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# The Internal–External Zone Boundary in the eastern Betic Cordillera, SE Spain: Discussion

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## INTRODUCTION

The character and timing of deformation along the Internal–External Zone Boundary in the Betic Cordillera, Spain, has been under discussion over the three last decades (Paquet 1966a,b, 1968, 1969, Soediono 1971, Geel 1973. Rivière *et al.* 1980, Martín-Algarra 1987, Lonergan 1991, 1993).

In a recent paper in the *Journal of Structural Geology*, Lonergan *et al.* (1994) reopened the debate and presented a structural and biostratigraphic study from the eastern Betic Cordillera (western zone of Río Pliego and Vélez Rubio corridor) to constrain the character and timing of deformation along the Internal–External zone boundary in this area. Lonergan *et al.* suggest the following. (1) The Internal–External Zone boundary in the eastern Betic Cordillera is a gently-dipping thrust zone, active in early to middle Miocene time (p. 177). (2) The Amalaya (*sic*, Almoloya) Formation is late Oligocene or Oligo-Miocene boundary, in age, and there is no evidence for missing biozones (p. 179). (3) The Bernabeles Formation is Burdigalian to Langhian in age and there is no evidence for any unconformity within this formation (pp. 179–180). (4) There has been continuous sedimentation from late Oligocene through to Langhian times in the Tertiary Basin (p. 180).

Despite the detailed structural analysis presented by Lonergan *et al.*, we believe that the Internal–External Zone Boundary in the eastern Betic Cordillera was only active at the end of the early Burdigalian, whereas in late Burdigalian to Serravalian times, the Internal–External Zone Boundary was only affected by N-directed strike-slip faults. We suggest that Lonergan's Amalaya Formation (Lonergan 1991) is late Oligocene to late Aquitanian in age, and that the Bernabeles Formation (Lonergan 1991) must be divided into two formations: the early Burdigalian Formation and the Bernabeles ss. Formation, Late Burdigalian to Serravalian in age. We suggest that there is evidence for missing biozones within the Oligo-Miocene sedimentation, that the different formations had different source areas, were deposited in differents basins and were affected by different tectonic processes. Thus, there could not have been continuous sedimentation from Late Oligocene through to Langhian times.

## SEDIMENTS ALONG THE INTERNAL–EXTERNAL ZONE BOUNDARY

Lonergan's Amalaya Formation is widely exposed in the area under the early Burdigalian or late Burdigalian to Serravalian deposits (Fig. 1). This formation is late Oligocene to late Aquitanian in age (Martín-Pérez *et al.* 1994b) and is made of reddish marl, sandstones and conglomerates. We clearly recognize, in sandstones and conglomerates, only Malaguide clasts (Martín-Algarra *et al.* 1995). Therefore deposition occurred in a Malaguide basin before the Alpujarride Complex was completely thrust by the Malaguide Complex (Martín-Algarra 1987).

The early Burdigalian deposits appear in both the Mula and the Almoloya areas (Fig. 1), and overlie the late Oligocene to late Aquitanian deposits. These deposits are low early Burdigalian in age (Martín-Pérez *et al.* 1994a,b), and made of greenish marl, siliceous pelites and sandstones with Malaguide and Alpujarride clasts (Chauve *et al.* 1973, Galán *et al.* 1984), which indicates that deposition occurred after the tectonics of the Internal Zone (after the Alpujarride Complex was thrust by the Malaguide Complex), in a different basin to that of the late Oligocene–late Aquitanian. The early Burdigalian deposits are thrust by the External Zone, in the Almoloya area (Fig. 1). Thereby, deposition in this period was before the suturing of the Internal–External Zone Boundary.

The External Zone (that appears backthrust onto early Burdigalian deposits in the Almoloya area) is clearly overstepped by the late Burdigalian to Serravalian deposits, in the Palomeque to Bernabeles area (Fig. 1). It indicates that the backthrusting occurred after the low early Burdigalian deposits, but before the late Burdigalian sedimentation, since the Sphenolithus belemnos biozone is missing (upper early Burdigalian) (Martini 1971, amended by Martín-Pérez *et al.* 1994b). Therefore, the late Burdigalian to Serravalian

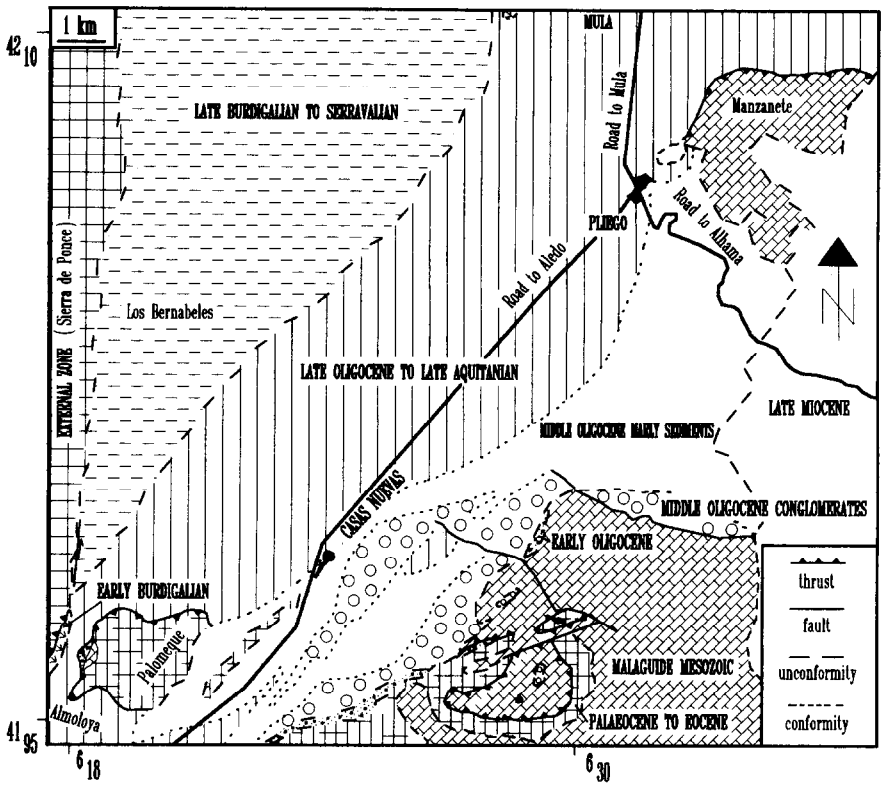


Fig. 1. Geological sketch map of Río Pliego area (Sierra Espuña).

deposition occurred after the Internal–External Zone Boundary was sutured, and, hence, in a new and different basin that was fed by the External Zone (Triassic red sandstones, Jurasic limestones and marls, Cretaceous marls and Tertiary bioclastic limestones). Although we find the middle Miocene deposits gently folded, after suturing of the Internal–External Zone Boundary, in late low Burdigalian, this boundary was only affected in the area by N- to NW-directed strike-slip faults (Fig. 1).

The above data allow us to conclude that there has not been continuous sedimentation in the Oligo-Miocene sediments and there are missing biozones in this period.

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