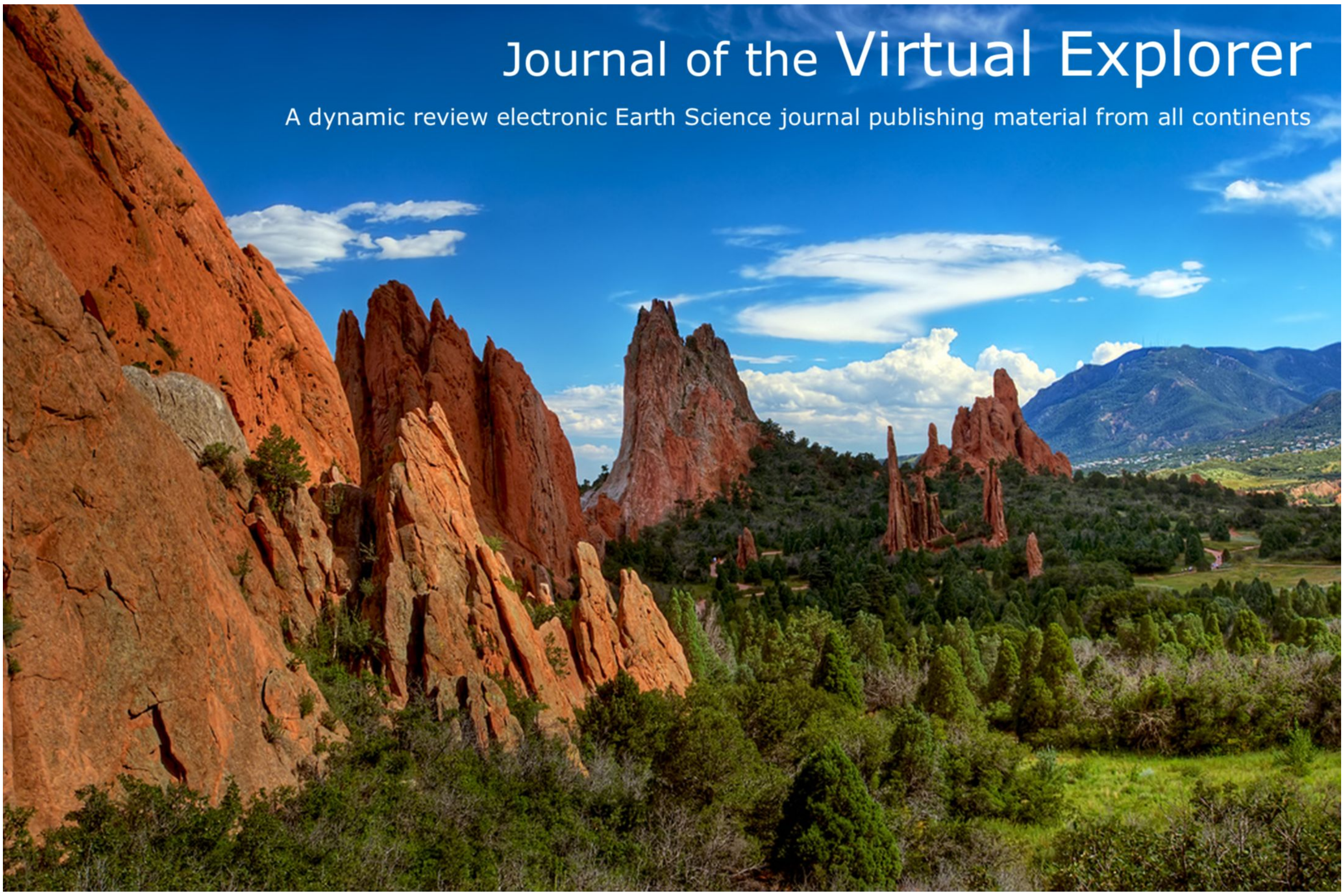

Introduction to the Field trips of the CorseAlp 2011

Giancarlo Molli, Jacques Malavieille

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Introduction to the Field trips of the CorseAlp 2011

Giancarlo Molli
University of Pisa, Dipartimento di Scienze della Terra Via S. Maria 53, 56126 PISA, Italy. *Email: gmolli@dst.unipi.it*

Jacques Malavieille
Geosciences Montpellier, UMR 5243 CNRS-UM2 Case courrier 60, Université Montpellier 2 34095 Montpellier cedex, France.

