Título: GEOMETRÍA, CINEMÁTICA Y PALEOSISMICIDAD DE LAS ZONAS DE FALLA DE BAZA Y GALERA

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Resumen: 1. Introduction and objectives

The study of active faults consists of a detailed characterisation of these structures to analyse and understand their behaviour within seismic regions and thus develop neotectonic deformation models. Moreover, knowing the fault geometry and kinematics is one of the first steps in the seismological and palaeoseismological characterisation of active faults.
The Central Betic Cordillera is one of the most active tectonic zones on the Iberian Peninsula and is associated with the highest seismic hazard.
This PhD thesis is focused on the characterisation of the Baza Fault (BF) and the Galera Fault (GF), the main active faults of the Baza Subbasin, located in the eastern sector of the Guadix-Baza Basin (Central Betic Cordillera, S Spain). This research integrates different approaches, including structural geology, tectonic geomorphology, palaeoseismology, tectonic geodesy, and seismology. Moreover, we discuss the influence of

these faults on the recent relief of the basin during the exorheic stage (ca. 500-600 ka) and propose a local neotectonic model for the Baza Subbasin, integrating both faults in the geodynamic setting of the Central Betic Cordillera.

2. Development and methods

From a structural approach, we define the surface fault geometry from geological mapping (1:5,000 scale). In these maps, we define the fault traces and offset deposits. We analyse fault kinematics from meso-scale kinematic indicators and stratigraphic and geomorphological markers and from the surface fault geometry.
To quantify the fault displacement, we calculate long-term slip rates from offset markers (geologic and geomorphic) and short-term slip rates from geodetic data of the Baza GPS network.
At the meso-scale, the BF and GF show highly complex and spectacular fault zone structures that result from the deformation of poorly-consolidated, water-saturated sediments during the endorheic stage of the Baza Subbasin. We characterise these structures in the BF, describing and interpreting 13 successive sections in a 15x15x4 m trench (the floor section is also studied). Then we integrate them to construct a 3D model of the fault zone.

From a geomorphological approach, we evaluate the geomorphic impact that these active structures have on the recent quaternary landscape of the Baza Subbasin. For this purpose, we analyse the topography and drainage network geometry and apply several geomorphic indices, as the assimetry factor, the normalized steepness index and the valley floor width to height ratio.

For the seismogenic characterisation, we carry out palaeoseismological studies in both faults in order to define surface-rupturing histories of palaeoevents. In adittion, for the BF we evaluate the seismic potential, calculating maximum expected magnitudes, recurrence times and a rupture scenario.

Finally, from geomorphic and GPS data, we study the regional significance of the BF and the GF in the recent quaternary history of the Guadix-Baza Basin and on the geodynamic setting of the Central Betic Cordillera, respectively.

3. Conclusions
We define the BF as a ca. 40 km-long, E-dipping fault that offsets upper Miocene to Holocene deposits. We divide the fault into two sectors according to its geometry: a narrow N-S to NNW-SSE northern sector and a wide NW-SE southern sector. These geometric differences are the result of i) basement differences between the north and south of the subbasin, ii) different orientations of the basement BF with respect to the regional extension direction, and iii) interaction with other active faults in their terminations.
We define the GF as a ca. 30 km-long fault, striking roughly SW-NE and dipping either vertically or to the NW. This fault offsets Pliocene to Holocene deposits. The distribution of the most recent endorheic deposits indicates tectonic control of the sedimentation. We divide the GF into four sectors based on the geometry of the fault array. This fault array forms segmented en échelon (sectors 2 and 4), anastomosing (sector 3), and linear (sector 1) patterns. These patterns are caused by i) the orientation of the basement fault and ii) the variable thickness of the sedimentary cover.

We conclude that the high heterogeneity in the distribution and styles of deformation within the BF zone is controlled by the throw and geometric variations of the fault strands and by the mechanical stratigraphy. In future work, we will study analogous structures in the left-lateral GF, which also features an exceptional fault zone and fault rocks.

The BF presents pure normal dip-slip kinematics in most of the fault zone. The GF is characterised by oblique kinematics, with a main left-lateral component and a minor vertical component of displacement.
Long-term slip rates for the BF range between 0.2 and 0.5 mm/yr, while short-term slip rates range between 0.3 ± 0.3 mm/yr and 1.3 ± 0.4 mm/yr. The long term vertical slip rates for the GF range between 0.02 and 0.05 mm/yr, while the short-term horizontal slip rate is 0.5 ± 0.3 mm/yr.
Geodetic data also show that the BF accommodates one-third of the WSW-ENE regional extension of the Central Betic Cordillera. From these data we establish a tectonic model for the Baza Subbasin, where the BF and GF are kinematically coherent and divide the subbasin into two tectonic blocks, a SE block and a NW block. These blocks exhibit westward displacement, but the relative velocities between them result in extension along the BF that is transferred to the E along the GF.

The activity of the BF and GF has left an imprint on the recent landscape evolution of the study area. Our results demonstrate that the relatively higher uplift of the BF upthrown block produced a double capture process in the basin during the Middle Pleistocene: first, the W sector was captured, followed by the capture of the E sector. Since then, the BF and GF activity have produced anomalies both in the topography (BF mountain front) and in the morphology and incision of the drainage network of the Guadix-Baza Basin and the Baza Subbasin, conditioning the formation of badland landscapes in the fault uplifted blocks.

We provide the first palaeoseismological data of both faults. From trench studies in the BF, we found evidence of 8 to 9 palaeoearthquakes in the last ca. 45,000 yr, with recurrence intervals ranging between 4,750 and 5,150 yr. The preliminary results for the GF indicate 3 to 7 events over the last ca. 24,000 yr.

We evaluate the seismic potential of the BF, considering it as an unsegmented master fault The magnitude of the Mmax event ranges between Mw 6.6 and Mw 7.1 using several scale relationships, and the recurrence times range between 2,000 and 5,400 yr for Mmax events and palaeo-events, respectively. A modelled rupture scenario of the BF for a Mmax event shows vertical displacements of > 0.40 m and an overall WSW¿ENE extension.

4 Main references (extended list in the thesis memory)

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