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Stacking and metamorphism of continuous segments of subducted lithosphere in a high-pressure wedge: The example of Alpine Corsica (France)

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ABSTRACT

Alpine Corsica consists of a stack of variably metamorphosed units of continental and Tethys-derived rocks. It represents an excellent example of high-pressure (HP) orogenic belt, such as the Western Alps, exposed over a small and accessible area. Compared to the Western Alps, the geology of Alpine Corsica is poorly unraveled. During the 1970s–80s, based on either lithostratigraphic or metamorphic field observations, various classifications of the belt have been proposed, but these classifications have been rarely matched together. Furthermore, through time, the internal complexity of large domains has been progressively left aside in the frame of large-scale geodynamic reconstructions. As a consequence, major open questions on the internal structure of the belt have remained unsolved. Apart from a few local studies, Alpine Corsica has not benefited of modern developments in petrology and basin research. This feature results in several uncertainties when combining lithostratigraphic and metamorphic patterns and, consequently, in the definition of an exhaustive architecture of the belt. In this paper we provide a review on the geology of Alpine Corsica, paying particular attention to the available lithostratigraphic and metamorphic classifications of the metamorphic terranes. These data are completed by a new and exhaustive metamorphic dataset obtained by means of thermometry based on Raman Spectroscopy of Carbonaceous Material (RSCM). This technique provides reliable insights on the peak temperature of the metamorphic history for CM-bearing metasediments. A detailed metamorphic characterization of metasediments, which have been previously largely ignored due to retrogression or to the lack of diagnostic mineralogy, is thus obtained and fruitfully coupled with the available lithostratigraphic data. Nine main tectono-metamorphic units are defined, from subgreenschist (ca. 280–300 °C) to the lawsonite-eclogite-facies (ca. 500–550 °C) condition. These units are homogeneous in metamorphism, laterally continuous and have characteristic lithostratigraphic features. This study also suggests a direct link between the pre-orogenic extensional setting and the present-day compressional structure of Alpine Corsica, indicating that large sections of subducted lithosphere were subducted and exhumed as coherent domains. These features provide important insight on the mechanism of stacking and exhumation of HP rocks, and make Alpine Corsica a unique reference for mountain-building processes in Tethyan-type orogens.

