Dowey, N., and Williams, R., 2022, Simultaneous fall and flow during pyroclastic eruptions: A novel proximal hybrid facies: Geology, v. 50, https://doi.org/10.1130/G50169.1

Simultaneous fall and flow during pyroclastic eruptions: a novel proximal hybrid facies.

Natasha Dowey and Rebecca Williams

Supplementary Data – Methods for quantitative grainsize analysis

Approach

This paper reports field data collected during a series of field seasons conducted by Dowey (Née Smith) and Williams during their PhD studies on the islands of Tenerife and Pantelleria respectively, between 2006 and 2012 (Smith, 2012; Williams, 2010). Field data gathered included extensive logging of stratigraphic architecture, stratigraphic sampling for petrographic and geochemical analysis, and photography.

On Tenerife, outcrops at the Diego Hernandez caldera were typically heavily cemented, rendering large-scale sampling for sieving and textural analysis of pumices impossible. Geoconservation was also a consideration, given the location of the outcrops within the Canadas National Park. At Pantelleria, outcrops presented in this study were on private land and sampling was not an option.

The quantitative grainsize distribution data for the lithofacies presented in this paper was acquired using analysis of representative outcrop imagery with JMicroVision Image Analysis Toolbox software (Roduit, n.d.). Sorting values were then calculated using Gradistat particle size analysis software (Blott and Pye, 2001). Examples of previous applications of image analysis in geology include evaluation of grainsize variations in clastic sediments (Francus, 1998) and particle shape in volcanic debris (Buckland et al. 2011).

Raw Data

Analysis of 6 lithofacies was conducted, using representative imagery. For the Poris, the basal bedded pumice lapilli facies (pL in Figure 1), the cross stratified pumice block facies (xspB in Fig 1) and massive lapilli tuff (mLT in Figure 1) were assessed. For the Green Tuff, the basal pumice lapillistone (pL in Fig 3) and cross stratified pumice block facies (xspB in Fig 3) were analysed. An example of the lithic-rich cross stratified pumice block facies (xspBL in Fig 3) was also analysed for componentry comparison. The 6 raw data images used for each are shown below in Figure S1. The images used for this analysis are from the log and sketch locations in Figures 1 and 3 (28.280273, -16.549526 and 36.819358, 11.988439 respectively).

Method

JMicrovision's spatial calibration tool was first used to ensure the image was calibrated to a known scale. The point counting tool was then used to randomly identify 200 points on each lithofacies image. As each point was identified, the 1D measurement tool was used to measure the apparent long axis of each clast (Figure S2 shows an example of this process for the Poris cross stratified pumice block facies). These values were documented within Excel software.

Human inspection of the image was used to categorise whether each clast was pumice or lithic. Any clast measuring less than 2 mm was categorised as ash. Resolution of JMicrovision image analysis depends on the resolution of the raw image; in this case it was sufficient to distinguish material of less than 2mm in size. This visual componentry analysis was used to create the pie charts shown in Figures 1 and 3.

Excel's histogram functionality was used to create the histograms presented in Figures 1 and 3, with mm scale converted to Phi scale, as is typical for presentation of volcanological grainsize data. Data was inputted into Gradistat (v9.1) which automatically generates Sorting values (σ_ϕ method of moments, logarithmic) as one of its outputs (very well sorted $<0.35\ \sigma_\phi$, well sorted 0.35-0.50, moderately well sorted 0.50-0.70, moderately sorted 0.7-1.00, poorly sorted 1.00-2.00, very poorly sorted 2.00-4.00, extremely poorly sorted >4.00; Blott and Pye, 2001).

Limitations

Image analysis for volcanic grainsize distribution provides an assessment of the exposed surface of the outcrop, and not the interior, and therefore may not provide an exact representation of the entire facies. However, this is also a limitation of sieving techniques, dependent on how deeply into an exposure material is sampled. During image analysis, the longest axis on view is analysed, which may lead to underestimates as a longer axis may run unseen into the outcrop face. Sieving also bears a risk of underestimation as pumice clasts are prone to breakage during the sampling and sieving process.

