Geophysical Research Abstracts
Vol. 21, EGU2019-4057, 2019
EGU General Assembly 2019

Subsurface controls on groundwater-surface water interactions in a small alluvial fan revealed by high resolution, near-surface geophysical surveys

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Alluvial fans often support ephemeral streams whose flow regimes are strongly controlled by fan sedimentary characteristics and interactions with shallow groundwater aquifers. The hydrogeology of such fans has most often been documented for large fans located within arid climate regions. This research focuses on a small (0.075 km^2) alluvial fan situated in a temperate, high rainfall climate region (the Lake District, North West England). Via an ephemeral stream that flows across it, the fan plays a key role in supplying water and sediment to the mainstem River Ehen, which is the focus of a restoration initiative designed to conserve populations of the endangered pearl mussel (*Margaritifera margaritifera*).

The research used Ground Penetrating Radar (GPR) and Electrical Resistivity Tomography (ERT), along with high temporal resolution stream flow, groundwater level and stream temperature data, to develop a conceptual model of the fan and its role in controlling the hydrology of the ephemeral stream. This model is presented here and used to provide insights into fan and aquifer properties that affect the frequency and magnitude of flows within the ephemeral stream and, in turn, delivery of water and sediment to the River Ehen.

Approximately 2.14 km of high resolution (<5m) ERT and 4.11 km of GPR data revealed heterogeneous sedimentary deposits within the fan consisting of debris flow, transitional and sheet flood deposits along with buried palaeochannels and fluvial deposits, all underlain by impermeable clay till.

The upper fan is composed of coarse permeable sediments with high infiltration capacity. Deposits generally become finer and debris flow deposits become increasingly transitional with distance from the apex. The conceptual model suggests that buried palaeochannels provide preferential groundwater flow pathways. Significant infiltration occurs along much of the ephemeral channel, although a less permeable zone occurs around mid-fan. Hydrological monitoring data and observations indicate that the ephemeral stream contributes to groundwater but there appears negligible groundwater contribution to the ephemeral stream.