Contents

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1. Introduction

Alpine Corsica offers a complete section through a Tethyan-type orogenic wedge, where almost all the tectonic units described in the Western Alps (*e.g.* Caron and Delcey, 1979; Durand-Delga, 1984; Lagabrielle and Lemoine, 1997; Schmid et al., 2004; Bousquet, 2008; Beltrando et al., 2010a) are exposed over a 40 km section. The High-Pressure (H*P*) terranes of Alpine Corsica are the prevailing lithologies, and peak metamorphic mineral assemblages, especially lawsonite-bearing rocks, are exceptionally well preserved. Compared to the Western Alps, late deformation is much more localized, and inherited primary lithostratigraphic features are well preserved and have been commonly documented (*e.g.* Caron, 1977; Durand-Delga, 1978; Caron and Delcey, 1979; Caron et al., 1979; Caron and Bonin, 1980; Caron et al., 1981; Lahondère, 1983; Amaudric du Chaffaut et al., 1984; Durand-Delga, 1984; Amaudric du Chaffaut et al., 1985; Caron et al., 1990; Lahondère et al., 1992; Guieu et al., 1994; Rossi et al., 1994a,b; Vitale Brovarone, 2011; Vitale Brovarone et al., 2011a,b; Meresse et al., 2012). Three major domains are classically recognized, the continental margin units, the Schistes Lustrés (SL) complex and the so-called Nappes Supérieures (*e.g.* Durand-Delga, 1978). Several lithostratigraphic studies are available for both the strongly metamorphosed SL complex and the lower grade terranes, *i.e.* the continental margin units and Nappes Supérieures (*e.g.* Caron, 1977; Nardi et al., 1978; Caron and Delcey, 1979; Caron and Bonin, 1980; Amaudric du Chaffaut, 1982; Durand-Delga, 1984; Lagabrielle and Lemoine, 1997; Ferrandini et al., 2010). In the same way, different metamorphic zones have been defined based on field observation and local P–Temperature (*T*) estimates over the belt (*e.g.* Caron et al., 1981; Péquignot and Potdevin, 1984; Caron and Péquignot, 1986; Lahondère, 1988, 1996; Lahondère et al., 1999; Oberhänsli et al., 2004). In general, most authors have given credence to either the lithostratigraphic or tectonometamorphic classifications, but their interdependencies, geographical boundaries and evolution are not well established throughout the belt. Successively, more interest has been paid to tectonics and geodynamics of Corsica in the frame of the surrounding Mediterranean system (*e.g.* Cohen et al., 1981; Faure and Malavieille, 1981; Malavieille, 1983; Péquignot and Potdevin, 1984; Harris, 1985; Gibbons et al., 1986; Jolivet et al., 1990; Fournier et al., 1991; Jolivet et al., 1991; Daniel et al., 1996; Lahondère, 1996; Jolivet et al., 1998; Molli and Tribuzio, 2004; Lacombe and Jolivet, 2005; Malasoma et al., 2006; Molli et al., 2006; Molli and Malavieille, 2010). The progressive shift from a lithostratigraphic to a tectonometamorphic/geodynamic approach resulted in a necessary simplification of the structure of the belt, and only the three major domains of the belt (SL, continental margin units and Nappes Supérieures) are commonly highlighted. This aspect, however, has resulted in several progressive assumptions regarding the structure of the SL complex, its origin and its geometrical and chronological relationships with the surrounding domains. Furthermore, the lack of lithostratigraphic and metamorphic studies in the SL during almost thirty years (a part from a few cases which are reviewed in the following), left several open problematic issues unsolved, and kept the Schistes Lustrés aside from fundamental improvements in basin research and quantitative petrology.

In the last years, authors have reconsidered some of the debated aspects of the Schistes Lustrés and other domains of the belt in the light of modern information about passive margins in Alpine Corsica and in the Western Alps (Rossi et al., 2002; Beltrando et al., 2010, 2012; Vitale Brovarone et al., 2011a; Meresse et al., 2012). Moreover, recent development in the petrological study of metasediments, and, in particular, the thermometric estimates based on Raman spectroscopy of Carbonaceous Material (RSCM) has allowed a more systematic and detailed study of metamorphic terranes independently from the extent of retrogression and from the occurrence of diagnostic mineralogy (e.g. Beyssac et al., 2002a). This technique thus allows a deep coupling between petrology of metasediments and lithostratigraphy, which is fundamental in the metasediment-rich terranes of Alpine Corsica as already demonstrated successfully in similar geological units of the Western Alps (*e.g.* Gabalda et al., 2009; Plunder et al., 2012).

The purpose of this study is to discuss the internal structure of Alpine Corsica by coupling the available lithostratigraphic, structural and metamorphic data and an exhaustive dataset of RSCM thermometry. Our dataset permits to define a high-resolution distribution of large tectonometamorphic units and their relationships with the main lithostratigraphic features described in the belt. As a result, a strong link between the paleogeography of the units and their Alpine tectonometamorphic evolution is established. We also conclude that Alpine Corsica represents a nice example of orogenic belt where large segments of subducted lithosphere are coherently exhumed back from various *P–T* conditions, from very low-grade metamorphism up to the lawsonite-eclogite facies conditions. As metamorphic conditions of the H*P* units of Alpine Corsica are comparable with many other H*P* belts (*e.g.* the Western Alps), exhumation mechanism observed in this belt (*i.e.* large coherent segments of subducted lithosphere) may serve as a reference for other Tethyan-type belts affected by stronger late deformation.

2. Geological setting

The island of Corsica occupies a central position in the Western Mediterranean sea (Fig. 1). It consists of two main geological domains