Regional Airborne Geophysical Data Analysis and New 2018 Ground-Based Geophysical Data Collection in Redwell Basin, Colorado

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Geologic controls on groundwater flow, particularly in tectonically and topographically complex mountainous terrain, can be difficult to quantify without a detailed understanding of the regional subsurface geologic structure. This structure can influence the direction and magnitude of groundwater flow through the mountain block, which in turn impacts groundwater composition and the flux of metals and nutrients to the near-surface ecosystem. In support of several ongoing studies in the upper East River and surrounding watersheds in central Colorado, regional-scale airborne electromagnetic (AEM), magnetic, and radiometric surveys were conducted in late 2017 over an area of nearly 500 square kilometers. These data give a new view of the geologic structure underlying the region that is unprecedented in both resolution and spatial coverage.

Inversions of the AEM data indicate good correlation with known geology and help to extend interpretations of geological model structure in this complex mountain watershed. Resistivity values exhibit a large dynamic range over the entire survey area—spanning more than four orders of magnitude—and suggest that AEM data will be useful in distinguishing important geologic features in the study area. Portions of the dataset exhibit strong airborne induced polarization (AIP) effects, including double sign changes, providing additional geological insights and identifying areas that may contain polarizable materials such as disseminated metals, fine grained lithology, or geochemical alteration. Modelling AIP extracts maximum information from the dataset, simultaneously producing more accurate resistivity models and chargeability models that can lead to better constrained geologic interpretations. Finally, ground-based geophysical data collection in 2018 included several transects of surface nuclear magnetic resonance (sNMR) data acquired in Redwell Basin near boreholes MW1 and MW2.1. New sNMR data collection was done in collaboration with Vista Clara, Inc. as part of a DOE SBIR Phase-II project to develop ‘rapid scanning’ NMR technology. Transects of sNMR data help to characterize lateral trends in shallow water content that will be used to extrapolate water level observations and other geophysical measurements at the borehole locations to a larger portion of the basin. These results will aid in the development of more accurate conceptual and numerical models of Redwell Basin’s groundwater flow system.