



## Research paper

# Composition and provenance of the Macigno Formation (Late Oligocene–Early Miocene) in the Trasimeno Lake area (northern Apennines)



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## ABSTRACT

Sandstone petrography and mudstone mineralogy and geochemistry of the Late Oligocene–Early Miocene terrigenous deposits of the Macigno Fm. of the Trasimeno Lake area (Central Italy) provide new information on provenance, paleoenvironment, palaeoclimate, and geodynamics during the early stages of the northern Apennines foreland basin setting. Sandstones are rich in trace fossils and are quartz-ofeldspatic with various crystalline phaneritic (mostly granitoids) and medium-low grade metamorphic rock fragments. Volcanic and sedimentary lithic fragments are rare.

The mudstone mineralogy contains a large amount of phyllosilicates, quartz, and feldspars and small amount of calcite, which increases in the mid-part of succession.

Palaeoweathering indices (Chemical Index of Alteration with and without CaO value; CIA and CIA' respectively) suggest a source area that experienced low to moderate weathering and low recycling processes (on average, CIA = 66.4 and CIA' = 69.7). Furthermore, very low and homogeneous values of Rb/K ratios (<0.006) suggest weak to moderate weathering conditions.

The sandstone and mudstone composition reflects a provenance derived from uplifted crystalline rocks. The different amount in feldspars, the variety of lithic fragments, the occurrence of mafic and carbonate input, coupled with evidence of multi-directional flows, suggest a provenance from different source areas. The geochemical proxies indicate a provenance from both felsic and mafic sources, predominantly for the Maestà section that shows Cr/V values ranging from 1.15 to 3.36 typical of source areas composed of both felsic and mafic rocks. The Western-Central Alps are inferred to be the main source area of the Macigno foreland system, but significant signals from the Mesomediteranean Microplate are also testified. These new data suggest that the Macigno Fm. was probably located in a peculiar area which received either distal fine turbidite flows from the northernmost Alpine area and residual sandy debris flows coming from the westernmost Alps.

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## 1. Introduction

The thrust belt-foreland system of Northern Apennines was characterized by a continuous eastward migration of depocentres reflecting detachment of subducted lithosphere as result of African-European collision in the Late Eocene and subsequent rollback during the Late Oligocene to Recent time (Van der Meulen et al.,

1998; Dinelli et al., 1999; Barsella et al., 2009). During the Oligocene–Miocene, foredeep depocentres were filled by thick debris of turbidite deposits in continuous and complex depositional units. The Macigno Fm. represents the first depositional unit of the Late Oligocene–Early Miocene foreland basin system of northern Apennines, linked to Alpine sectors through longitudinal feeding of the foreland basin (Ricci Lucchi, 1986, 1990). The Macigno Fm. is traditionally divided into a westernmost and oldest portion (late Chattian), cropping out along the Tuscan coast and named “Macigno Costiero” and an eastern and younger portion (late Chattian–Aquitania) named “Macigno Appenninico” thrust

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eastward on the Marnoso-arenacea Formation in the Casentino area (Boccaletti et al., 1990; Milighetti et al., 2009 among others). The Modino–Cervarola–Trasimeno units and associated facies (now included in eastern Macigno) and the overlying Marnoso-Arenacea Fm. represent the Mid-Late Miocene foreland basin system, whereas, the depositional framework and basin architecture of the foreland system are well developed (Ricci Lucchi, 1986, 1990; Centamore et al., 2002; Guerrera et al., 2012b). Differently to Ricci Lucchi (1986, 1990), Valloni et al. (1991), Pandeli et al. (1994) and recently Barsella et al. (2009) indicated only one terrigenous source

area for the Macigno Fm., identified with the western-central Alps. Other authors recently claim that alpine source interfingered with an increasing contribution from the emerging Apennines from the Early Miocene onward, involving the upper portion of the Macigno Formation, especially the Modino–Cervarola unit (Gandolfi et al., 1983; Andreozzi and Di Giulio, 1994; Di Giulio, 1999). According to Cornamusini (2002) and Cornamusini et al. (2002), new sedimentological and petrographic data suggest that the Corsica-Sardinian Hercynian basement is the source area of the debris flow and turbidite sandstones of the “Macigno Costiero”. Thus, the