Abstract: Corsica is located in the Mediterranean sea, about 90 km from the Italian coast of Tuscany and 175 km from the French Riviera. This relatively large island stretches for 180 km in the north-south direction and 85 Km east-west. The rugged landscape, with a mean elevation of ca. 500 m and the highest point at 2710 m (Monte Cinto) is interrupted only by a major plain along the east coast.

CorseAlp 2011 was held in April 2011. A link to the website is here: CorseAlp 2011. The CorseAlp field trips were designed to introduce the participants to the general features of the geology of Alpine Corsica and to recent specific discoveries. Field trip 1 focused on the geology of the Ocean-Continent Transition preserved in the Monte San Petrone, in Central Corsica, which was subducted to eclogite facies conditions during the Alpine orogeny. The three days post-workshop field trip (Field trip 2) focused on the general architecture of Alpine Corsica in an EW transect between the Balagne region and Bastia. The main topics of Field trip 1 and 2 allow discussion about the overall evolution of Alpine Corsica in the framework of Mediterranean geodynamics, with a focus on the most controversial aspects.

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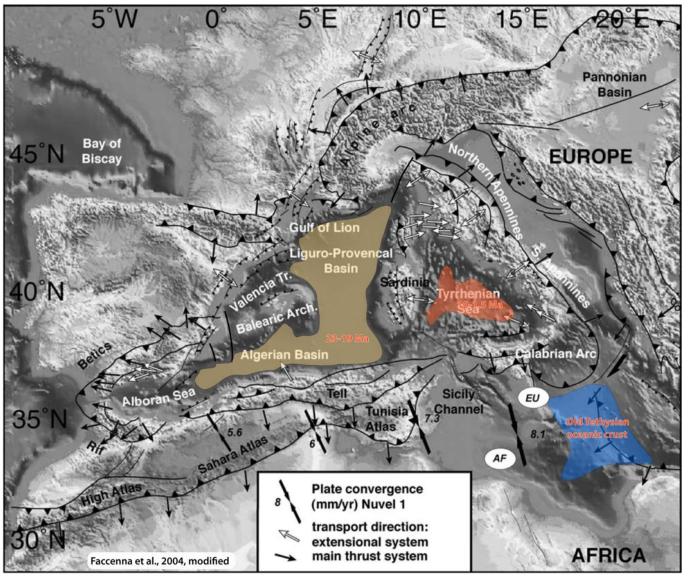
Introduction

Corsica is located in the northern part of the Western Mediterranean (Fig.1). It is subdivided into two main geological domains: a western area, mainly consisting of Late Hercynian granitoids and minor relicts of host rock-basement (Hercynian Corsica), and an eastern area characterized by continental and oceanic-derived units pervasively deformed during the Alpine orogeny (Alpine Corsica).

