GSA Data Repository 2018415

Transition of eruptive style: pumice raft to dome-forming eruption at the Havre submarine volcano

Michael Manga[1], Samuel J. Mitchell[2], Wim Degruyter[3], and Rebecca J. Carey[4]

[1]Department of Earth and Planetary Science, University of California, Berkeley, CA 94720, USA
[2]Department of Geology and Geophysics, University of Hawai'i at Manoa, Honolulu, HI 96822, USA
[3]School of Earth and Ocean Sciences, Cardiff University, Cardiff CF10 3AT, Wales, UK
[4]School of Earth Sciences, University of Tasmania, Hobart, Tasmania 7001, Australia

October 30, 2018

1 Supplementary materials

Table DR1: Composition and vesicularity of raft and dome OP samples. Composition of raft from Rotella et al. (2015) and dome OP is the average of two values from Carey et al. (2018). Dome OP vesicularity is from Table DR2 and the raft value is mean from Rotella et al. (2015) and Carey et al. (2018).

	raft	dome OP
SiO_2	72.11	72.20
TiO_2	0.46	0.46
Al_2O_3	13.99	14.11
Fe_2O_3	3.35	3.25
MnO	0.12	0.10
MgO	0.64	0.70
CaO	2.67	2.56
Na_2O	5.15	5.14
K_2O	1.44	1.40
P_2O_5	0.08	0.08
LOI	1.08	0.50
vesicularity	78%	39%

Table DR2: Clast densities measured using the methods of Houghton and Wilson (1989). Vesicularity calculated using a dense rock equivalent density of 2380 kg/m^3.

sample	unit	fragment mass (g)	density (kg m^{-3})	Vesicularity (%)
HVR0013	Dome P carapace	28.28	1898	20.9
		5.94	1967	18.0
HVR0010	Dome O carapace	11.94	1675	30.2
		8.39	1892	20.5
		5.38	1622	31.8
		2.07	1899	20.9
HVR0007	Dome OP talus	21.64	1384	42.3
		15.22	1407	41.4
		14.22	1365	43.1
		7.02	1390	42.1
		6.46	1366	43.1
		5.46	1362	43.3
		5.17	1249	50.7
		4.92	1348	43.8
		4.63	1272	49.3
		4.27	1400	41.7
		3.58	1253	49.9
		3.40	1429	40.5
		3.27	1422	40.8
		2.21	1348	43.9
		1.46	1446	39.8
		1.45	1394	41.9
		1.43	1444	39.8
		1.37	1370	42.9
		1.36	1360	43.3
		1.31	1456	39.4
		1.18	1372	42.8
		1.01	1312	45.3
		0.76	1407	41.4
HVR0118	Dome OP talus	45.22	1108	53.8
		4.98	1634	31.3
		4.40	1701	28.5
HVR0187	Dome OP talus	60.31	1310	45.4
		14.20	1538	35.9
		8.01	1288	46.3
		2.06	1856	22.7

Houghton B.F. and Wilson C.J.N., 1989, A vesicularity index for pyroclastic deposits: Bulletin of volcanology, v. 51, p. 451-462.

Table DR3: H_2O concentrations, with two standard deviation error, of melt inclusions within Quartz and Plagioclase. Phenocrysts were taken from raft pumice (RPAUS and RPFJ) and giant pumice (GP). Concentrations acquired through SIMS analysis at the Woods Hole Oceanographic Institution.

Melt inclusion	H_2O (wt %)	two sigma
RPAUS-F 156	4.63	0.48
RPAUS-F 157	4.58	0.46
RPAUS-C 162	4.32	0.44
RPAUS-K 167	4.47	0.45
RPAUS-A 173	4.66	0.47
RPAUS-H 175	4.94	0.50
RPAUS-C 163	4.46	0.51
RPAUS-C 164	4.45	0.45
RPAUS-L 170	5.59	0.65
RPAUS-A 172	4.99	0.51
RPAUS-L 171	4.82	0.49
RPFJ-F 242	5.04	0.51
RPFJ-F 243	4.97	0.50
RPFJ-D 250	4.28	0.44
RPFJ-R 252	5.10	0.51
RPFJ-E 253	4.99	0.55
RPFJ-O 234	4.78	0.48
RPFJ-O 235	4.90	0.50
RPFJ-I 238	5.20	0.52
RPFJ-Q 240	5.71	0.60
RPFJ-F 241	5.00	0.51
RPFJ-F 245	5.20	0.53
RPFJ-S 254	5.22	0.53
RPFJ-S 255	4.01	0.40
RPFJ-K 236	4.41	0.44
RPFJ-R 251	4.97	0.50
GP-A 188	4.82	0.48
GP-H 204	4.68	0.47
GP-K 210	4.80	0.48
GP-G 214	4.01	0.40
GP-G 215	4.89	0.50
GP-B 187	5.62	0.56
GP-A 190	5.47	0.56
GP-A 192	4.61	0.46
GP-J 194	4.65	0.46
GP-H 203	5.00	0.50
GP-G 213	5.20	0.52
GP-D 201	5.03	0.52
GP-D 202	5.09	0.52
average	4.86	0.80

