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Significant rotations related to cover–substratum decoupling: Example of the Dôme de Barrôt (Southwestern Alps, France)

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ABSTRACT

The Barrôt area presents an important contrast of deformation between a foliated, faulted and non-rotated Permian substratum and a folded and strongly rotated Meso-Cenozoic sedimentary cover. The Permian substratum and the sedimentary cover are separated by a décollement level of Triassic gypsum. While numerous studies have been done on the Dôme de Barrôt (i.e., the Permian substratum), we focused our work on the deformed Meso-Cenozoic sedimentary cover around the Dôme de Barrôt where we measured and analyzed both the magnetic susceptibility fabrics and the paleomagnetic directions. Our results highlight an arcuate pattern of the directions of shortening trajectories revealed by type II–III fabrics of anisotropy of magnetic susceptibility (which predates the folding) and a later syn- or post-folding anticlockwise rotation of large amplitude ($64 \pm 14°$) for the sedimentary cover. The arcuate pattern of the directions of shortening and the different rotations between the Permian substratum and the sedimentary cover can be partly explained after restoring the paleogeographic location of the sedimentary cover before the Oligocene Alpine compression event. We tend to interpret the remaining 30° anticlockwise rotation as a result of the high efficiency of the Triassic gypsum décollement surface, a nearby regional left-lateral shear zone (RDFZ), and a possible near-field gravitational sliding near the later exhumed Dôme de Barrôt.

1. Introduction

The propagation of décollement surfaces into fold-and-thrust belts often results in a significant decoupling of deformation patterns between shallower and deeper units (Costa and Vendeville, 2002; Dahlen et al., 1984; Malavieille, 2010). Such decoupling with differential shortening rates in fold-and-thrust belts with respect to the substratum rocks under a décollement is usually evoked for explaining the arcuate shape of the shallower units (Macedo and Marshak, 1999; Vidal-Royo et al., 2009). In the foreland of the Western Alps, the fold-and-thrust belts of Castellane and Nice in France are typical examples of arcuate fold-and-thrust belts (Fig. 1A). The main décollement surface is located in the Triassic gypsum layers (Graham, 1981), along which the Meso-Cenozoic cover overthrusted the underlying Permian substratum (Fig. 1C). These fold-and-thrust belts were first documented being of convex curvature in late 70s (Siddans, 1979). It was more explicitly interpreted as an inherited structure or a primary arc-shaped feature (Weil and Sussman, 2004), based on the evidence of no paleomagnetic rotation in the Permian substratum in the "Dôme de Barrôt", the Argentera (Bogdanoff and Schott, 1977) and the Estérel massifs (Zjiderveld, 1975). Later on, although Aubourg and Chabert-Pelline (1999) observed a 40° anticlockwise rotation at level of the Digne nappe in the Neogene sediments, they did not question the primary arc-shaped nature because the rotations was interpreted to be controlled and bounded by the inherited structural pattern. Nevertheless such interpretations remained skewed by not taking into account (1) the strain decoupling between the substratum and the shallow cover, and (2) the structural pattern near the shear zone of the Rouaine–Daluis Fault Zone (RDFZ, Fig. 1B).

The Dôme de Barrôt is located in the inner part of the fold-and-thrust belt of Castellane, to the Southwest of the Argentera crystalline massif (Fig. 1A). To the southern edge of this Permian dome, the Meso-Cenozoic sedimentary cover presents a spectacular arcuate shape bounded farther to the West by the RDFZ. From West to East, the trend of the fold axes turn from NE–SW to E–W. This area provides a good opportunity to study a possible decoupling of deformation between the Paleozoic substratum and the Meso-Cenozoic cover through

