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The operation of Tethyan detachment faults and the maximum moment failure criterion

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Here we review the evidence that demonstrates that some Tethyan detachment faults did form with a shallow dip. This is not to decry evidence for footwall uplift, or the evidence that some high-angle normal faults may have been rotated into gently inclined orientations. But we challenge the oft-repeated assertion that it is physically impossible for detachment faults to have formed with gently inclined orientations, because Andersonian mechanics does not allow. Part of the problem is cartoon-like representations of tilt-block arrays above detachment faults, as these poorly represent actual map patterns. Another difficulty is the confusion as to the physical significance of failure criteria, e.g., in simulation and modelling of Coulomb failure where researchers utilise the Drucker-Prager yield condition. In essence this is no more than a pressure-dependent Mises condition, hence predicting 90° failure angles, and thus failing to simulate Coulomb-Mohr failure angles. Decades of controversy as to fault initiation angles can be resolved by considering an alternative failure criterion, namely yield on planes with the maximum moment. The Maximum Moment criterion may apply to failure under semi-brittle conditions, or to ductile failure when shear bands form due to fabric or material softening. Under plane strain conditions, in a horizontally stretching lithosphere, the Maximum Moment criterion predicts yield on planes that dip 22.5° into the Earth, gently inclined to the least compressive stress, or to the principal axis of maximum stretching.