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Faults as preferential flow paths in delta and offshore sediments, Gulf of Corinth, Greece.

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Faults formed in poorly consolidated sediments can affect groundwater flow and storage within shallow aquifers. We have completed a comprehensive study of fault architecture and deformation mechanisms from a number of outcropping normal-fault arrays within poorly consolidated sediments, in order to address their potential hydrogeological effects. Fault arrays are well exposed in sediments along the southern margin of the Gulf of Corinth rift (GoC) as a result of rapid uplift and associated valley incision. Pleistocene delta conglomerates form an upper aquifer which is hydraulically separated from a lower limestone aquifer by late Pliocene marls. We believe that faults within these sediments are analogous to those where basin subsidence is continuous, but subsequently less well exposed.

Hydraulic structure of these faults in relation to the surrounding sediments is inferred from porosity and permeability perturbations resulting from faulting processes, and evidence from previous fluid flow. Beds of the coarse delta sediments are dragged into fault cores through particulate flow, causing disaggregation of the fault core, grain rotation and progressive mixing of beds. We find a high proportion of fractured grains within fault cores, despite low confining pressures. Sands and marls within these successions are rare but may form continuous smears along the fault core. Mechanical strength of sediments seems to be increased significantly by cementation and enables strain localisation along brittle slip planes. Contrasts in competencies between different sediments leads to the formation of lenses within fault cores. There is abundant evidence for preferential fluid flow through these fault cores, in the form of precipitates or cements. Faults within the Pliocene marl succession are characterised by clay smears and thin marl lenses, commonly bound by slip planes. Small scale dilation bands are sometimes associated with these faults and often show evidence of precipitates and accordant fluid flow.

This evidence suggests that fluid flow within faulted conglomerates would be focused along the fault cores, despite a decrease in grain size sorting parameters with progressive homogenisation of fault cores. The intensification of calcite cementation within fault cores at the ground surface suggests that along-fault fluid flow may be a principal mechanism for groundwater recharge. However, fluid flow within fault cores is predominantly anisotropic, with only occasional evidence of cross-fault flow. As cementation within fault cores progresses faults are more likely to act as baffles to fluid flow perpendicular to them. Slip planes and clay smears originating from fine grained contributing beds will also limit cross-fault flow. Lenses within fault cores add complexities as they have the potential to either connect aquifer compartments, or block along-fault flow. Potentially of significance, faults within marl sequences may result in a connection between the upper and lower aquifers due to associated dilation bands. Consequently, we find that the hydraulic structure of faults in poorly consolidated within the GoC may differ from those previously described. Outcrops investigated in this study suggest that faults in young sedimentary basinal settings have the potential to act as preferential groundwater flow paths within aquifers, and are likely to have a persistent, and complex, effect on aquifer compartmentalisation and connectivity.