Natural and anthropogenic influences on hydrological conditions can induce periodic or long-term reduced conditions in geologic materials. Such conditions can cause significant impacts on biogeochemical processes of trace elements in subsurface or near surface environments. The objective of this work was to examine the influence of stimulated redox conditions on bioegeochemical transformations of Zn, Pb and Cu in multi metal-rich geomaterials. Two contrasting metal-rich geomaterials from the Tri-State mining region were used for this study. Organic C (OC, as lactate) at 3 different rates was added tri-weekly to support growth of microorganisms. Samples were incubated for more than 200 days in an anaerobic glove box chamber to ensure long-term anaerobic conditions. Although trends in pH were similar, trends in Eh were significantly different between two systems (OC added and no OC) indicating that the level of OC in these systems are critical in determining redox changes. Scanning electron microscopy and energy dispersive x-ray analyses (SEM-EDXA) on samples submerged for 110 days revealed more C in metal-rich particles (appeared more like fresh precipitates in secondary electron (SE) and backscattered electron (BSE) images) from systems in which OC was added. In contrast, S concentrations in metal rich particles were either SEM-EDXA non-detectable or very low. We suspect that high carbonate in these geological materials and microbial respiration caused increased levels of bicarbonate concentrations and the formation of metal carbonate solid solutions instead of sulfide solid solutions. Micro-x-ray absorption near edge structure (μ-XANES) spectra of selected Zn rich points located by μ-x-ray fluorescence (μ-XRF) mapping collected, at Sector 13 BM (Advanced Photon Source (APS), Argonne National Laboratory, Argonne, IL), on samples submerged for 60 days, showed that OC added samples contained more Zn silicate- and Zn carbonate-like Zn phases as compared to no-OC added samples. This is an on-going study and most recent data including Zn, Pb and Cd speciation will be presented and discussed.