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Detailed models of fluid flow through the Moab fault: the importance of understanding slip surface permeability

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The Moab Fault is a synsedimentary normal fault in Eastern Utah. It cuts through a predominantly clastic sequence of Jurasic to Permian rocks and has a maximum throw of 960m (Foxford et al., 1998). We have mapped the internal structure and composition of the Moab fault core at several sites in mm scale detail. These maps identify several features that form possible controls on fluid flow. A likely barrier is formed by siltstone which forms a dominant component of the fault core. Pathways through the siltstone may be formed by sandstone lenses in the fault core. The sandstone and siltstone lenses are frequently bounded or cut by slip surfaces, which form a third control on fluid flow. Slip surfaces are potentially important controls on fluid flow as they are the longest and most continuous structures in the fault zone. From both fieldwork and literature it is uncertain if these slip surfaces act as barriers or conduits.

We use MODFLOW to model single-phase fluid flow through the Moab fault core. We further investigate slip surface behaviour in this study by modelling three different scenarios for the slip surface permeability. In the first scenario slip surfaces act as thin low permeability baffles. The case for low permeability slip surfaces is motivated by the thin shale and silt smears frequently found along the slip surfaces. Combined with mechanical grain crushing this seems a likely mechanism to lower the permeability of the slip surfaces. In the second scenario slip surfaces act as open fractures forming conduits for fluid flow. For the same fault Solum et al. 2005, have inferred large volumes of fluid responsible for the precipitation of authigenetic clays. According to their work, at least some fluid flow has occurred within the fault core (or gouge zone) as opposed to the surrounding damage zone. As the gouge is dominated by low permeability siltstone and shale, this would imply that fluids flow through poorly connected sandstone lenses and likely slip surfaces.

A third scenario in which the slip surfaces have no influence is also considered. Although the slip surfaces form discrete and continuous structures, their permeability does not necessarily differ enough from other rocks in the fault zone to significantly influence fluid flow.

The three modelling scenarios demonstrate that despite being very thin, the slip surfaces could potentially form an important control on fluid flow. The resulting bulk permeability of the fault zone varies over three orders of magnitude. In addition the permeability of the slip surfaces regulates access to the high permeability sandstone lenses. High permeability slips surfaces could link up lenses they cut through. As opposed to low permeability slip surfaces which can limit flow into lenses they bound. We compare regions where the model shows high flow rates with regions where fault rocks are geochemically altered. The comparison favours low permeability slip surfaces but requires further evaluation. This work demonstrates the need for a quantitative understanding of slip surface permeability and its' spatial and temporal variation.

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References

Solum, J.G., van der Pluijm, B.A. & Peacor, D.R. Neocrystallization, fabrics and age of clay minerals from an exposure of the Moab Fault, Utah. Journal of Structural Geology 27, 1563–1576 (2005).

Foxford, K.A. et al. Structure and content of the Moab fault zone, Utah, USA, and its implications for fault seal prediction. Geological Society London Special Publications 147, 87 (1998).