Unconventional Mineral Resource Potential in a Low-Temperature Geothermal System

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New approaches to exploration and discovery of unconventional mineral resources are paramount to securing the materials needed for a green energy transition. One promising economic mineral target is weathered unconformities formed from low-temperature alteration by ancient fluid pathways. This study links unconventional mineral resources with geothermal energy using geomet concepts to aid mineral resource evaluation of a low-temperature geothermal system.

In 2022, Cornell University constructed a geothermal borehole observatory to a depth of 9,790.5’ to characterize a potential low-temperature geothermal reservoir in upstate New York. The well intercepted Ordovician to Precambrian units and a ~500-m.y. unconformity between the Cambrian Potsdam sandstone and the Neoproterozoic Grenville basement. Moreover, the nearby Adirondacks host economic deposits of carbonate-hosted Zn, iron oxide-apatite (IOA), wollastonite, garnet, salt, and graphite. The observatory employs engineering techniques to assess the feasibility of geothermal energy, including target identification and underground analysis; however, those approaches lack mineral-specific data. Thus, this geomet work links mineral characterization for exploration under deep cover with geothermal development.

Wireline logs and samples showed unexpected variations in lithology, porosity, bedding style, and fracture density at and below the unconformity, indicating a deeply fractured basement and mineral alteration. Quantitative mineralogy of cuttings sampled every 5’ between 9,330’ and 9,575’ using TIMA-X and hyperspectral scanning define the variability of mineralogy, texture, grain size distribution, and litho-fragment population with depth to identify potential economic indicators around the unconformity. There are notable occurrences of pyrite, chalcopyrite, and magnetite at the level of the unconformity zone, and thin-section analysis and XRD results document chlorite, hematite, phlogopite, muscovite, biotite, and graphite, indicating greenschist facies or hydrothermal alteration in an otherwise amphibolite-grade terrane. Future subsurface data from planned well pairs will have broader implications and applications elsewhere in the northeast US.