Structure and magnetic fabric of a phonolite dome : Mont Gerbier de Jonc, Massif Central

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Abstract

The Mont Gerbier de Jonc is a famous landmark in the French Massif Central, for it marks the spring of the river Loire. The mountain, with its onion like structure and other features exposed by erosion, was emplaced in a single intrusion of hyperalkaline phonolite, of agpaitic character. Its phonolite is also characterized by a regular fine grain.

This study is based on field observations, extensive sampling and preparation of specimen for analysis of magnetic susceptibility (AMS), a proven method of fabric analysis in igneous rocks (Arbaret et al., 1993). Mineral fabrics of selected samples were also studied under the microscope, combining with the AMS a complementary SPO (shape preferred orientation) and microfabrics analysis.

In this study we successfully obtained AMS structural data from a fine grained agpaitic phonolitc body in the Velay. This allowed us to better understand the macroscopic structures characterizing the Mont Gerbier de Jonc. Furthermore, using simplified SPO and microfabrics analysis, we were able to well constrain the microscopic structures shaping the fabric of a few selected samples, and to extend their interpretation to the magnetic and macroscopic structures.

The unusual feldspathoid microcryst driven trachytic structure appeared to correlate well with all level of structural data, with nonetheless some substantial deviation between the observed main foliations (macroscopic, magnetic and SPO).

The sources for this deviation, sets of shear planes, provided a surprise in that two radically different types were observed, leading to different interpretations depending on their differing localization within the structure, and providing snapshots of the strain conditions in those places during the last stages of the dome's emplacement.

The dome's structure's superficial layers are characterized with conjugated subhorizontal and subvertical shear planes, oriented similarly to the foliation: those are testament to superficial strain condition, dominated by gravity and/or the expansion of the underlaying magma. Deeper layers, on the other hand, were shown to be characterized with conjugated shear plane near perpendicular to the foliation, indicating radial shortening, constrained by the overlaying layers and underlaying magma, and accommodating the lava dome's lateral expansion, which appeared in the AMS results.

We were able to provide a representation of the Mont Gerbier de Jonc emplacement process: after the rapid extrusion of viscous phonolitic magma into a stocky lava dome; subsequent endogenous growth, essentially lateral, developed the corresponding magmatic foliation, and induced as well the appearance of dome shape driven shear fabrics in the most superficial layer; palaeotopography oriented this growth to the South, further developing magmatic foliation, and developing in the inner layers radial shortening constrained shear fabrics; ultimately, the last somersault of magmatic pressure caused the rigidified dome to fracture in typical radial and concentric fashion, leading to the degassing of magma and putting an end to the activity.

Given the excellent readability of the Mont Gerbier the Jonc's specific fabrics, its rocks and context could be the object of further studies, using complementary techniques for better constrained results. The detailed structural study of a complete or partial composite semi sections, in the light of analogue and numerical models, would be an interesting prospect.