Figure 1. Morphostructural sketch map of the Mediterranean region

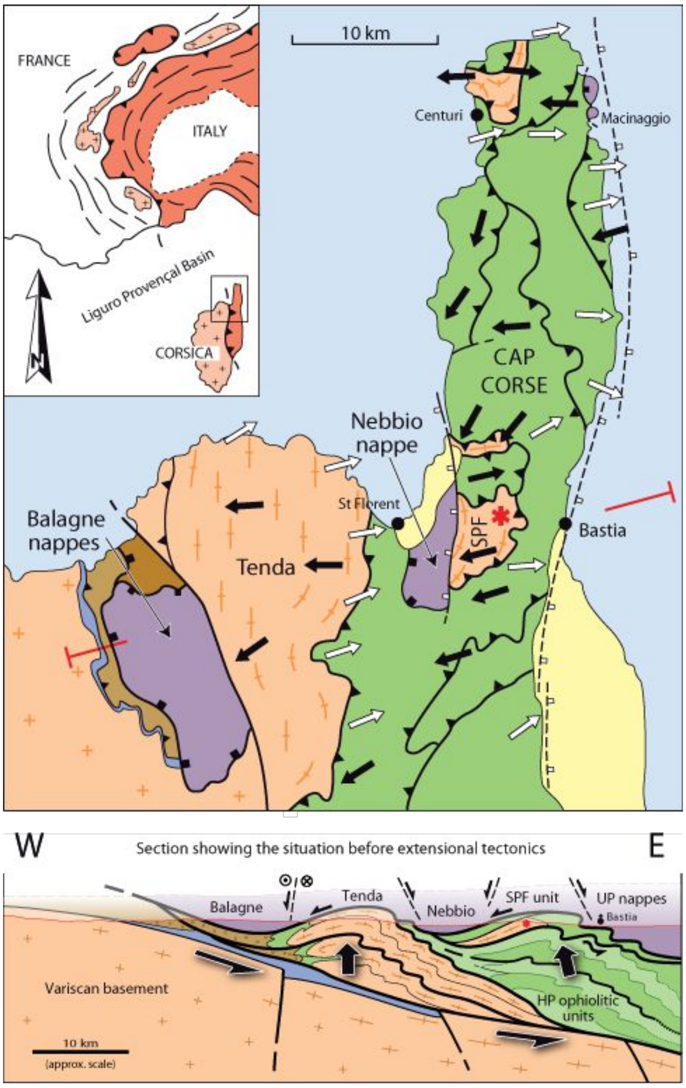


Morphostructural sketch map of the Mediterranean region showing the main orogenic systems the present day kinematics and age of opening of the different oceanic domains (modified after Faccenna *et al.*, 2004).

Corsica and Sardinia are traditionally regarded as a microblock originally welded to southern France-Northern Iberia until Middle-Oligocene (Fig.1), when rifting and then drifting in the Liguro-Provençal basin took place (Guegen *et al.* 1997; Carminati *et al.*, 1998; Speranza *et al.* 2002; Rollet *et al.* 2002 and references therein). Therefore, the western Hercynian domain is correlated with the Maures-Esterel basement of southern France whereas Alpine Corsica is regarded as the southern prolongation of western Alps, through the Western Liguria and Voltri Group Alpine units (Durand Delga, 1984 and references therein).

The eastern part of Corsica (Alpine Corsica), is made up by a stack of tectonic units, some including rocks of oceanic origin (ophiolitic basement and related cover rocks) and others of continental origin (Mattauer *et al.* 1981; Durand Delga 1984; Dallan and Nardi 1984; Dallan and Puccinelli 1995; Malavieille *et al.* 1998; Rossi *et al.* 2003). The maps and the schematic cross-section of Fig.2 outline the overall architecture of the belt and its major internal subdivisions. From bottom to top four different groups of units can be distinguished:

Figure 2. Tectonic map and regional cross-sections of northern Corsica



Tectonic map and regional cross-sections of northern Corsica showing the main tectonic units and the regional trend of stretching/mineral lineations with sense of shear for subduction- (black arrows) and low-pressure greenschist-related extensional fabrics.

1) "Autochthonous" Corsica, forming the western side of the island, consisting of Hercynian units (mainly Carboniferous to Permian granitoids and Permian volcano-sedimentary sequences) locally weakly affected by Alpine deformation and a reduced and incomplete Mesozoic to Mid-Eocene sedimentary cover of Briançonnais affinity (Durand Delga 1984; Michard and Martinotti 2002).

2) Corsica-derived continental-crust units, which include mildly to strongly reworked crystalline rocks of the Hercynian basement (including Permian granitoids) and their Mesozoic to Mid-Eocene sedimentary cover originally deposited on the distal part of the Corsica continental margin (Faure and Malavieille 1980; Rossi *et al.* 2002; Molli 2008). This group of units will be described in further detail below.

