.54	3.46	0.52	4.85	10.45	5.75	1.63		
																BCR-2	0.705006	0.000010
																NBS987	0.710231	0.000011
																NBS987	0.710241	0.000007
																NBS987	0.710242	0.000009

Table DR3. Mineral chemistry

Chlorite mineral analyses

Sample	Transect	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	Cr_2O_3	Total
4078-1728	Alvin 4078	29.28	0.00	16.47	21.82	0.26	19.27	0.08	0.07	0.03	-	87.29
4078-1728	Alvin 4078	29.04	0.06	16.44	21.70	0.30	19.20	0.12	0.06	0.03	-	86.96
4078-1728	Alvin 4078	29.15	0.05	16.90	21.89	0.29	18.69	0.06	0.11	0.01	-	87.14
4078-1728	Alvin 4078	27.92	0.00	18.48	22.97	0.15	17.62	0.04	0.02	0.00	-	87.20
4078-1728	Alvin 4078	48.74	0.03	12.20	16.46	0.22	14.90	0.06	0.12	0.04	-	92.77
4078-1728	Alvin 4078	27.26	0.00	17.43	21.26	0.20	18.11	2.19	0.05	0.06	-	86.55
4078-1728	Alvin 4078	27.64	0.03	16.84	22.96	0.22	17.67	0.12	0.09	0.06	-	85.62
4078-1728	Alvin 4078	28.17	0.04	17.91	21.76	0.16	19.36	0.07	0.05	0.05	-	87.58
4078-1728	Alvin 4078	27.72	0.02	17.50	24.00	0.14	18.00	0.02	0.04	0.04	-	87.47
4078-1735	Alvin 4078	28.41	0.01	17.04	22.90	0.28	18.22	0.05	0.06	0.04	-	87.00
4078-1735	Alvin 4078	28.10	0.04	17.72	23.12	0.18	18.55	0.05	0.08	0.02	-	87.86
4078-1735	Alvin 4078	28.03	0.00	17.21	22.36	0.25	18.12	0.04	0.04	0.03	-	86.08
4078-1735	Alvin 4078	28.25	0.09	17.24	23.19	0.32	18.39	0.10	0.05	0.05	-	87.67
4078-1735	Alvin 4078	29.60	0.05	15.67	21.75	0.24	18.64	0.17	0.07	0.09	-	86.29
4078-1735	Alvin 4078	29.73	0.01	16.30	21.74	0.19	18.91	0.13	0.01	0.05	-	87.08
4078-1735	Alvin 4078	30.04	0.03	16.34	22.16	0.17	19.38	0.07	0.02	0.06	-	88.27
4078-1735	Alvin 4078	29.80	0.03	16.01	22.29	0.15	18.87	0.10	0.03	0.08	-	87.36
4078-1735	Alvin 4078	29.76	0.04	16.32	22.37	0.16	19.31	0.11	0.04	0.05	-	88.17
4078-1735	Alvin 4078	29.65	0.00	16.44	22.22	0.25	19.72	0.10	0.04	0.08	-	88.48
4078-1742	Alvin 4078	28.76	0.22	15.82	22.21	0.26	17.81	0.28	0.08	0.04	-	85.47
4078-1742	Alvin 4078	29.55	0.07	16.19	22.42	0.26	18.87	0.10	0.04	0.06	-	87.57
4078-1742	Alvin 4078	29.14	0.00	15.57	21.58	0.17	18.09	0.10	0.07	0.06	-	84.78
4078-1742	Alvin 4078	29.77	0.01	16.66	20.26	0.27	19.84	0.26	0.09	0.07	-	87.22
4078-1742	Alvin 4078	30.19	0.04	16.20	20.21	0.20	20.16	0.11	0.03	0.07	-	87.21
4078-1742	Alvin 4078	30.15	9.30	11.93	15.40	0.29	14.98	7.33	0.03	0.02	-	89.44
4078-1742	Alvin 4078	30.08	0.03	16.63	20.75	0.27	20.04	0.09	0.03	0.04	-	87.96
4078-1802	Alvin 4078	27.73	0.01	17.54	22.42	0.16	18.33	0.04	0.06	0.06	-	86.37
4078-1802	Alvin 4078	28.15	0.10	17.38	21.64	0.22	18.21	0.09	0.06	0.04	-	85.91
4078-1802	Alvin 4078	29.11	0.00	17.03	24.20	0.43	16.85	0.12	0.08	0.11	-	87.94
4078-1802	Alvin 4078	28.05	0.04	17.41	21.95	0.21	18.57	0.09	0.03	0.01	-	86.35
021005-0742	Jason J2-120-4	29.15	0.02	16.87	22.71	0.29	17.59	0.28	0.10	0.07	-	87.10
021005-0742	Jason J2-120-4	29.04	0.16	16.32	22.72	0.25	17.96	0.28	0.12	0.07	-	86.92
021005-0742	Jason J2-120-4	28.70	0.00	17.50	22.19	0.18	18.86	0.05	0.00	0.02	-	87.49
021005-0742	Jason J2-120-4	28.64	0.00	17.16	22.48	0.28	18.95	0.06	0.00	0.05	-	87.63
021005-0742	Jason J2-120-4	28.79	0.03	17.20	22.40	0.31	18.83	0.07	0.01	0.00	-	87.64
021005-0742	Jason J2-120-4	27.66	0.01	17.21	24.99	0.28	16.86	0.17	0.01	0.01	-	87.20
021005-0742	Jason J2-120-4	28.89	0.01	16.42	24.09	0.29	17.62	0.05	0.12	0.10	-	87.59
021005-0742	Jason J2-120-4	29.29	0.02	16.77	22.86	0.32	17.51	0.06	0.15	0.09	-	87.08