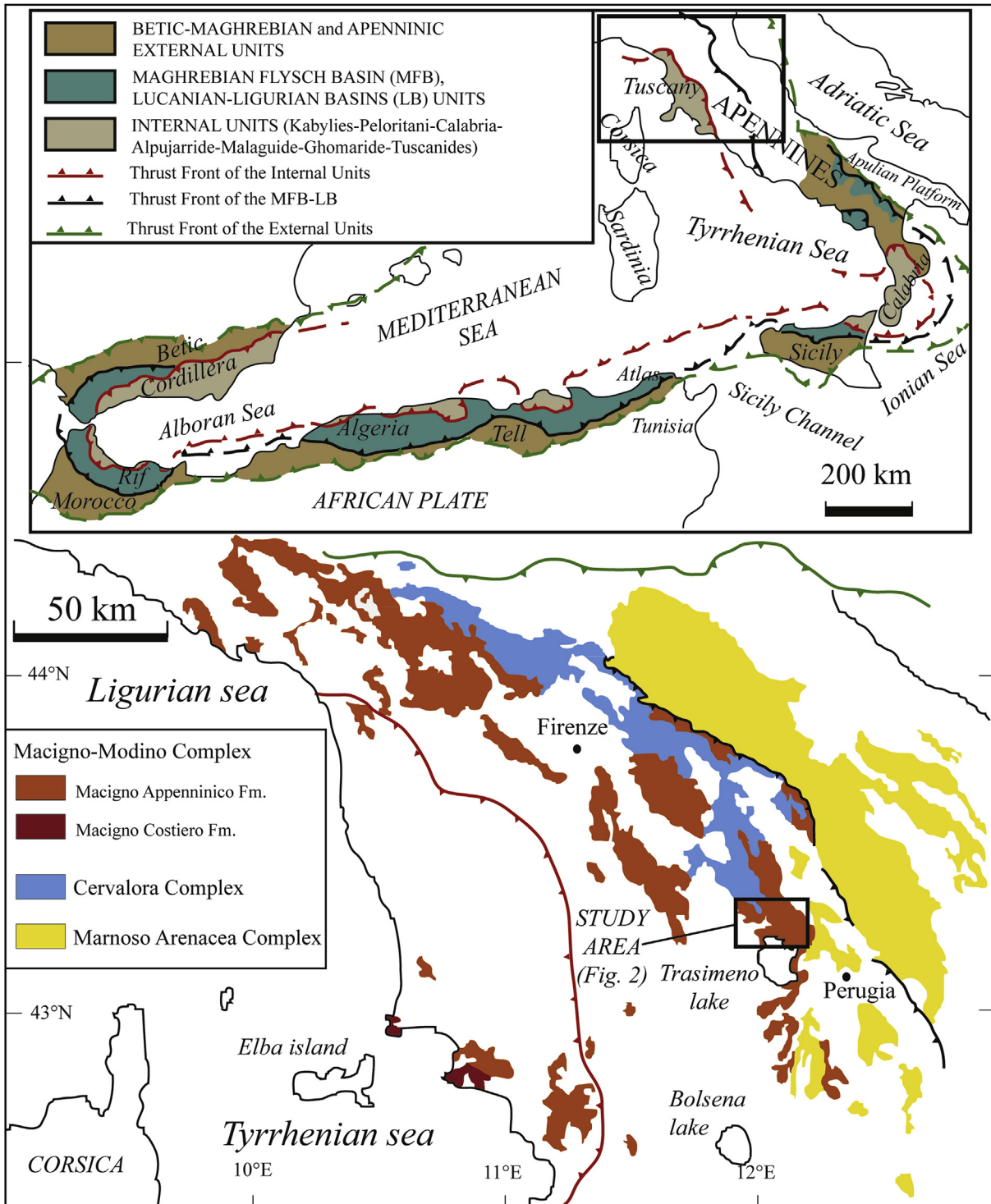


Fig. 1. Outcrop distribution of main Northern Apennines turbidite foredeep units, with indication of study area (modified after Dunkl et al., 2001).

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