3) The 'Schistes Lustrés' composite nappe, comprising Ligurian Tethys-derived oceanic sequences (mantle ultramafics, gabbros, pillow lavas and associated Jurassic to Cretaceous metasediments) and relicts of the former ocean-continent transition (OCT) domain,. The latter consists of exhumed mantle, ophiolitic metagabbros and metabasalts associated with slices of continental upper crust and related metasedimentary cover rocks (Caron and Delcey 1979; Durand Delga 1984; Lagabrielle *et al.* 2005; Vitale *et al.* 2009). These groups of units show peak metamorphism ranging from blueschist to eclogite facies conditions and various degrees of retrogression under greenschist facies conditions (Dal Piaz and Zirpoli, 1979; Gibbons *et al.* 1986; Waters, 1990; Caron 1994; Fournier *et al.* 1991; Daniel *et al.* 1996; Molli *et al.* 2006; Vitale Brovarone *et al.* 2009; Vitale Brovarone *et al.*, 2011).

4) The upper-Nappe system also called Nappe Supérieure includes the Balagne, Nebbio and Macinaggio units. It is formed by ophiolitic as well as continent-derived rocks mainly associated with Late-Cretaceous siliciclastic and calcareous-marly flysch deposits (Durand Delga 1984; Dallan and Nardi 1984; Marroni and Pandolfi 2003). The units are characterized by low-grade metamorphic assemblages (prehnite/pumpellyite in mafic rocks) and a geometrically high position in the nappe stack. The ophiolitic Balagne nappe is found in the external zones directly overriding the continental units ("autochthonous and external continental units" see below), while the Nebbio and Macinaggio units occupies a more internal position, resting on top of the high-pressure low-temperature Schistes Lustrés composite units.

The uppermost nappes and their contacts with the underlying units are locally unconformably sealed by lower Miocene "post-orogenic" continental or marine sediments of the Francardo, St. Florent and Aleria basins (Dallan and Puccinelli 1995; Ferrandini *et al.* 1998; Cavazza *et al.*, 2001).

Discussion

The structural and metamorphic evolution of the Corsica-derived continental units may be used to provide first order constraints on the kinematics of the Corsican orogen. The Corsica-derived continental units and continental slices from the former OCT show a variable high pressure/low temperature metamorphic imprint. It ranges from lower grade (high pressure greenschist to lower blueschist facies) in the external and presently geometrically lowermost units, to eclogite facies in the more internal and uppermost ones (see page for more details; Bézert and Caby1988; Egal and Caron 1988; Bézert 1990; Caron 1994; Lahondère 1991; Tribuzio and Giacomini 2002; Molli and Tribuzio 2004; Malasoma *et al.* 2006; Molli *et al.* 2006; Molli 2008; Chopin *et al.* 2008; Vitale Brovarone *et al.* 2009, 2011a and 2011b).

Pervasive composite mylonitic foliation with relicts of eclogite fabrics can be observed in the uppermost slices. Stretching lineation and shear sense indicators associated with eclogite fabrics provide rare evidence of top north/northwest shearing (Lahondère 1996; Lahondère and Caby 1997), whereas the blueschist retrograde fabric formed the mappable main foliation associated with an east-west stretching lineation and a dominant top-to-west kinematics (Fig. 1.2) (Faure and Malavieille 1981; Mattauer *et al.* 1981; Malavieille 1983; Harris 1985 a, b; Jolivet *et al.* 1991; Fournier *et al.* 1991; Daniel *et al.* 1996).

The Tenda and Centuri units are characterized by a heterogeneous deformation pattern with low strain domains without metamorphic mineral fabrics (i.e. isotropic) or with a magmatic grain-shape fabric surrounded by mylonitic orthogneisses and/or mylonites. The dominant fabric in the Centuri unit is represented by blueschist facies assemblages (Malavieille 1983) whereas in the Tenda unit greenschist facies exhumation-related tectonites are widespread (Gibbons and Horack 1984; Molli and Tribuzio 2004). Kinematic criteria in the blueschist assemblages in the Centuri unit suggest both top-to-east as well as top-to-west shearing (Malavieille 1983; Harris 1984; Malavieille *et al.* 1998) while the preserved blueschist relict domains in the Tenda unit witness dominant top-to-west shearing (Mattauer *et al.* 1981; Lahondère *et al.* 1999; Daniel *et al.* 1996; Molli and Tribuzio 2004; Molli *et al.* 2006).

