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Partition Coefficients Determined from Phenocryst and Glass Analyses of the Climactic Ejecta of Mount Mazama, Oregon

Charles R. Bacon[1]

Wes Hildreth[1]

Timothy H. Druitt[2]

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[1]Menlo Park, California

[2]Department of Geological Sciences, University of Liverpool, Liverpool L69 3BX, U.K.

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This report contains whole-rock, glass, and phenocryst analyses (Table 1) and calculated crystal/liquid partition coefficients (Table 2) for six samples of the climactic ejecta of Mount Mazama and one of a preclimactic rhyodacite obsidian. These data may be of use in modeling crystallization of calcalkaline andesitic to rhyolitic liquids. Bacon and Druitt (1988) assembled a set of partition coefficients with which to model crystallization of Mount Mazama magmas from these and literature data. The partition coefficients should be used with caution for a number of reasons enumerated below.

Samples 80C227, 82C879, and 83C1013 were analyzed in U.S. Geological Survey laboratories by instrumental neutron activation (INAA) at Reston, Virginia by J. S. Mee, except for Ba, Rb, Sr, Y, and Zr in glass and plagioclase, which were determined by energy-dispersive x-ray fluorescene (XRF) at Menlo Park, California by P. E. Bruggman. Samples C-16, C-19, C-20, and C-68 were analyzed by INAA at the Lawrence Berkeley Laboratory of the University of California by H. R. Bowman and W. Hildreth. Data in Table 1 are reported to the number of significant figures appropriate for precision of measurements made in the respective laboratories. Partition coefficients are reported to no more than two significant figures.

Every effort was made to obtain pure mineral and glass separates for analysis. However, minute inclusions of apatite are common in all crystalline phases, and blebs of pyrrhotite are rare. Some crystals, especially plagioclase in the scoria samples, contain glass inclusions. Potential effects of these contaminants should be kept in mind when using the tabulated partition coefficients. We have not attempted to correct our results for contamination. Mineral and glass separates were judged to be >99% pure but this estimate does not incorporate mineral or glass inclusions.

The analyzed samples consist of crystals and glass separated from the following materials:

Sample	Material	Unit	Locality
C-16	pumice block	ignimbrite	Pinnacles, near base of exposure
C-19	pumice block	ignimbrite	Pinnacles, about 1 meter below transition to scoria-rich zone
C-20	scoria block	ignimbrite	Pinnacles, about 5 meters above transition to scoria-rich zone
C-68	pumice lapilli	airfall	Roadcut 6.5 miles north of Crescent, Highway 97
80C227	obsidian	Grouse Hill flow	Outcrop on southwestern side of Grouse Hill lava flow
82C879	scoria block	veneer	Caldera rim near Grotto Cove
83C1013	pumice block	Wineglass Welded Tuff	Above trail to lake at Cleetwood Cove

All whole-rock samples contain plagioclase, orthopyroxene, clinopyroxene, hornblende, and titanomagnetite. Many also contain ilmenite, but it was not practicable to obtain pure ilmenite separates. We do not report data for hornblende from 80C227 because it was found to consist of two compositional

populations on the basis of microprobe analyses. Additional data and information on the mineralogy and petrology of rocks from Mount Mazama can be found in Ritchey (1979, 1980), Bruggman, et al. (1987), Bacon and Druitt (1988), and Druitt and Bacon (1988).

Compositional parameters for crystals, glasses, and rocks

Sample	Rock SiO_2	Glass SiO_2	Plagioclase An	Orthopyroxene Mg/Mg+Fe	Clinopyroxene Mg/Mg+Fe	Hornblende Mg/Mg+Fe	Magnetite TiO_2
80C227	71.0	74.3	50	0.70	0.72		
82C879	56.0	67.2	55	0.73	0.77	0.68	
83C1013	71.0	72.0	38	0.70	0.74		9.1

The above mineral compositional parameters are approximate because all crystals except magnetite are zoned (Druitt and Bacon, 1988). Silica values are calculated volatile-free with $Fe^{2+}/Fe^{total} = 0.7$. Comparable data for samples C-16, C-19, C-20, and C-68 are unavailable. Experience with other Mazama samples suggests that mineral, glass, and rock compositions for C-16, C-19, and C-68 will be similar to those of 83C1013; mineral compositions for C-20 should be similar to those of 82C879.

