Present and proposed research

Low aspect-ratio ignimbrites are thought to be emplaced by particularly hazardous radial pyroclastic density currents that flow in all directions from source simultaneously, overtopping topographic barriers. We propose to test how these currents behave and evolve with time, by taking apart a chemically zoned, low-aspect ratio (≥ 1:5,000) ignimbrite sheet on the island of Pantelleria, Italy. The study will test the following hypotheses: (1) Do density currents that deposit low-aspect ratio ignimbrites flow radially, or do they initially flow predominantly towards one sector and then progressively shift direction around the volcano with time? (2) How do these energetic density currents interact with topography? Does the leading edge advance over topographic barriers initially, or may the barrier temporarily block (or deflect) the current until the mass-flux waxes sufficiently, or until deposition modifies the topography sufficiently, for the current to progress further? Do topographic highs deflect or reflect the currents, as indicated by some experimental models?

A pristine ignimbrite deposited during a single eruption ~45,000 years ago, on Pantelleria, Italy is zoned from pantellerite to trachyte. To date, my research has concentrated on identifying a detailed chemical stratigraphy for the deposit. The chemical stratigraphy is used as a proxy for time given that the chemistry of material erupted at the volcanic vent changed with time, resulting in a vertically zoned deposit. These 'time-surfaces' are being mapped internally through the deposit, both longitudinally from source and laterally around the broadly circular sheet, up and around draped topographic barriers, taking advantage of the superlative exposure. This will allow temporal correlations within the sheet to be established in order to reconstruct the behaviour of the sustained, unsteady current as it waxed and waned, and encroached and overtopped barriers, at durations of less than an hour. Early results indicate diachronous rather than uniform deposition, and complex interaction with various scales of topography.

Interestingly, the chemical stratigraphy cuts through previously identified lithofacies correlations. This would suggest that lithofacies are diachronous and should not be correlated as a time-related event. It is more likely that lithofacies changes within ignimbrite deposits are in fact related to local changes in topography and waxing and waning of the density current.

A detailed study of these lithofacies is now required. Does the lithic breccia seen in the deposit correlate to a caldera collapse event, or is it related to current dynamics? Is the distribution of the coarse material related to underlying topography or is it related to waxing and waning of the current? What detailed changes occur up and over exposed palaeo-topography and can these changes be tracked to suggest how the current behaved as it met topographic barriers? Was the current fully dilute or was it a granular fluid? Can hiatuses in the current be identified similar to how suspension sedimentation in turbidites have been used to infer a pause in current sedimentation? Analysis of the bedforms can also be used to infer current direction, such as studying clast imbrications.

This application is for fieldwork funding to spend a field season studying the lithofacies within the deposit to try and answer some of these questions. It would build on similar work done on Tenerife, but will be the first such study on a welded ignimbrite sheet. This is also the first study to use chemical stratigraphy of an ignimbrite deposit as a proxy for time with the lithofacies interpreted in conjunction with this independent time stratigraphy. If successful, this study will vastly improve our knowledge on the emplacement and sedimentation of pyroclastic density currents and in particular, how they interact with topography.

A full understanding of how pyroclastic density currents behave has many applications and can be cross disciplinary. This study has drawn a lot of information from the research on how turbidites interact with topography and it is hoped that the outcome of this study can feed back into this research. For the volcanological community, it is essential to understand these very hazardous phenomena behave. 26.8% of deaths that occur during volcanic eruptions are attributed to pyroclastic density currents and efforts to reduce this number and produce effective hazard assessments has to come from understanding how they flow, are emplaced, and how they evolve with time. Particularly as topographic barriers are often used to determine 'safe zones' on the down-current side of a potential current, yet our understanding of how these currents interact with topography is incomplete.

Personally, I will benefit greatly from a field season dedicated to sedimentological study. It will be a unique learning experience to study the lithofacies of a welded ignimbrite in the field and broaden my skill set as a geologist.