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The shallow velocity structure of the Carboneras fault zone from first arrival traveltime tomography

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Understanding and characterizing fault zone structure at depth is vital to predicting the slip behaviour of faults in the brittle crust. The CFZ is a large offset (10s of km) strike-slip fault that constitutes part of the diffuse plate boundary between Africa and Iberia. It has been largely passively exhumed from ca. 4 to 6 km depth. The friable fault zone components are excellently preserved in the region's semi-arid climate, and consist of multiple strands of phyllosilicate-rich fault gouge ranging from 1 to 20 m in thickness. We conducted four high-resolution seismic refraction tomography lines. Two of these lines crossed the entire width of the fault zone ($\sim$1km long) while the remaining lines concentrated on individual fault strands and associated damage zones ($\sim$100m long). For each line a combination of seismic sources (accelerated drop weight, sledgehammer and 100g explosives) was used, with 2m-geophone spacing. First breaks have been picked for each of the shot gathers and inputted into a two different 2D travel time inversion and amplitude-modeling packages rayinvr (Zelt & Smith, 1992) and FAST (Zelt and Barton, 1998) to obtain first break tomography images down to a depth 100m for the longer lines. The fault zone is imaged as a series of low velocity zones associated with the gouge strands, with Vp=1.5-1.75 km/s a velocity reduction of 40-60% compared to the wall-rock velocities (Vp=2.8-3.2km/s). These velocities are consistent with first break tomographic observations across the Dead Sea Transform fault (Haberland et al., 2007), but lower than the velocities imaged along the Punchbowl fault zone (part of the San Andreas system). Along the longer profiles we image multiple fault strands that exhibit a variety of thicknesses ($\sim$20-80m).