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Tectonic control on the formation and isolation of the Fortuna basin: how weak is the lithosphere?

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Introduction

The complex tectonic development of the Fortuna basin, one of the Neogene intramontane basins of the Betic Cordillera in SE Spain, comprises several phases of deformation. The basin is bounded by two subparallel major strike-slip zones trending ENE-WSW and NE-SW, respectively: the Crevillente Fault Zone (CFZ) at the NW margin and the Alhama de Murcia Fault (AMF) at the SE margin interact through transtension and transpression in different stages according to their relative slip. The basinal deposits mask the contact between the Internal and External Zones of the Betic Cordillera. During the early Tortonian the first phase of extension initiated sedimentation of about 500 m of turbidites and marls (Los Baños Formation). Subsequent sedimentation of evaporites of the Rio Chicamo Formation points to confinement, which preceeds (Dinarès-Turell et al., 1999) or clearly predates the late Messinian salinity crisis (Garcés et al., 2001). Restriction is accompanied by continued subsidence and relatively high sedimentation rates. The overlying late Messinian Rambla Salada Formation consists of a thick succession of continental sediments. Pliocene sedimentation starts with local marine ingressions and turns into an alluvial-lacustrine environment. Tectonically controlled isolation of the basin in the late Tortonian and influence of sea level changes are subject of discussion. This paper presents new structural data on the tectonic evolution and a preliminary model based on detailed analyses of remote sensing and outcrop data.

Methods

The Fortuna basin provides several distinctive sedimentary units which can be used to constrain the tectonic evolution. Digital image processing of remote sensing data

(LANDSAT TM, SRTM) and synoptic data integration (GIS) improve the detectability of morphological and structural features. Applying the concept of dip domains in map view we use structural field data to locate not exposed faults and assess their orientation. Using a high resolution DTM from aerial photographs we generate cross sections through areas with high data density and well constrained information on deformation increments. We combine balanced cross sections and surface data to quantify the amount of deformation, sedimentation and isostatic compensation providing a 3D model of basin evolution.

Results

From structural analysis of remote sensing and field data we are able to define several subbasins with different deformation history. The SB1 subbasin in the North of the CFZ mainly contains early Tortonian sediments. Between the CFZ and the AMF the SB2 subbasin comprises all sedimentary units. SB2 can be further divided into an area (SB2-1) at the E part of the SE margin, where mainly the Rambla Salada Formation crops out, and an area (SB2-2) at the S part of the SE margin dominated by Pliocene units. SB2-1 and SB2-2 are separated by a N-S trending fault.

Arrangement and distribution of early Tortonian sediments are characterized by a NE-SW trend and a rhomboidal shape delineated by the E-W striking northern margin. In the eastern part, the earliest sediments of basinal deposits show no indication for synsedimentary vertical offset at the CFZ. During the late Tortonian the CFZ acts as a sinistral oblique slip fault dipping to the SSE subdividing the early Tortonian basin into SB1 and SB2 and offsetting NE-SW trending early Tortonian units. Sinistral pull-aparts are visible using dip domains of adjacent Tortonian marls and late Tortonian evaporites. This is further confirmed by the trace of Messinian lamproites. Sedimentary thickness increases towards the AMF. The continental late Messinian Rambla Salada sediments are restricted to a subbasin further S (SB2-1) separated from evaporites by normal faults dipping to the SE and bounded by the AMF in the SE. The continental succession is then uplifted along a NE (40˚) trending antiform linking the NE (55˚) trending AMF and the ENE (65˚) trending CFZ. No sedimentary contact to Pliocene units is documented, hence uplift of SB2-1 must have occurred during the late Messinian to Late Pliocene as overlying Quarternary units show no tilting. SB2-2 is dominated by Pliocene sediments which exhibit strong tilting at the SE margin (i.e., along the AMF).

Conclusions

In the early Tortonian the Fortuna basin opened during a NW-SE orientation of σ_1 (Montenat & Ott d´Estevou, 1990) as a NE-SW trending dextral (?) pull-apart. Subsidence of approximately 500 m is accompanied by flexural uplift along the margins, a process doubted by Garcés et al. (2001) assuming no flexural isostatic response according to a weakened lithosphere. Our modelling, however, shows that even low values for T_e (i.e., 5km) yield a significant uplift of the flanks. Clockwise rotation of the σ_1 to N-S in the late Tortonian triggers sinistral movement along the ENE trending CFZ leading to further narrowing of the basin as a transtensional link to the sinistral AMF develops in the SE part of the early Tortonian basin. Increased subsidence documented by higher sediment thicknesses at the transtensional stepover in combination with increased throw and strain localization at the NE-SW trending border faults enhances flexural uplift of the footwall. As the footwall connects the basin to the open marine environment, uplift results in an early restriction of the basin prior to the late Messinian sea level lowstand. Yet high-frequency sea level variations seem plausible to explain higher sedimentation rates indicated by late Tortonian evaporites. A structural high induced by transpression proposed by Garcés et al. (2001) is in contradiction to the sinistral stepover and high sedimentary thicknesses between the two main faults. As indicated by the distribution of late Messinian sediments the area of subsidence is further narrowed to the proximity of the AMF as well as the transtensional stepover during continued sinistral shear on both faults. These late Messinian sediments are then uplifted by transpression between the AMF and the CFZ creating a pressure ridge. This may coincide with a late Pliocene anticlockwise rotation of σ_1 to NNW-SSE triggering dextral displacement. During the Pliocene to Quartenary, a W dipping normal fault separates SB2-1 form SB2-2 related to renewed sinistral displacement along the AMF.

References

Dinarès-Turell, J., Orti, F., Playa, E. & Rossel, L. (1999): Palaeomagnetic chronology of the evaporitic sedimentation in the Neogene Fortuna Basin (SE Spain): early restriction preceding the “Messinian Salinity Crisis”. *Palaeogeogr., Palaeoclim., Palaeoecol.*, 154, 161-178.

Garcés, M., Krijgsman, W. & Agusti, J. (2001): Chronostratigraphic framework and evolution of the Fortuna basin (Eastern Betics) since the Late Miocene. *Basin Research*, 13, 199-216.

Montenat, C. & Ott d´Estevou, Ph. (1990): Eastern Betic Neogen Basins – A Review. *Doc. et Trav. IGAL*, 12-13, 9-15.