The external continental unitsare also characterized by high pressure/low temperature metamorphic overprint with structures associated with an east-west direction of transport and dominant top-west kinematics which is observable all along the boundary between Alpine and Hercynian Corsica (Bézert and Caby1988; Egal 1988; Bézert 1990; Malasoma *et al.* 2006, Molli 2008).

As a whole, the present geometry, internal structure, deformation style and metamorphic peak conditions of the Corsican continental units within the nappe stack can provide first order constraints on the role of the Corsican continental margin during the early stages of the Alpine orogenic history. These data sets indicate a progressive underthrusting of the upper Corsican crust in a framework of east-dipping continental subduction (Mattauer and Proust 1975; Mattauer *et al.* 1981; Gibbons *et al.* 1986; Gibson and Horack 1984; Malavieille *et al.* 1998; Molli *et al.* 2006; Molli 2008; Molli and Malavieille 2010).

The age of the earliest stages of Alpine metamorphism in Corsica is still under investigation (Handy and Oberhänsli 2004; Berger and Bousquet 2008). Despite these limitations, available geochronological data, coupled with independent geological observations, provide a coherent regional framework for the overall evolution of the belt. In the Schistes Lustrés, eclogites yielded a Sm-Nd whole rock Grt-Gla-Cpx isochron age of 84 ±5 Ma (Lahondère and Guerrot 1997). Phengite from continent-derived eclogitic gneisses of the Farinole unit yielded a $^{40}Ar/^{39}Ar$ discordant age spectrum with ages increasing from 55.3 ±4.3 Ma to 65,3±0,7 Ma, whereas post-eclogitic phengites give ages from 54.3 ±0.5 Ma to 37.4 ±0.4 Ma (Brunet *et al.* 2000). Similar retrogression-related ages were previously obtained by Maluski (1977) and Lahondère (1996).

For the Tenda unit, celadonite-rich phengites (Si = 3.5 apfu) from a deformed granitoid, (see also Maluski 1977; Cohen *et al.* 1981) yielded a discordant $^{40}Ar/^{39}Ar$ spectrum increasing from about 25 Ma to 47 Ma (Brunet *et al.* 2000). This suggests that high-pressure metamorphism in the Tenda Massif has a minimum age of 47 Ma (Molli and Tribuzio 2004). The more recent U/Pb TIMS study of Maggi *et al.* (2011) yielded ages between 48 ±18 Ma (MSWD 7.3) and 54 ±8 Ma (MSWD = 48).

On the base of stratigraphic observations, underthrusting and subduction of the Corsican continental crust is documented to last until at least the Bartonian (40-37 Ma). This conclusion is based on the presence of a sedimentary cover containing Nummulites biarritzensis and Discocyclina sp. (Bézert and Caby 1988), dated to early Mid-Eocene in the External Continental Units, which are affected by high-pressure greenschist facies to high pressure/low-temperature metamorphism (Bézert and Caby 1988; Bézert 1990; Malasoma *et al.* 2006; Malasoma and Marroni 2008; Molli 2008) contain

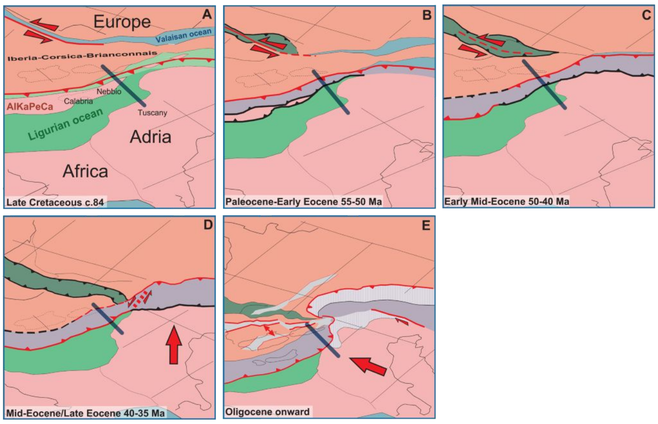
Conclusion

In conclusion, two major tectonic stages characterize the evolution of Alpine Corsica (Figs. 3,4):

