The Role of Outcrop and Surface Geomorphological Investigations in Developing High-Resolution Conceptual Site Models

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Groundwater remediation projects often underperform due to an inadequate understanding of the subsurface heterogeneity. Therefore, detailed geological investigation is increasingly being recognized as paramount for developing effective remedial strategies. This has resulted in increased acquisition of subsurface data through monitoring wells and geophysical logs in recent days. However, an equal emphasis is often not given on incorporating outcrop and geomorphological investigations in the subsurface investigation workflow.

This study highlights the critical role of outcrops and surficial geomorphological analogs in improving Conceptual Site Models (CSMs) by providing the 'ground-truth' for subsurface heterogeneity. Such analogs, especially in close proximity to areas of investigation, provide essential information on the dimension (width-thickness ratio), geometry, and connectivity of high-transmissive and low-transmissive units. These stratigraphic parameters are particularly important for inferring the correlation length of depositional units (e.g. channel bars and mouthbars) in environmental projects where borehole data are sparse or incomplete.

We demonstrate several case studies that leverage outcrop and surficial geomorphological analogs to determine subsurface dimensions, geometry and interconnectivity of flow units for contamination at complex remedial sites. The outcrop investigations were conducted by taking detailed field measurements of width, thickness and length of the different exposed depositional units. Their internal sedimentary structures, as well as their interconnectivity were also recorded. These measurements were then utilized to guide subsurface cross-sections based on bore-hole data and/or geophysical logs. Likewise, surficial geomorphological analogs (from GoogleEarth) were used to understand the probable geometry and dimensions of the subsurface depositional features, where applicable.

Application of outcrop and surficial geomorphological data provided a robust and realistic scientific basis for developing detailed subsurface correlations for high resolution CSMs. The integration of analogs with subsurface data helps avoid common pitfalls of correlation, particularly where subsurface data is sparse or incomplete. Therefore, study of outcrop and surficial geomorphology, should become an integral part of any subsurface stratigraphic workflow.