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# Gravity inversion, AMS and geochronological investigations of syntectonic granitic plutons in the southern part of the Variscan French Massif Central

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ABSTRACT

Magnetic fabric analyses, gravity inversion associated with chemical U–Th–Pb dating and structural observations are carried out to elucidate relationships between faulting and magmatic processes. This multidisciplinary study has been undertaken on Late Carboniferous plutons, situated in the southern part of the Variscan French Massif Central (FMC). The Glénat, Omps and Boisset plutons crop out on both sides of the crustal-scale Sillon Houiller Fault (SHF). The Anisotropy of Magnetic Susceptibility (AMS) measurements and structural observations show that (i) the plutons acquired their final structure during the magma crystallization and record a NW–SE maximum stretching trend; (ii) in the Boisset pluton, post-magmatic fabrics predominate with a NNW–SSE trending lineation. The structural pattern deduced from the AMS study is thus consistent with the NW–SE late orogenic extensional tectonic regime that has been documented in other parts of the FMC during Late Carboniferous. The 3D geological modelling refined by 3D gravity inversion does not show any evidence of rooting of the granites along the SHF. Therefore, despite the apparent cartographic relationship between the SHF and the three plutons, our study does not support a genetic link between fault and plutons. It also questions the existence of the SHF in this part of the Massif Central at the time of pluton emplacement, and emphasises the dominant role of the regional tectonic framework rather than local faulting as a factor controlling pluton emplacement.



## 1. Introduction

Since last two decades, the scientific community places increasing interest in the relationships between magmatic processes, pluton architecture and emplacement, as well as the role played by regional or local structures (e.g. Hutton, 1982, 1988; Castro, 1986; Clemens and Mawer, 1992; D'Lemos et al., 1992; McCaffrey, 1992; Tikoff and Teyssier, 1992; Neves and Vauchez, 1995; Tikoff and Saint Blanquat, 1997; Crawford et al., 1999; McNulty et al., 2000). The collapse of mountain belts is often accommodated by ductile extensional tectonics, crustal melting and syntectonic magma emplacement (e.g. Malavieille, 1993; Faure, 1995; Vanderhaege and Teyssier, 2001). However, the mechanisms of pluton emplacement and to what extent their emplacement can be related to nearby structures, such as faults or folds, are still a matter of debate (e.g. Paterson and Schmidt, 1999).

Monazite U–Th–Pb chemical dating of granitic massifs is now increasingly used to address geochronological questions as it provides accurate and fast age determination that allow to constrain tectonic belt evolution and pluton emplacement (Cocherie and Albarède, 2001; Cocherie et al., 2005; Be Mezème et al., 2006a, b). Granitic bodies often record tectonic regimes developed during a short time interval. Granitic plutons can be used as kinematic markers allowing a detailed reconstruction of the late stages of the tectonic evolution of orogenic belts and also understand the mechanism of pluton emplacement (Gleizes et al., 1997; Benn et al., 2001). This is the case for the late stage of the evolution of the Variscan French Massif Central (FMC, Fig. 1, e.g. Faure and Pons, 1991; Faure, 1995; Talbot et al., 2004, 2005a, b; Gébelin et al., 2004).

The Anisotropy of Magnetic Susceptibility (AMS) is a powerful tool to investigate the internal structures of plutons where the macroscopic preferred mineral orientation is poorly expressed or absent (e.g. Bouchez, 1997). In particular, the lineation is often difficult to observe in the field because, unless they are significantly deformed, granitoids do not develop planar and linear fabrics that can be easily observed. The advantage of using magnetic techniques

