1. Introduction
Parameterisations of lava rheology form an important part of lava flow models, but are difficult to validate. We investigate the use of time-lapse digital photography and close range photogrammetric techniques to record the advance of a lava flow front, from which slope, velocity, volumetric flow rate and flow depth can be ascertained. Digital elevation models (DEMs) are calculated from pseudo-stereo image pairs, using an automated processing pipeline. The results allow the bulk rheology of the lava to be assessed.

2. Location and cameras
Images of an active 'aʻā lava flow lobe were collected during the 2008-9 eruption of Mt. Etna, Sicily.
- 2 tripod-mounted Canon EOS 300D digital SLR cameras
- 13 control targets, coordinates determined by dGPS
- Image capture (every minute) synchronised by cable and controlled by external interval timer
- Pseudo-stereo image pairs collected over 220 minutes

3. DEM processing pipeline
- Camera models and control target locations initially refined by multi-view bundle adjustment using VMS software
- For each epoch, image orientations calculated by resection
- SIFT-features used to seed sequence matching
- Matching uses a pyramidal dense matcher, p-GOTCHA
- Following epochs seeded from previous epoch results

4. Results: DEMs
- 56 DEMs generated (at 4-minute intervals), covering the advancing flow front lobe

5. Flow cross sections and surface velocity
- Plane of cross sections shown in red (line A-B is horizontal)
- On initial slope, front advances at 0.094 m min⁻¹.
- Flow slows and thickens on reaching flat ground.

6. Flow viscosity
Jeffery’s equation for Newtonian flow in a wide channel can now be used with either the surface velocity measurements or the volumetric flux, to estimate the apparent viscosity, \( \mu \):
\[
\mu = \frac{g h^2 \rho \sin \frac{\theta}{2}}{2v}
\]
\[
\mu = \frac{g h^2 \rho \sin \alpha}{3Q}
\]
- \( g = \) gravity (9.8 m s⁻²)
- \( h = \) flow thickness (2.0 m)
- \( \rho = \) fluid density (2500 kg m⁻³)
- \( v = \) surface velocity (0.13 m min⁻¹)
- \( \alpha = \) slope (20°)
- \( w = \) flow width (9 m)
- \( Q = \) volumetric flow rate (3.5 m³ min⁻¹)

7. Conclusions and further work
- DEM sequences can deliver flow depth and volume flux data to enable robust bulk rheological measurements of active lavas
- Longer duration occupations, over a range of slopes, will permit non-Newtonian flow models to be assessed