



# A constrained African craton source for the Cenozoic Numidian Flysch: Implications for the palaeogeography of the western Mediterranean basin

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## ABSTRACT

The provenance of the Numidian Flysch in the western Mediterranean remains a controversial subject which hinders understanding of this regionally widespread depositional system. The Numidian Flysch is a deep marine formation dated as Oligocene to Miocene which outcrops throughout the Maghreb and into Italy. Evidence that is widely used for provenance analysis has not previously been reviewed within the context of the Maghreb Flysch Basin as a whole. The structural location within the Alpine belt indicates deposition proximal to the African margin, while the uniformity of the Numidian Flysch petrofacies suggests a single cratonic source, in stark contrast to heterolithic and immature flysch formations from the north of the basin. Detrital zircon ages constrain a source region with Pan-African and Eburnian age rocks, unaffected by either Hercynian or Alpine tectonic events, which precludes the European basement blocks to the north of the basin. Palaeocurrent trends which suggest a northern source are unreliable given foreland basin analogues and observed structural complications. An African craton source remains the only viable option once these data are reviewed in their entirety, and the Numidian Flysch therefore represents a major Cenozoic drainage system on the North African margin. Deposition is concurrent with regional Atlas uplift phases, and coincidental with globally cooling climates and high sea levels. The Numidian Flysch is therefore interpreted to represent a highstand passive margin deposit, with timing of deposition controlled primarily by hinterland uplift and climatic fluctuations.

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## 1. Introduction

The Cenozoic Numidian Flysch is a foreland basin deposit representing the most widespread tectono-stratigraphic unit in the western Mediterranean (Wezel, 1970a; Dejong, 1975) (Fig. 1). Numidian Flysch sediments were fed into the east–west oriented foreland basin (Mahgrebian Flysch Basin (MFB)) which resided in the western palaeo-Tethys realm between a growing accretionary prism to the north and the passive African margin to the south (Elter et al., 2003; Guerrero et al., 2005). Facies include hemipelagic mudstones and a variety of density flow deposits both unconfined and confined within channel bodies (Vila et al., 1995; Johansson et al., 1998) (Fig. 2). Depositional environment is assigned to both the slope and basin floor environments within a deep marine setting (e.g. Wezel, 1969; Johansson et al., 1998; Riahi et al., 2007). Displaying a seemingly continuous ultramature quartzarenite petrofacies throughout the western Mediterranean, the Numidian Flysch has been a formation of great controversy regarding its provenance since the 1950s (Gottis, 1953; Wezel, 1970a; Caire and Duée, 1971). Attempts to reconcile this fundamental problem have been hampered by its homogeneous nature and the complexity of its allocthonous emplacement. Its vast regional extent (>2000 km) has also lead some authors to promote it as a facies rather than a single formation (Magné and Raymond, 1972; Giunta, 1985; Moretti et al., 1991). Its source region has ultimately been described as being northern, from European terrains and the foreland basin orogenic wedge; southern from the African craton; or a mixture of both. Evidence has focused upon its structural position relative to other units within the basin, petrology of the clastic fraction, ages of detrital zircons, and palaeocurrent orientations. Progress has stagnated in recent years with heated debate over palaeocurrent orientations giving no obvious

conclusion (see Johansson et al., 1998; Parize et al., 1999; Stow et al., 1999). More recently, work has spread to provenance analysis of mudstones rather than the clastic fraction which has failed to resolve the debate so far (Barbera et al., 2009). The lack of a definitive source area has hampered understanding of the Numidian Flysch system as a whole, and little evidence exists concerning either basin architecture or controls upon deposition. The duration and large regional extent of Numidian Flysch deposition potentially offers an insight into the palaeogeography and drainage in the entire western Mediterranean once these problems are addressed. Here we present the first integrated critical review of the published evidence on provenance, together with additional field and petrological data, in order to constrain the source of the Numidian Flysch and place it within a palaeogeographic framework of the western Mediterranean during the Cenozoic.

## 2. Geological setting

The Mahgrebian Flysch Basin (MFB) represents a major Mesozoic domain of the Alpine orogenic belt (Guerrera et al., 2005) which today marks the northern extent of the African margin from Morocco to southern Italy (Wezel, 1970a) (Fig. 1). The basin, a remnant of the neo-Tethys ocean, lay to the north of the African margin and trended approximately east–west, linking the Atlantic and eastern Mediterranean domains (Piqué et al., 2002; Guerrero et al., 2005) (Fig. 3). The original oceanic basin was initiated through the northwards separation of Eurasia from Gondwana during the Jurassic breakup of Pangea (Golonka, 2004). An east–west trending group of continental microplates, variously termed the Meso-Mediterranean Terrain (MMT) (Guerrera et al., 1993; de Capoa et al., 2004; Zaghoul et al., 2007) or AlKaPeCa domain (Al = Alboran block, Ka = Kabylie

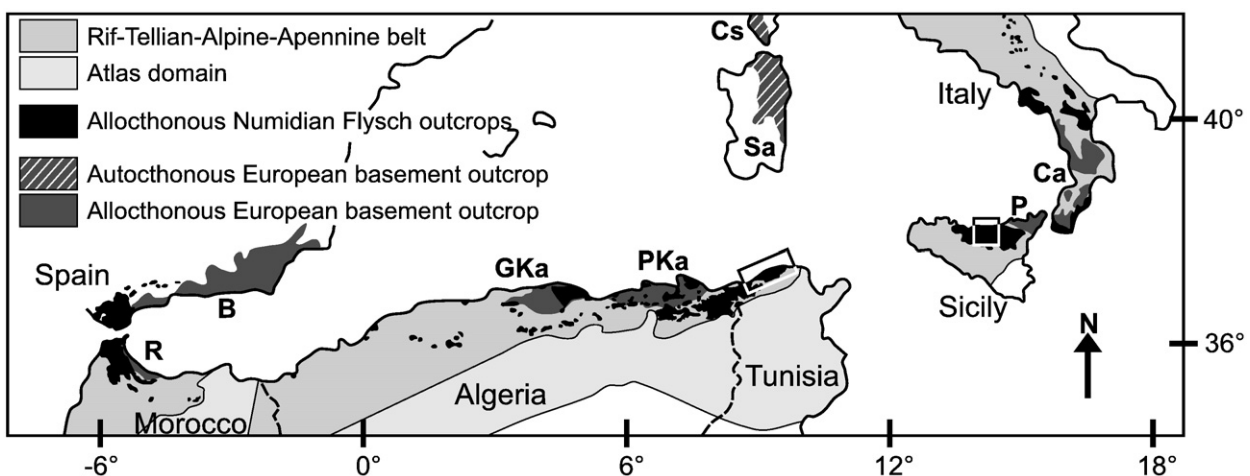


Fig. 1. Numidian Flysch outcrops and their relation to the Alpine and Atlas fold and thrust belts. European basement blocks from the AlKaPeCa domain are; R, Riff; B, Betic; Gka, Grand Kabylie; Pka, Petit Kabylie; Cs, Corsica; Sa, Sardinia; P, Peloritani; Ca, Calabria. Numidian Flysch outcrops taken from Wezel (1970a). See text for other data. Sicilian and Tunisian field areas used for this study are boxed.

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