REFERENCES:

Bacon, C.R., and Druitt, T.H., 1988, Compositional evolution of the zoned calkalkaline magma chamber of Mount Mazama, Crater Lake, Oregon: Contributions to Mineralogy and Petrology (in press).

Bruggman, P.E., Bacon, C.R., Aruscavage, P.J., Lerner, R.W., Schwarz, L.J., and Stewart, K.C., 1987, Chemical analyses of rocks and glass separates from Crater Lake National Park and vicinity, Oregon: U.S. Geological Survey Open-file Report 87-57, 36 pages.

Ritchey, J.L., 1979, Origin of divergent magmas at Crater Lake, Oregon: PhD thesis, University of Oregon, Eugene, 209 pages.

Ritchey, J.L., 1980, Divergent magmas at Crater Lake, Oregon: products of fractional crystallization and vertical zoning in a shallow, water-undersaturated chamber: Journal of Volcanology and Geothermal Research, v. 7, p. 373-386.

TABLE 1. Trace Element concentrations (ppm)

Sample	Phase	Ba	Co	Cr	Cs	Hf	Mn	Ni	Rb	Sb	Sc	Sr	Ta	Th	U	Y	Zn	Zr
80C227	Rock	807	3.9	7.7	3.7	5.7			67	0.6	6.70	267	0.54	5.9	2.2	27	48	233
80C227	Glass	875	1.6		4.4	6.1			70	0.7	4.72	178	0.60	6.6	3.1	28	43	234
80C227	Plag	450	0.2		0.1	0.2			13		0.11	1170				8	15	52
80C227	Opx		78.7	89	0.8	1.2					42.3		0.08	0.7	0.4		274	
80C227	Cpx		33.5	19		2.4					158						130	
83C1013	Rock	756	3.7		3.0	5.9			48	0.5	6.52	385	0.46	4.9	1.8	25	33	231
83C1013	Glass	795	1.7		3.1	5.9			56	0.6	5.46	299	0.47	4.9	2.0	25	47	247
83C1013	Plag	384	0.3		0.1				17	0.2	0.13	1310				7	22	49
83C1013	Opx		65.8	16.2		0.6					38.9		0.05	0.7	0.3		280	
83C1013	Cpx		29.7	34		1.7					180							
83C1013	Hb		63.6	131		3.1					74.0		0.20				108	
83C1013	Mt		139	118		1.4					27.4		0.56		0.4		690	
C-19	Rock	720	3.9	5.3	2.9	5.8	465	7	59	0.44	7.26		0.387	4.68	1.92		37	
C-19	Glass	740	1.4	2.8	2.6	5.4	360		52	0.37	5.27		0.352	4.69	1.97		38	
C-19	Opx	70	68.9	18	0.7	0.8	5620	60			39.6		0.14	0.64	0.21		341	
C-19	Cpx		38.9	32	0.8	1.5	3150	60	24		186		0.187	0.5	0.17		346	
C-19	Hb	310	59.3	56		3.2	1550	130	15		86.0	600	0.21	0.9	0.20		224	
C-68	Rock	760	3.5	2.3	2.8	6.6	445		54	0.31	7.02		0.424	5.29	2.22		44	
C-68	Glass	680	1.9	1.4	2.4	5.3	320		44	0.32	4.84		0.332	4.28	1.76		44	
C-68	Plag	400	0.3			0.3	28		3		0.21	1700	0.010	0.16	0.10		11	
C-68	Opx	90	64.3	8.0	0.4	1.2	6120	50			42.9	1500	0.30	0.64	0.4		447	
C-68	Cpx	190	35.5	21	1.4	2.5	3190	10			198		0.193	0.8	0.21		578	
C-68	Hb	180	65.1	158	1.3	3.2	1200	220			78.1	600	0.21	0.8	0.20		66	
C-16	Rock	790	4.5	2.7	3.0	6.0	435		57	0.44	6.51		0.398	5.01	2.09		42	
C-16	Glass	870	1.2	1.3	2.3	4.6	300	5	45	0.23	4.45		0.299	3.91	1.62		33	
C-16	Opx	110	65.6	10	0.5	0.9	6910	20			43.5		0.24	0.56	0.24		430	
C-16	Cpx	100	37.4	43	0.5	1.0	3230	70	16		200		0.183	0.1	0.26		709	
C-16	Hb		64.4	150		3.1	1230	160			79.7		0.181	0.5	0.17		91	
C-20	Rock	380	12.2	5.2	1.0	1.9	760		23	0.07	12.6		0.173	1.38	0.63		60	
C-20	Glass	630	5.9	2.9	2.0	4.0	575	7	39	0.29	7.11		0.286	3.38	1.39		47	
C-20	Opx	40	83.7	43	0.9	0.3	3960	150			33.6	300	0.031		0.26		237	
C-20	Cpx	80	42.0	185		1.8	2060	60	15		132		0.042		0.10		258	
C-20	Hb	300	62.4	129		2.5	1180	200			87.8	700	0.20	0.6	0.21		397	
82C879	Rock	318	22.3	21.5	0.9	1.9			18	0.2	17.3	736	0.18	1.4	0.6	16	80	86
82C879	Glass	643	6.6		2.2	4.1			35	0.4	8.08	408	0.41	3.1	1.69	23	60	171
82C879	Plag	172	0.4						14	0.8	0.12	1370				6	26	53
82C879	Opx		77.5	24							34.7						219	
82C879	Cpx		35.9			1.9					141						120	
82C879	Hb		40.2	17.2		2.2					101		0.24				95	360