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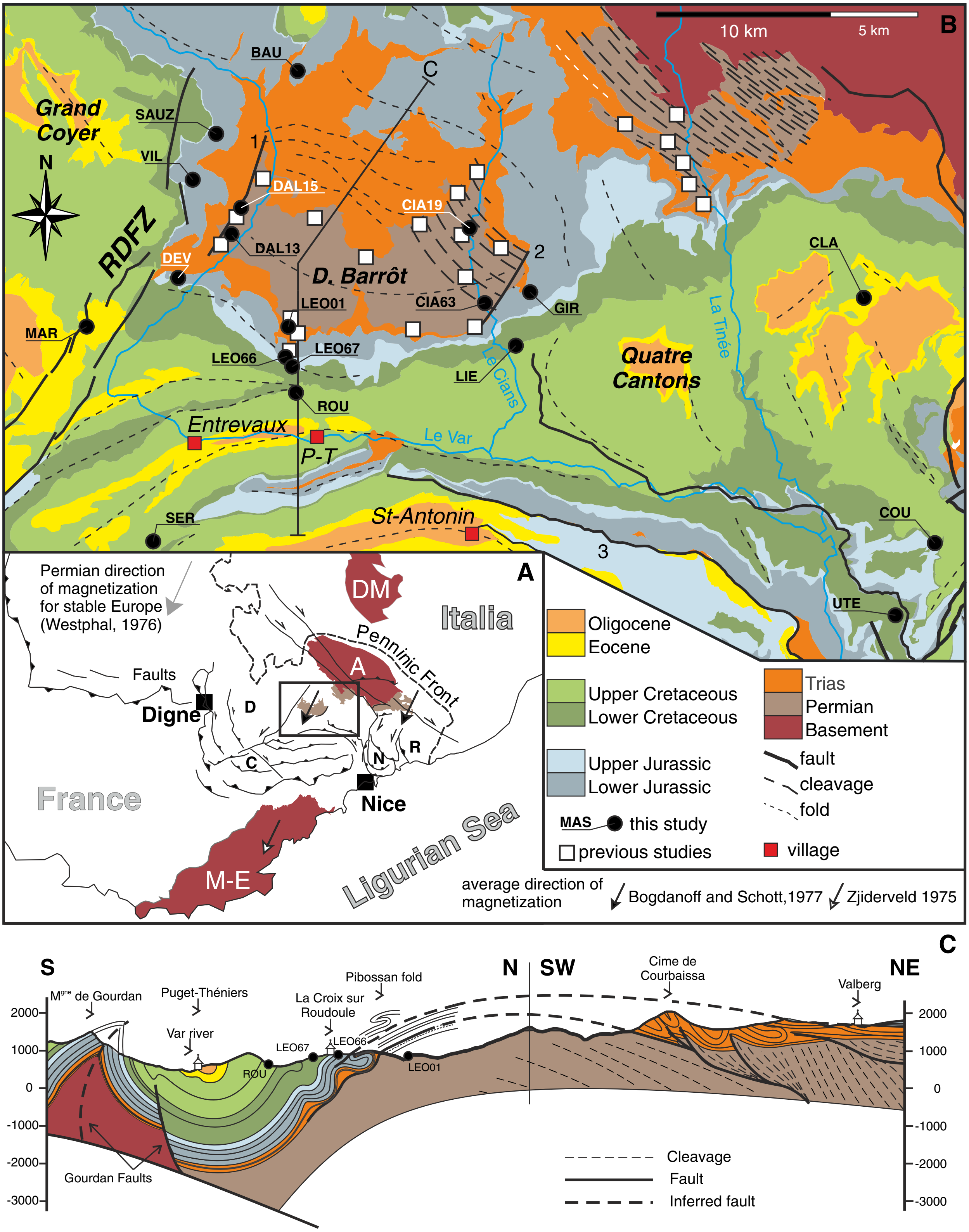

Fig. 1. (A) Geological context of the Dôme de Barrôt and location of the sampling sites in the study area. The black arrows represent the direction of magnetization for Permian layers (from Bogdanoff and Schott, 1977; Westphal, 1976; Zjiderveld, 1975). DM, A and M–E: Dora Maira, Argentera and Maures–Estérel crystalline basements; N: Nice salient; R: Roya salient; C: Castellane salient; D: Digne nappe. (B) Synthetic geological map of the studied area, modified from the geological maps of Puget–Théniers (Goguel et al., 1957) and Entrevaux (Campredon et al., 1980). The previous studies refer to the AMS and paleomagnetic works of Cogné and Perroud (1985), Graham (1978), Henry (1973), Kligfield et al. (1981), Siddans et al. (1984) and Van den Ende (1977). P–T: Puget–Théniers village. D. Barrôt: Dôme de Barrôt; 1: Daluis fault; 2: Girent fault; 3: Gourdan fault. (C) Geological cross-section through the Dôme de Barrôt.

the analysis of magnetic fabric and paleomagnetism. The decoupling that occurred between the Permo-Werfenian substratum and the Rhetian to Chattian sedimentary cover is probably due to the existence of a décollement of gypsum layers, the Muschelkalk and Keuper (Triassic) in age. For simplification of terminology, we use in this paper the terms Permian substratum or Paleozoic substratum and