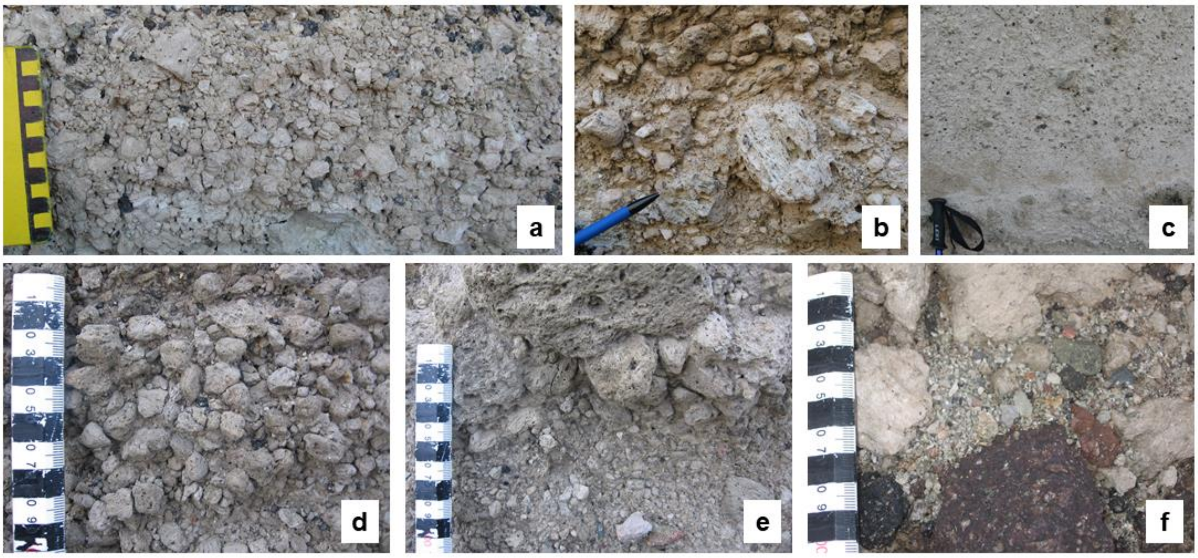

Figure S1: Images used for JMicroVision Analysis. (a) Poris basal bedded pumice lapilli facies (pL in Fig 1), (b) Poris cross stratified pumice block facies (xspB in Fig 1), (c) Poris massive lapilli tuff (mLT in Fig 1), (d) Green Tuff basal pumice lapillistone (pL in Fig 3), Green Tuff cross stratified pumice block facies (xspB in Fig 3), (f) Green Tuff lithic-rich cross stratified pumice block facies (xspBL in Fig 3).

Figure S2: Poris cross stratified pumice block facies image following point counting and long axis measurement of 200 random clasts using JMicroVision software. Red lines show locations of measurements taken.

References

Blott, S.J. and Pye, K., 2001, GRADISTAT: a grain size distribution and statistics package for the analysis of unconsolidated sediments: Earth Surface Processes and Landforms v. 26, p. 1237-1248.

Buckland, H. M., Saxby, J., Roche, M., Meredith, P., Rust, A. C., Cashman, K. V., & Engwell, S., 2021, Measuring the size of non-spherical particles and the implications for grain size analysis in volcanology: Journal of Volcanology and Geothermal Research, v. 415, [107257]. https://doi.org/10.1016/j.jvolgeores.2021.107257.

Francus, P., 1998, An image-analysis technique to measure grain-size variation in thin sections of soft clastic sediments: Sedimentary Geology, v. 121, p. 289-298.

Roduit, N. JMicroVision: Image analysis toolbox for measuring and quantifying components of high-definition images. Version 1.3.3. https://jmicrovision.github.io (accessed May 2020).

Smith, N., 2012, Near-vent processes of the 273 ka Poris eruption (Tenerife): PhD thesis, University of Liverpool, 300 p., https://livrepository.liverpool.ac.uk/6253/.

Williams, R., 2010, Emplacement of radial pyroclastic density currents over irregular topography: the chemically-zoned, low aspect-ratio Green Tuff ignimbrite, Pantelleria, Italy: PhD thesis, University of Leicester.