TABLE 1. Trace element concentrations (cont'd)

Sample	Phase	La	Ce	Nd	Sm	Eu	Tb	Dy	Yb	Lu
80C227	Rock	19	41	23	4.0	0.91	0.66		2.4	0.35
80C227	Glass	22.7	46	23	5.2	0.82	0.68		2.63	0.36
80C227	Plag	6.0	8.9	3.6	0.5	1.88				
80C227	Opx	7.7	20.6	13	3.4	0.44	0.57		2.37	0.38
80C227	Cpx	10.3	30	33	12	1.92	2.2		6.1	0.93
83C1013	Rock	20	41	22	4.3	0.97	0.56		2.2	0.34
83C1013	Glass	19.4	40	21	4.2	0.77	0.65		2.19	0.31
83C1013	Plag	5.8	8.7	4.1	0.5	1.51	0.09			
83C1013	Opx	7.8	18.0		3.2	0.47	0.55		1.99	0.43
83C1013	Cpx	10.1	33	29	12	1.96	2.5		6.5	1.20
83C1013	Hb	6.9	27	34	9.5	2.47	1.6		2.9	0.57
83C1013	Mt	12.8	28	20	4.8	0.70	0.85		0.96	
C-19	Rock	19.0	40	21	3.86	1.08	0.52	3.5	2.13	0.32
C-19	Glass	19.4	41	21	3.78	1.11	0.50	3.5	1.99	0.30
C-19	Opx	9.0	22	16	3.63	0.61	0.49	3.3	2.1	0.31
C-19	Cpx	9.3	40	37	12.10	2.44	2.2	14.2	5.9	0.86
C-19	Hb	9.6	35	41	10.98	3.08	1.5	10.5	4.1	0.54
C-68	Rock	21.5	48	24	4.56	1.09	0.58	4.5	2.50	0.37
C-68	Glass	18.2	38	19	3.59	1.11	0.45	3.4	1.95	0.29
C-68	Plag	6.4	10.0	2.7	0.47	1.54	0.04	0.5	0.10	0.02
C-68	Opx	13.4	34	24	5.23	0.84	0.72	5.1	2.62	0.39
C-68	Cpx	12.5	41	41	12.39	2.47	2.3	14.9	6.0	0.89
C-68	Hb	6.9	28	33	8.52	2.56	1.1	8.4	3.1	0.40
C-16	Rock	20.5	45	21	4.19	1.09	0.57	3.9	2.28	0.34
C-16	Glass	18.0	36	17	3.20	1.12	0.42	2.9	1.77	0.26
C-16	Opx	11.7	29	22	4.71	0.75	0.59	4.7	2.53	0.38
C-16	Cpx	13.2	40	39	12.75	2.47	2.2	15.3	6.0	0.97
C-16	Hb	6.1	30	34	9.12	2.99	1.3	8.1	3.1	0.43
C-20	Rock	9.3	22.3	14	3.01	1.47	0.38	2.8	1.28	0.18
C-20	Glass	19.8	41	23	4.02	1.35	0.47	3.2	1.69	0.24
C-20	Opx	3.5	9.3	6.5	1.47	0.34	0.2	1.7	1.09	0.17
C-20	Cpx	4.6	16.6	19	5.96	1.70	1.1	7.0	2.77	0.42
C-20	Hb	7.7	26	33	8.73	2.63	1.1	8.0	2.88	0.38
82C879	Rock	10	20	13	3.4	1.05	0.45		1.4	0.20
82C879	Glass	17.2	36	21	4.8	1.21	0.62		1.99	0.31
