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Pull-apart emplacement of the Margeride granitic complex (French Massif Central). Implications for the late evolution of the Variscan orogen

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Abstract

A microstructural, magnetic fabric and gravity study is performed on the Carboniferous Margeride granitic complex that crops out in the central part of the Variscan French Massif Central. This complex consists of three facies, namely, a main porphyritic monzogranite, a two-mica granite, and late leucogranite dykes and stocks. In spite of local variations, the magnetic lineation mainly trends NW–SE with a shallow plunge throughout the complex. The magnetic foliation pattern is more complex with various strikes and generally a moderate dip. This fabric pattern complies with the late-orogenic NW–SE regional extensional deformation already recognised in this part of the Variscan Belt. New gravity measurements complete available data and are used to build up a gravity map and a cross-section with which four gravity minima are identified. Three gravity minima are interpreted as extensional fractures consistent with a NW–SE maximum stretching. The last gravity low corresponds to an extensional jog between the two westernmost fractures. The structural and gravity features of the complex are used to propose a feeding and emplacement model controlled by the regional late-orogenic extensional tectonics. The Margeride complex is interpreted as a kilometre-scale laccolith-like pluton emplaced in a transtensional setting controlled by a NW–SE opening direction. Such a model strengthens the relationships between pluton emplacement and late-orogenic collapse of the Variscan Belt.

Keywords: Anisotropy of magnetic susceptibility (AMS); Granitic pluton; Extensional tectonics; French Massif Central; Margeride pluton

1. Introduction

The internal fabric of granite plutons is now routinely used to determine the magmatic processes occurring in crystallising magma chamber and also, in some cases, to determine if regional deformation prevailed during the emplacement and crystallisation of the magma (Gleizes et al., 1997; Benn et al., 1998, 1999, 2001; Cruden et al., 1999; Becker et al., 2000; Bolle et al., 2003; Neves et al., 2003). Such studies are made easier by the use of the anisotropy of magnetic susceptibility (AMS) method, which allows a fast and accurate measurement of the magnetic fabrics of plutons (Tarling and Hrouda, 1993; Bouchez, 1997). Granite bodies can be very useful as kinematic markers, since they may record structural features during a short time interval allowing an accurate reconstitution of the tectonic evolution of orogenic belts (Gleizes et al., 1997; Benn et al., 2001). However, since fabrics are often acquired quite late during the crystallisation process of granite, the internal fabric is less helpful to characterise the emplacement mechanisms of plutons (Paterson et al., 1998). In addition, the knowledge of the 3D shape of a pluton can bring important information on the emplacement process, for example by locating and characterising the likely feeder zones (Brun et al., 1990; Vigneresse, 1990; Aranguren et al., 1996; Améglio et al., 1997). Several studies illustrate the usefulness of combining gravity and structural data when investigating the emplacement mode and structural evolution of a granite pluton (Améglio et al., 1997; Vigneresse and Bouchez, 1997; Talbot et al., 2004).

During Middle and Late Carboniferous times, numerous plutons emplaced in the Variscan Belt of the French Massif Central attest to a significant crustal melting event resulting

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from the Early to Middle Carboniferous nappe stacking (Duthou et al., 1984; Downes et al., 1997). This granitic magmatism occurred mainly during the last stages of the compressional event or during the late-orogenic extensional collapse (Duthou et al., 1984; Faure, 1995). Both events begin earlier in the northern part of the massif than in the southern part (Faure, 1995). The southward shifting with time of the two deformation events is still not accurately constrained. Moreover, these two events are partly synchronous; the extensional event begins in the northern part of the massif, whereas the southern part is still in compression. The change from the compressional tectonic event to the extensional tectonic regime must be investigated in more detail in order to understand the evolution of the Variscan Belt.

This study, based on the combined results of several methods, such as field and microstructural observations, low-field AMS measurements and gravity data modelling, was carried out on one of the largest pluton of the French Massif Central, namely the Margeride granitic complex, located in the central part of the French Massif Central (Fig. 1). This complex consists of several granitic bodies with distinct facies emplaced at the end of the Variscan Orogeny when the two tectonic events, extensional and compressional, occur in the northern and southern parts of the massif, respectively. The choice of the Margeride complex as a study area is supported by: (1) the central location of this granitic complex in the Massif Central between the northern and southern parts of the massif, (2) the large size of the granite body, and (3) the occurrence of two facies that emplaced in an interval of about 10 Ma. The location and the period of emplacement of these facies allow us to investigate the change of tectonic deformation in the Massif Central. The aim of this study is to better constrain the internal structure and the emplacement processes of this granitic complex bringing new insights not only on the late-orogenic tectonic evolution of the French Massif Central, but also on the mechanisms controlling the emplacement of such large plutons. Our feeding and emplacement model is different than that previously proposed for this pluton

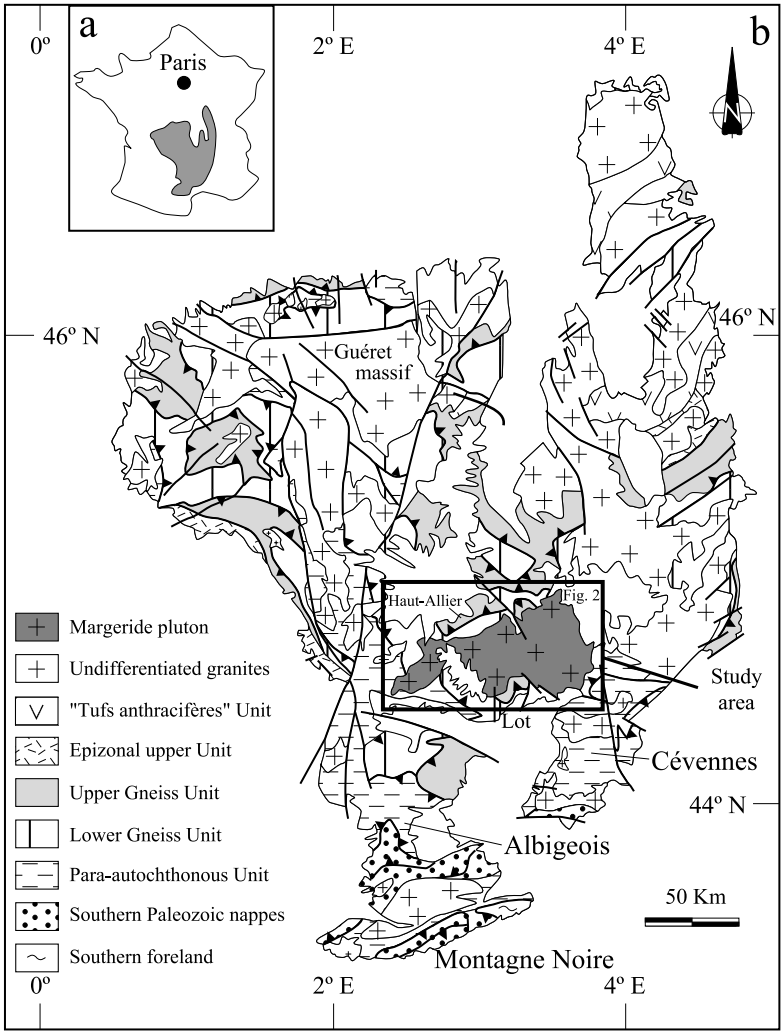

Fig. 1. (a) Location map of the French Massif Central. (b) Structural map of the French Massif Central and location of the study area.