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Implications of Pleistocene-Holocene climate transitions for the slip rate of the Garlock fault, southern California, USA

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he tectonic significance of the left-lateral Garlock fault in relationship to the eastern California shear zone (ECSZ) and Pacific-North America plate boundary deformation remains a geologic enigma. Geodetic studies imply that the majority of present-day elastic strain accumulation occurs on strike-slip faults oriented northwest-southeast as part of the ECSZ, almost normal to the orientation of the Garlock fault, while strain accumulation parallel to the Garlock fault is minimal. Yet, a large number of offset alluvial landforms along strike of the fault are suggestive of higher tectonic activity than what geodetic strain accumulation rates imply. In an effort to understand the role of this major fault system and how it accommodates deformation along the Pacific-North America plate boundary, we analyzed data from an offset site on the central section of the Garlock fault. An incised channel is offset by 49 +/- 8 m, while the age of the deposit in which the channel was incised is 13.3 +5.9/-1.0 ka. Making the assumption that the channel was incised immediately after the sediment was deposited yields a geologic slip rate of $\sim$3.5 mm/yr. However, such a slip rate is only about half of the geologic slip rate reported previously from sites east and west of our study area. The most likely explanation for such a discrepancy is the timing of the channel incision, which could have occurred much later than the timing of the sediment deposition. A climatic pulse between 13-10 ka covering the Mojave Desert has been suggested to result in the formation of alluvial fans region-wide. This climatic pulse was most likely responsible for the deposition of the incised sediment present at our site. Between 10 and 8 ka a subtropical "monsoonal" air has been contributed to be responsible for channel incision in the Mojave Desert, which most likely caused the incision of the offset channel at our study site. If incision occurred some time between 10-8 ka, then the geologic slip rate that we obtain is 5-6 mm/yr. We believe that this slip rate is the better estimate and our site is representative of a study area where incision of the offset channel occurred much later than the time of sediment deposition. Such an interpretation is consistent with previous work done by McGill et al. (2009) at a site approximately 65 km west of our study site, where they report an offset incised channel in a $\sim$13 ka-old deposit. A $\sim$8 ka-old deposit inside the channel was interpreted as the minimum age of incision.

As more slip-rate data emerge from the Garlock fault, it becomes apparent that the geologic slip rate has been spatially (over 150 km along strike) and temporally (Holocene to late Pleistocene) consistent at 5-7 mm/yr. Such a geologic slip rate is in disagreement with the strain accumulation rate, and a possible explanation could be the existence of a strain transient as suggested for the faults of the eastern California shear zone south of the Garlock fault. In addition, the presence of sediments and incised channels formed around the same time along strike is suggestive of climatic events that were regional in scale and affected sediment transport across most of the Mojave Desert.