82C879	Plag	3.1	4.2		0.3	0.91				
82C879	Opx	4.4	11.4	9.8	2.2	0.406	0.43		1.53	0.22
82C879	Cpx	4.8	17.0	18	7.8	1.39	1.7		4.0	0.75
82C879	Hb	5.4	19.4	25	9.6	2.30	1.8		4.1	0.70

TABLE 2. Partition coefficients (crystal/glass)

Sample	Phase	Ba Kd	Co Kd	Cr Kd	Cs Kd	Hf Kd	Mn Kd	Ni Kd	Rb Kd	Sb Kd	Sc Kd	Sr Kd	Ta Kd	Th Kd	U Kd	Y Kd	Zn Kd	Zr Kd
80C227	Plag	0.51	0.13		0.02	0.03			0.19		0.02	6.6				0.29	0.35	0.22
80C227	Opx		49		0.2	0.20					9.0		0.13	0.11	0.13		6.4	
80C227	Cpx		21			0.39					33						3.0	
83C1013	Plag	0.48	0.18		0.03				0.30	0.3	0.02	4.4				0.28	0.47	0.20
83C1013	Opx		39			0.10					7.1		0.11	0.14	0.15		6.0	
83C1013	Cpx		17			0.29					33							
83C1013	Hb		37			0.53					14		0.43				2.3	
83C1013	Mt		82			0.24					5.0		1.2		0.20		15	
C-19	Opx	0.1	49	6.4	0.27	0.15	16				7.5		0.40	0.14	0.11		9.0	
C-19	Cpx		28	11	0.31	0.28	8.8		0.5		35		0.53	0.11	0.09		9.1	
C-19	Hb	0.4	42	20		0.59	4.3		0.3		16		0.60	0.19	0.10		5.9	
C-68	Plag	0.6	0.16			0.06	0.09		0.07		0.04		0.03	0.04	0.05		0.25	
C-68	Opx	0.1	34	5.7	0.17	0.23	19				8.9		0.90	0.15	0.23		10.2	
C-68	Cpx	0.3	19	15	0.58	0.47	10.0				41		0.58	0.19	0.12		13.1	
C-68	Hb	0.3	34	113	0.54	0.60	3.8				16		0.63	0.19	0.11		1.5	
C-16	Opx	0.1	55	7.7	0.22	0.20	23	4			9.8		0.80	0.14	0.15		13	
C-16	Cpx	0.1	31	33	0.22	0.65	10.8	14	0.4		45		0.61	0.03	0.16		21	
C-16	Hb		54	115		0.67	4.1	32			18		0.61	0.13	0.10		2.8	
C-20	Opx	0.1	14	15	0.45	0.08	6.9	21			4.7		0.11		0.19		5.0	
C-20	Cpx	0.1	7.1	64		0.45	3.6	9	0.4		19		0.15		0.07		5.5	
C-20	Hb	0.5	11	44		0.63	2.1	29			12		0.70	0.18	0.15		8.4	
82C879	Plag	0.27	0.06						0.40	2	0.01	3.4				0.26	0.44	0.31
82C879	Opx		12								4.3						3.7	
82C879	Cpx		5.4			0.46					17						2.0	
82C879	Hb		6.1			0.54					13		0.59				1.6	2.1

