The 3D geometry of small-scale soft sediment faults

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Faults initiate as arrays of kinematically related fault segments. Displacement is transferred between adjacent fault segments via zones of high strain referred to here as relay zones. As displacement increases relay zones are breached by the formation of a through going fault. The character of relay zones is well documented from outcrop studies of i.e. relay ramps between normal faults, and extensional and contractional jogs between strike-slip faults. However, outcrop studies are generally restricted to a single plane of inspection so that the 3D structure of relay zones cannot be determined. High quality seismic reflection data provide views of map view relay zones on normal faults, but only very rarely views of cross-sectional relay zones. Here we describe 3D relay zone geometries recorded from serial sections of small (mm-cm displacement) normal faults offsetting soft-sediments.

Serial sections (~0.5-1 cm spacing) have been cut through faults within finely inter-bedded Miocene sands, silts and clays from the East coast of Denmark. The sections were imported into a mapping package and digitised to allow analysis of fault surface geometry and displacement distribution. The 3D structure of the fault zones can be extremely complex, particularly for faults with greater than ~10cm offset. Here we present only the simplest relay geometries observed on the smallest displacement faults.

Our studies show that continuous fault traces may bifurcate along strike into two fault lobes, which overlap forming a relay zone in cross-section. Further along strike fault lobes may continue to diverge or they may reconnect so that the relay zone represents a hole in an otherwise continuous fault surface. Fault geometries in the area where the fault surface bifurcates often resemble those of breached relay zones indicating that relay structures may be intact and breached at different points along their length. Fault bound lenses display a wide range of 3D geometries reflecting the geometry of the pre-existing relay zone and its mode of breaching. While these 3D fault surface geometries have been previously supposed from fault growth models, not all have been previously observed.

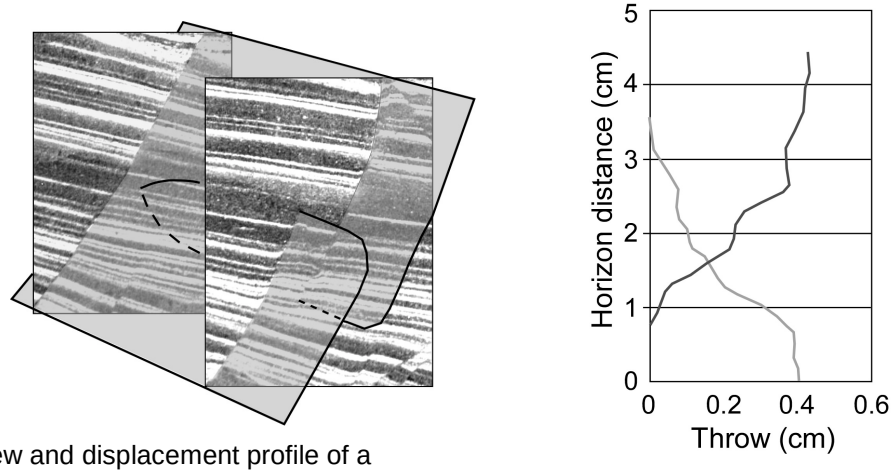

Fig.1 3D view and displacement profile of a contractional relay. The two fault segments bounding the relay link along strike.