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## The Numidian Sand Event in the Burdigalian Foreland Basin System of the Rif (Morocco) in a source-to-sink perspective

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During the Tertiary evolution of the Western Mediterranean subduction system, the orogenic accretion at the Maghrebian margin led to the stacking of three main tectonic zones of the Rif fold-and-thrust belt: 1) the Internal Zone; 2) the “Maghrebian Flysch” Nappes; and 3) the External Zone. In this context, a migrating foreland basin system developed between the Maghrebian orogenic belt and the adjacent African Craton.

A comprehensive reconstruction of the foreland basin system of the Rif Chain for each phase of its accretional history is still missing. In this work, by integrating field observations with quantitative biostratigraphic data from calcareous nannofossils assemblages, sandstone composition, and detrital zircon U-Pb geochronology from selected stratigraphic successions, we reconstruct the foreland basin system that in the early Miocene developed in front of the growing Rif orogen. The analyzed successions are representative of (1) the “Beliounis Facies”, made of quartz-arenites and litharenites (Numidian-like “mixed succession”), from the Predorsalian Unit; (2) the “Mérinides Facies”, made of a Numidian-like “mixed succession”, from the “Maghrebian Flysch Basin”; and (3) the classical “Numidian Facies”, exclusively made of quartzarenites, from the Intrarifian Tanger Unit.

The petrographic analyses and the detrital zircon U-Pb ages show the provenance of the quartzarenites of the “Numidian Facies” from the African Craton, whereas the sublitharenites and feldspathic litharenites, of both the “Mérinides Facies” and “Beliounis Facies”, show provenance from a cratonic area and the growing and unroofing Rif Chain, respectively.

The Alpine signature of the detrital grains sedimented into the foredeep deposits of the early Miocene orogenic system of the Rif Chain is from the feldspathic litharenites of both the Mérinides Facies and the Beni Ider Flysch. Both show Mesozoic and Cenozoic U-Pb zircon populations, with a large population of zircons centered at ca. 32 Ma. The U and Th concentration, the Th/U ratio, and the REE pattern of this population of zircons suggest a possible source area from Oligocene doleritic rock intrusions, similar to the magmatic dyke swarms (diorite) cropping out in the Malaga region (SE Spain).

The biostratigraphic analyses pinpoint the same age for the arrival of the quartz grains in the Numidian, Mérinides, and Beliounis deposits, indicating about 1 Myr for their sedimentation (ca. 20-19 Ma, early Burdigalian). Together with field evidence, the biostratigraphic results point to an autochthonous deposition of the Numidian Sandstones on top of the Tanger Unit, allowing to delineate the early Burdigalian foreland basin system of the Rif Chain. The foreland depozone involved the Tanger Unit and received the "Numidian Facies" deposits ; the foredeep depozone hosted about 2000 m of the "Mérinides Facies" and the Beni Ider Flysch, and developed on the so-called "Flysch Basin Domain"; and, finally, the wedge-top depozone, characterized by the "Beliounis Facies", developed on top of the Predorsalian Unit.

The Numidian Sandstones and the Numidian-like deposits analyzed in Morocco show the same age of similar deposits from Algeria, Tunisia, and Sicily, suggesting a comparable early Burdigalian tectono-sedimentary evolution along the southern branch of the Western Mediterranean subduction-related orogen.