(1) the orogenic stage, related to the Late Cretaceous–Middle Eocene east-dipping subduction and progressive underthrusting of the Corsican continental crust. This event ended with the arrival at the trench of the thick Corsican crust, which blocked the subduction in the late Mid-Eocene;

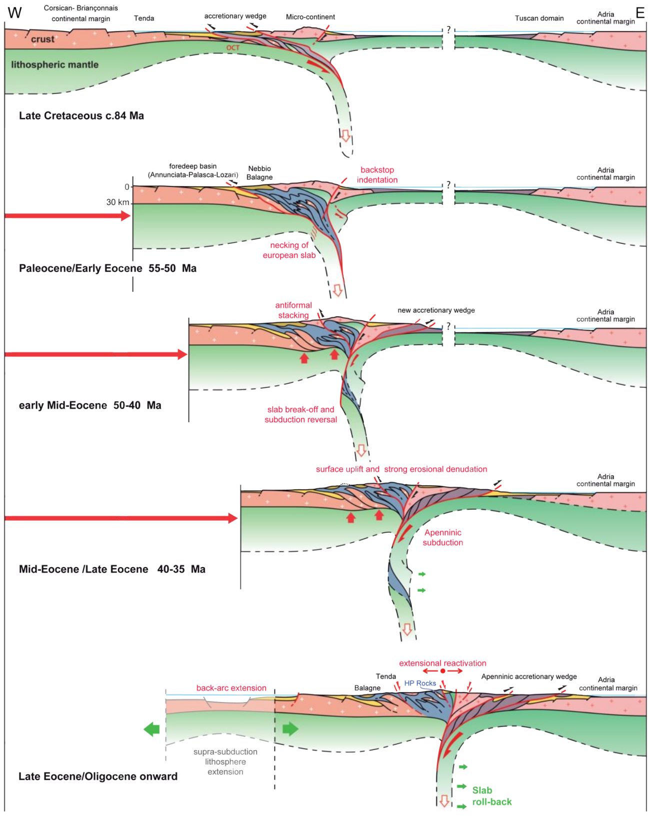
(2) a post-orogenic stage, stretching from the early Oligocene–Miocene to the present day, related with the west-dipping Apenninic subduction. This geodynamic context is responsible for the reactivation of pre-existing thrusts in transpression/transtension during the Corsica-Sardinia block rotation, which ended with the development of Miocene basins and their subsequent deformation. The extensional tectonics described by Jolivet at al. (1990); Daniel *et al.* (1996); Jolivet *et al.* (1998); Guyedan et al (2003) and references therein took place during this post-orogenic stage. Deformation related to this stage generally results in low-displacement reactivation of previous subduction- and syn-contractional exhumation-related fabrics and structures (see details in the second day of Field trip 2).

Figure 3. Palaeotectonic sketch maps



Palaeotectonic sketch maps for the evolution of Corsica/Northern Apennine orogenic system from Late Cretaceous to Oligocene in oblique aerial view (mainly based on Dewey *et al.* 1989; Cello *et al.* 1996; Gueguen *et al.* 1997; Lagabrielle and Polino 1998; Stampfli *et al.* 1998; Séranne 1999; Neugebauer *et al.* 2001; Michard *et al.* 2002; Dèzes *et al.* 2004; Rosenbaum and Lister 2005; Schettino and Turco 2006; Molli 2008). Thin black bar indicates the location of cross-sections of Fig. 5. In 4e are represented the Campidano, Valencia and Rhone valley grabens. Thin black line in each sketch are present-day longitudes and latitudes. Different others paleotectonic interpretation can be found in the literature between others Handy *et al.* (2010); Vignaroli *et al.* (2009); Argnani (2009); Schettino and Turco 2006; Lacombe and Jolivet, 2005; Faccenna *et al.* (2004) and references therein.

Figure 4. Evolutionary model



Evolutionary model for the Corsica/Northern Apennine orogenic system based on the first-order tectonic constraints from the former opposite continental margins and tectono-sedimentary evolution of Alpine Corsica and Tuscan-derived continental units (after Molli and Malavieille, 2010).

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