Plagioclase mineral analyses

Sample	Transect	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	Cr_2O_3	Total
4078-1728	Alvin 4078	66.71	-	19.73	0.13	0.03	0.05	0.51	10.84	0.13	-	98.12
4078-1728	Alvin 4078	68.95	-	20.08	0.07	0.00	0.01	0.45	11.35	0.04	-	100.95
4078-1728	Alvin 4078	67.09	-	19.85	0.11	0.00	0.04	0.53	10.61	0.09	-	98.32
4078-1728	Alvin 4078	69.55	-	19.79	0.18	0.03	0.00	0.34	11.31	0.02	-	101.22
4078-1728	Alvin 4078	67.34	-	19.99	0.23	0.00	0.03	0.40	11.18	0.04	-	99.21
4078-1735	Alvin 4078	66.38	-	19.73	0.65	0.00	0.39	0.25	10.83	0.03	-	98.27
4078-1735	Alvin 4078	68.33	-	20.06	0.30	0.00	0.04	0.60	11.09	0.06	-	100.48
4078-1735	Alvin 4078	67.45	-	20.24	0.25	0.02	0.00	0.34	11.16	0.11	-	99.57
4078-1735	Alvin 4078	68.97	-	20.54	0.25	0.00	0.01	1.04	10.97	0.00	-	101.77
4078-1735	Alvin 4078	66.91	-	20.64	0.61	0.00	0.00	0.94	11.00	0.05	-	100.15
4078-1735	Alvin 4078	68.08	-	19.88	1.03	0.01	0.09	0.98	11.18	0.02	-	101.27
4078-1735	Alvin 4078	68.75	-	19.94	0.37	0.04	0.00	0.12	11.52	0.04	-	100.78
4078-1735	Alvin 4078	69.37	-	19.89	0.40	0.01	0.01	0.31	11.73	0.04	-	101.77

4078-1802	Alvin 4078	68.34	-	20.27	0.07	0.03	0.00	0.76	11.16	0.04	-	100.67
4078-1802	Alvin 4078	67.76	-	19.92	0.05	0.00	0.01	0.22	11.21	0.08	-	99.26

Epidote mineral analyses

Sample	Transect	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	Cr_2O_3	Total
4078-1728	Alvin 4078	37.00	0.10	23.52	12.76	0.13	0.06	23.15	0.05	0.01	0.01	96.80
4078-1728	Alvin 4078	38.13	0.14	24.01	11.89	0.15	0.07	23.10	0.00	0.00	0.00	97.49
4078-1802	Alvin 4078	36.81	0.02	22.84	12.83	0.11	0.13	23.02	0.03	0.02	0.04	95.84
4078-1802	Alvin 4078	36.49	0.10	22.29	13.31	0.28	0.24	22.07	0.02	0.02	0.00	94.81
4078-1802	Alvin 4078	36.72	0.12	22.98	13.03	0.13	0.45	22.96	0.01	0.02	0.01	96.43
4078-1802	Alvin 4078	37.39	0.14	21.88	14.18	0.06	0.03	23.07	0.00	0.02	0.02	96.80
4078-1802	Alvin 4078	37.26	0.16	25.06	10.06	0.11	0.05	23.15	0.03	0.00	0.06	95.94
4078-1802	Alvin 4078	36.95	0.17	22.83	12.40	0.16	0.16	22.11	0.05	0.03	0.00	94.86
4078-1802	Alvin 4078	37.56	0.19	22.98	12.83	0.28	0.27	22.80	0.02	0.00	0.00	96.94
4078-1802	Alvin 4078	37.23	0.32	22.09	13.26	0.09	0.07	22.39	0.00	0.01	0.02	95.48
4078-1802	Alvin 4078	36.51	0.45	21.34	15.03	0.11	0.05	23.01	0.02	0.01	0.00	96.53
4078-1802	Alvin 4078	35.77	0.53	20.97	14.35	0.03	0.09	22.60	0.03	0.01	0.03	94.42