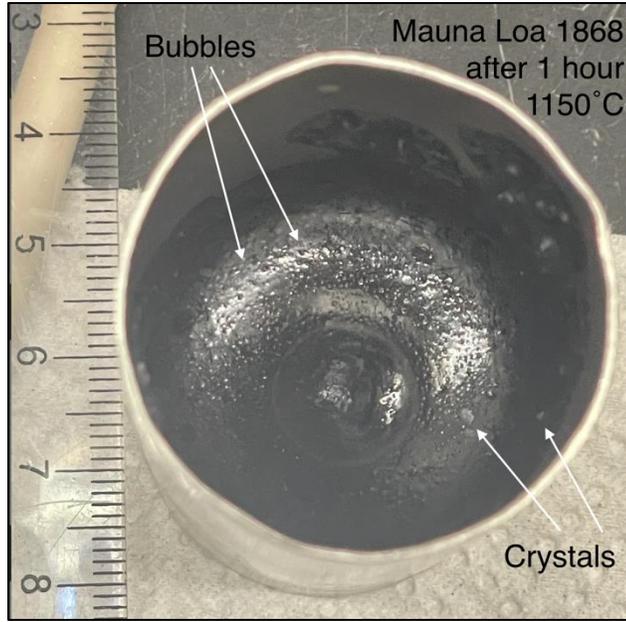


Three-Phase Lava Rheology Measurements Reveal the Importance of Bubbles in Facilitating Fast Flow Emplacement

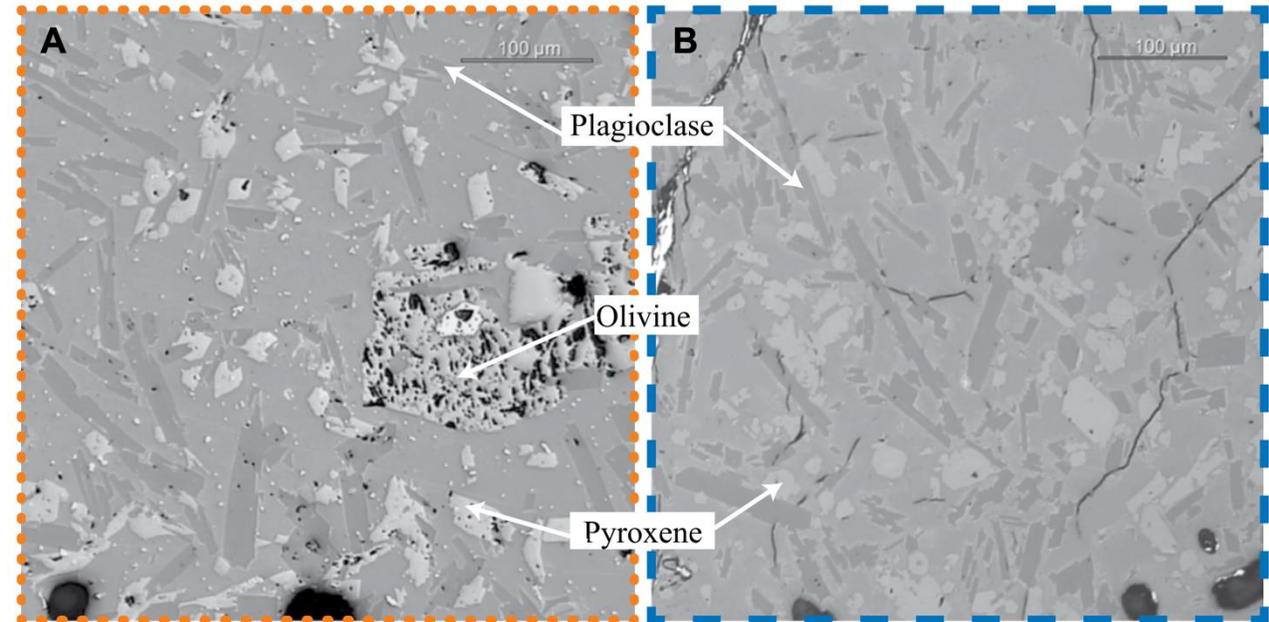
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Three-phase = liquid + crystals + bubbles
 (relevant to conduits, lava flows)



We preserve phenocrysts, bubbles, and lava textures



GEOLOGY



From flow to furnace: Low viscosity of three-phase lavas measured at Kīlauea 2018 eruption conditions

Brenna A. Halverson* and Alan Whittington

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TABLE 1. CRYSTALLINITY AND VESICULARITY VALUES FOR EXPERIMENTS AND NATURAL SAMPLES

Sample	Vesicularity	Vesicle-normalized %				Total crystallinity
		Plagioclase	Pyroxene	Olivine	Oxides	
1105 °C	31.1%	12.8%	13.8%	3.2%	10%	30.8%
1115 °C	18.8%	7.6%	1.9%	2.7%	0.3%	12.6%
1150 °C	19.2%	2.4%	0.2%	2.6%	0.4%	5.6%
1175 °C zero-time sample	36.1%	6.5%	1.9%	5.6%	3.5%	14.3%
1115 °C traditional method	2.0%	0.0%	14.9%	0.0%	2.5%	17.4%
FB.11	13.5%*	21.4%	14.4%	0.0%	0.0%	41.5%†
FB.25b		25.7%*		N/A		N/A

Low viscosity of three-phase lava at 1115 °C

Three-phase viscosity for Kilauea 2018 Fissure 8

At 1150 °C: ~100-160 Pa s, $\phi_x \sim 6\%$, $\phi_b \sim 19\%$

At 1115 °C: ~180 Pa s, $\phi_x \sim 13\%$, $\phi_b \sim 19\%$

Eruption at ~1145 °C (Ganseccki et al. 2018) so **little viscosity increase for first 30 °C of cooling** (actual ϕ_b near vent was much higher than ~19%)

Liquid data (Soldati et al. 2021; Baur et al. in review)

Apply Maron-Pierce (1956) model for crystals. Infer:

At 1150 °C, 19% bubbles increases η by 51%

At 1115 °C, 19% bubbles decreases η by 32%

At 1105 °C, 31% bubbles changes η by +113%/-53% depending on strain rate

Bubbles can have strong and variable effects



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