TABLE 2. Partition coefficients (cont'd)

Sample	Phase	La Kd	Ce Kd	Nd Kd	Sm Kd	Eu Kd	Tb Kd	Dy Kd	Yb Kd	Lu Kd
80C227	Plag	0.26	0.19	0.16	0.10	2.3				
80C227	Opx	0.34	0.45	0.57	0.65	0.54	0.84		0.90	1.1
80C227	Cpx	0.45	0.65	1.4	2.3	2.3	3.2		2.3	2.6
83C1013	Plag	0.30	0.22	0.20	0.12	2.0	0.14			
83C1013	Opx	0.40	0.45		0.76	0.61	0.85		0.91	1.4
83C1013	Cpx	0.52	0.83	1.4	2.9	2.5	3.8		3.0	3.9
83C1013	Hb	0.36	0.68	1.6	2.3	3.2	2.5		1.3	1.8
83C1013	Mt	0.66	0.70	0.95	1.1	0.91	1.3		0.44	
C-19	Opx	0.46	0.54	0.76	0.96	0.55	0.98	0.94	1.1	1.0
C-19	Cpx	0.48	0.98	1.8	3.2	2.2	4.4	4.1	3.0	2.9
C-19	Hb	0.49	0.85	2.0	2.9	2.8	3.0	3.0	2.1	1.8
C-68	Plag	0.35	0.26	0.14	0.13	1.4	0.09	0.15	0.05	0.07
C-68	Opx	0.74	0.89	1.3	1.5	0.76	1.6	1.5	1.3	1.3
C-68	Cpx	0.69	1.1	2.2	3.5	2.2	5.1	4.4	3.1	3.1
C-68	Hb	0.38	0.74	1.7	2.4	2.3	2.4	2.5	1.6	1.4
C-16	Opx	0.65	0.81	1.3	1.5	0.67	1.4	1.6	1.4	1.5
C-16	Cpx	0.73	1.1	2.3	4.0	2.2	5.2	5.3	3.4	3.7
C-16	Hb	0.34	0.83	2.0	2.9	2.7	3.1	2.8	1.8	1.7
C-20	Opx	0.18	0.23	0.28	0.37	0.25	0.43	0.53	0.64	0.71
C-20	Cpx	0.23	0.40	0.83	1.5	1.3	2.3	2.2	1.6	1.8
C-20	Hb	0.39	0.63	1.4	2.2	1.9	2.3	2.5	1.7	1.6
82C879	Plag	0.18	0.12		0.06	0.75				
82C879	Opx	0.26	0.32	0.47	0.46	0.34	0.69		0.77	0.71
82C879	Cpx	0.28	0.47	0.86	1.6	1.1	2.7		2.0	2.4
82C879	Hb	0.31	0.54	1.2	2.0	1.9	2.9		2.1	2.3