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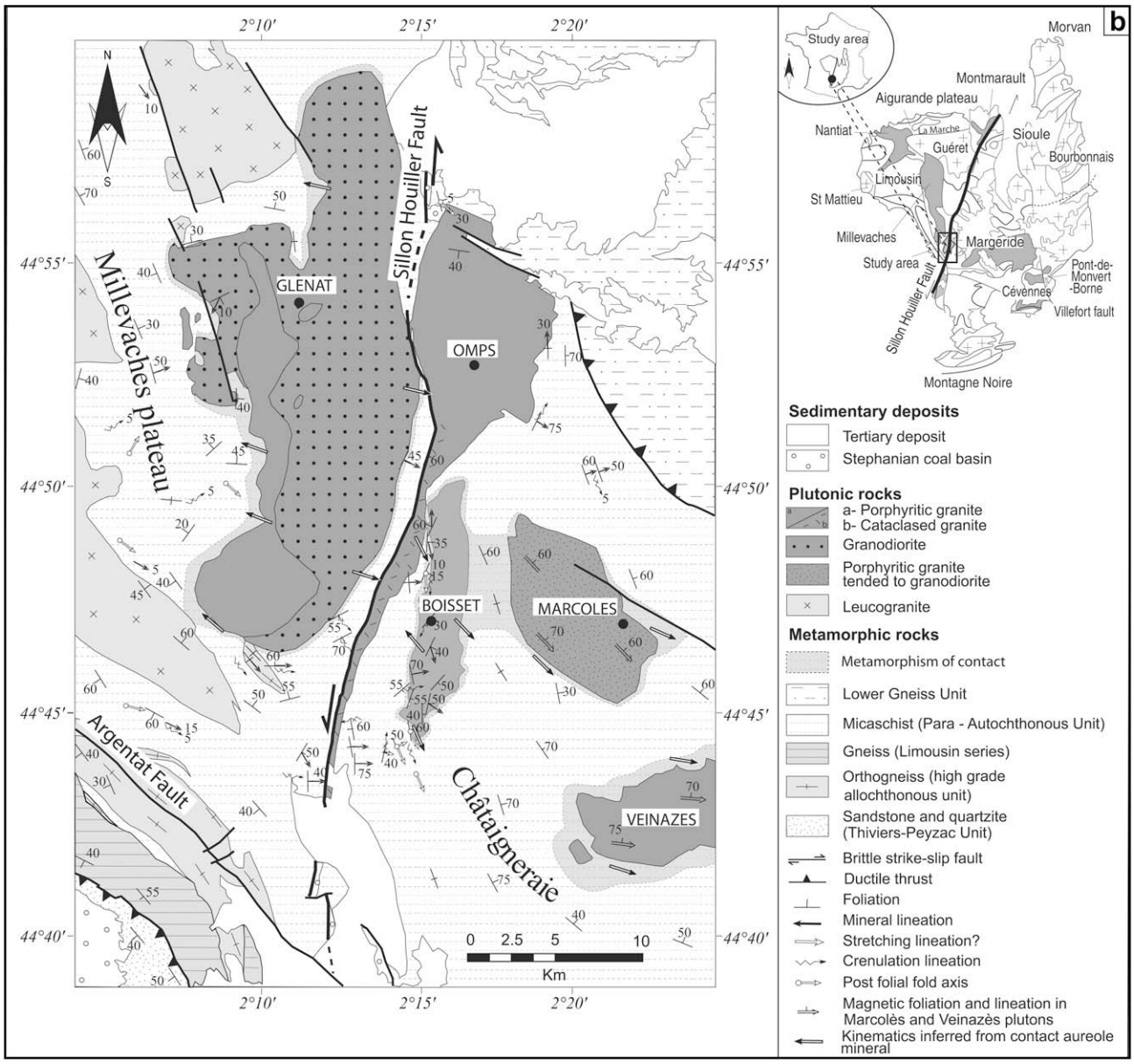


**Fig. 1.** Structural map of the Glénat, Omps and Boisset plutons (a), located in the French Massif Central (b).

in fabric studies of plutons lies in the fact that precise, reproducible and efficient foliation and lineation measurements can be obtained for any outcrops in a pluton (Hrouda, 1982; Bouchez, 1997, 2000). The analysis of petrographic textures and fabrics developed in a pluton and its wall rocks allow us to present a model delineating the rheological evolution of the magma during the pluton emplacement history.

In addition, the knowledge of the 3D shape of a pluton brings important information on the emplacement process, for example, by locating the possible feeder zones (Vigneresse, 1990; Aranguren et al., 1996; Améglio et al., 1997; Joly et al., 2008) and by defining the relationships between the host rocks and the granitic pluton. Several studies illustrate the usefulness of combining gravity and structural data when investigating the emplacement mode and structural evolution of a granitic pluton (e.g. Améglio et al., 1997; Vigneresse and Bouchez, 1997; Talbot et al., 2004). In order to obtain a consistent model, the 3D geological model is directly computed from the available structural data (field observations and AMS results) and constrained by geophysical data (Martelet et al., 2004; Joly et al., 2008). Namely, the geological boundaries at depth are assessed by inversion of gravity data (Guillen et al., 2008), and their uncertainties are quantified in a statistical way (Tarantola and Valette, 1982; Li and Oldenburg, 1998). With respect to forward modelling, this inversion procedure provides a fast and statistically robust estimate of probable 3D geometries and density contrasts.

This paper presents the results of a combined structural, geochronological, AMS and gravity investigation of Glénat, Omps and Boisset plutons in the southern part of the Variscan French Massif Central (Fig. 1). The architecture, kinematics, and timing of these Carboniferous plutons are discussed in the structural framework of the late orogenic evolution of the Variscan chain of the FMC. The relationships between the emplacement of these plutons and the nearby Sillon Houiller Fault (SHF) are considered and compared with previous results obtained in the northern part of the SHF (Joly et al., 2007, 2008).