Geophysical Research Abstracts
Vol. 13, EGU2011-4875, 2011
EGU General Assembly 2011

The structure and history of the Carboneras Fault Zone, S.E. Spain

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The Carboneras fault zone (CFZ) is a major NE-SW trending tectonic lineament in SE Spain. Of Miocene through Recent age, it separates the volcanic Cabo de Gata terrain from the tract of uplifted metamorphic basement blocks and post-orogenic basins that comprise the Betic Cordilleras lying to the NW. We present the results of new geological mapping and age determinations, which constrain the geometry and geological history of the fault zone.

The CFZ consists of two main strands, about 100m apart, each containing several metres thickness of low metamorphic grade, clay-bearing fault gouge, formed in the uppermost 3 to 5 km of the crust. Outside the fault cores, there is widespread cataclastic damage done to the country rocks, plus some subsidiary fault strands. There is a striking lack of fault rocks derived from greater depths, posing the question of how a distinctly higher grade tract of metamorphic basement rocks (including migmatitic schists) has been incorporated at its present crustal level between the two main strands of the fault zone. Internal structures unequivocally demonstrate a left-lateral strike-slip pattern of movements developed over several millions of years during the Miocene, and stratigraphic constraints in basement rocks show that there has been little relative vertical displacement across the CFZ. The greatest movements are Langhian through Tortonian in age, but effects on Messinian and Pliocene rocks show that less intense movements have continued to the present day. Offsets of several km are seen on several fault strands, but the total offset on the CFZ is unknown. The two main faults strands are now known to cut pre-existing fault rocks and tectonic features, also formed under shallow crustal conditions.

The oldest calc-alkaline volcanic rocks lying to the SE of the CFZ are 21 Ma in age, and were originally deposited prior to the onset of fault movements. These rocks are now upended against the fault zone, and an 11 Ma unconformity within the volcanic sequence oversteps the southern strand of the fault zone. The youngest volcanic rocks are lower Messinian (6 Ma in age), step across the fault zone yet are cut by its youngest movements. On the north size of the CFZ the oldest post-metamorphic sedimentary rocks deposited are Serravallian in age (15 Ma) and a series of unconformities and deformation episodes affecting successive sedimentary formations attests to the relationships between fault movements and sedimentation.

The fault zone has acted as a conduit for subvolcanic rocks rising to the surface, and substantial tracts of the CFZ are decorated with andesitic intrusions, yet none of the eruptive material is preserved to the NW of the CFZ.