Table DR4: Variables, parameters and values

variable or parameter	symbol	value	reference
mass flux	q	$10^2 - 10^7$ kg/s	
lateral gas loss	Q_w	calculated	equation (8)
conduit radius	r	12 and 30 m	
depth below seafloor	z	$0 - 5000$ m	
vent depth		900 m	
exsolved gas volume fraction	ϕ	calculated	
melt velocity	u_l	calculated	
gas velocity	u_g	calculated	
pressure	P	calculated	
temperature	T	850^oC	Manga et al. (2018)
chamber pressure	P_{ch}	calculated	
dissolved gas mass fraction	c	calculated	equation (5)
initial gas mass fraction	c_0	4.9 weight %	Table DR3
saturation constant	s	4.11×10^{-6} Pa$^{-1/2}$	
melt density	ρ_l	2400 kg/m^3	Manga et al. (2018)
gas density	ρ_l	calculated	
country rock density	ρ_r	2400 kg/m^3	
gas viscosity	μ_g	10^{-5} Pa s	
melt viscosity	μ_l	calculated	Giordano et al. (2008)
magma viscosity	μ_m	calculated	Llewellin and Manga (2005)
magma permeability	k	calculated	Mueller et al. (2005)
wall rock permeability	k_w	$10^{-14} - 10^{-12}$ m^2	
magma-wall drag	F_{lw}	calculated	equation (6)
gas-melt drag	F_{lg}	calculated	equation (7)

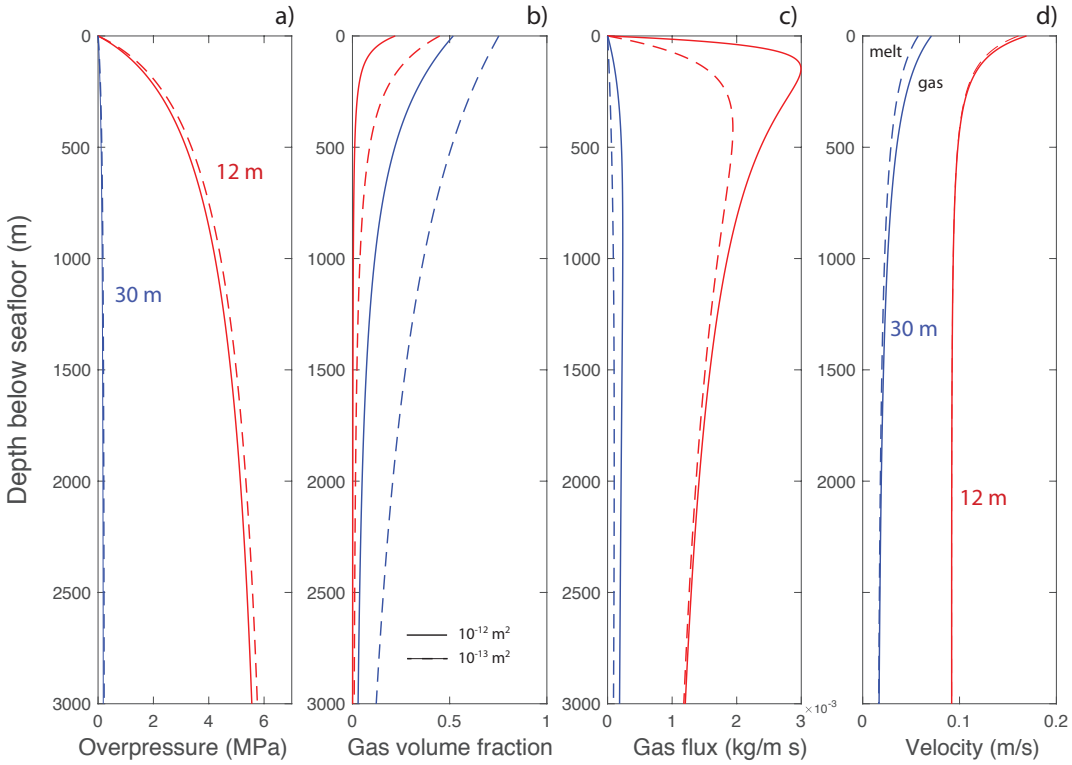

Figure DR5. a) Overpressure (magma pressure minus country rock pressure) and b) vesicularity, and c) volatile flux through the conduit walls (mass per unit height per unit time), as a function of depth for a representative mass eruption rate of 10^5 kg/s and two different conduit radii (12 and 30 m) and country rock permeabilities (10^{-12} and 10^{-13} m^2). d) Gas (solid curves) and melt (dashed curves) ascent velocity for the same mass eruption rate and $k_w = 10^{-13}$ m^2.