Variation in throw-rate histories between initially localised and initially distributed normal fault systems.

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We show that temporal changes in deformation rate for active normal fault systems are linked to interaction/localisation processes inherent in the growth of fault systems.

Central Italy contains an active normal fault system whose length (155 km) was twice its across strike width when extension initiated at c. 3 Ma, due to the presence of upto 7 parallel fault sets. Localisation has begun, with 2 of the 7 fault sets becoming inactive by the mid-lower Pleistocene (c. 0.7 Ma), with the rest still active. Throw and throw-rates are greatest on faults located centrally along-strike of the fault sets that remained active, showing that the faults are interacting elastically. Also, throw-rates increased on the faults that remained active when activity on the 2 other faults sets ceased. Throw-rates increased by the greatest amount on faults located centrally along strike (factor of 6). The change in throw-rates is revealed by a comparison between measured throws and throws that would develop if the present-day throw-rates were allowed to run for 3 Myrs, the total time extension has been active. Throws predicted in this way and summed between faults across strike are about twice as large as measured throws at the centre of the fault system, with values decreasing along strike. There is no evidence that regional extension rates increased over the time period considered.

In contrast, the active normal fault system in southern Italy was, at the initiation of extension, 8 times longer (175 km) than its across strike width, composed of only 2 parallel fault sets. 2 parallel fault sets remain active today. Like central Italy, throw and throw-rates are greatest on faults located centrally along-strike, but, again in contrast, measured throws are very similar to throws that would develop if present-day throw-rates were allowed to run for 3 Myrs. Thus, at first sight, throw-rates do not appear to have increased through time. However, the fact that central faults have the largest throw and throw-rate values suggests that the faults are behaving as a single larger structure (175 km long), with throw-rates at the centre attempting to produce a throw concomitant with the entire length of the structure due to elastic interaction. Thus, throw-rates must have increased on the central faults as some point in time as interaction developed during fault growth. One way to explain the similarity between measured and predicted throws is if the throw-rates increased very early in the deformation history (before c. 2 Ma). Our data do not allow us to resolve whether a similar throw-rate increase - due to the start of along-strike interaction - also occurred in central Italy.

Thus, although extension started at c. 3 Ma in both areas, in central Italy, throw-rates increased recently (c. 0.7 Ma) when localisation started, whereas throw-rates increased at c. 2 Ma in southern Italy, following along-strike interaction. The key difference appears to be the initial fault geometries. The above suggests that throw-rate histories on individual faults are not solely controlled by the regional tectonic extension rate; fault interaction/localisation processes have a role to play.