

## Critical Zone Evolution by Jerks

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One challenge of Critical Zone (CZ) science is the effective prediction of internal structure formation (vegetation, soil, bedrock fractures) over geomorphic time scales. Another involves forecasting how evolved structure at any geologic time shapes CZ dynamic response (water, solute, gas, sediment) to contemporaneous pulses (“jerks”) such as precipitation inputs to semi-arid systems or catastrophic wildfire. Dissipative products of reactions among oxidants, reduced carbon, water, and silicates include gases, solutes and sediments. The stoichiometry and speciation of efflux is dynamic and convolves upgradient processes. Models are needed to convolve how these coupled physical, biological and chemical processes respond to climate (e.g., EEMT) to enable better prediction of such CZ parameters as watershed chemical denudation rate, soil depth distribution, water transit time, and stream solute flux. An improved understanding of the mechanistic underpinnings of such predictions, however, and why they succeed or fail, requires direct observation of parallel data streams generated in situ, such as those produced by the Critical Zone Observatories (CZOs). Data from the Jemez-Catalina (JRB-SCM) CZO indicate that climatic forcing that varies significantly between years drives corresponding differences in dissipative element flux, speciation, and stoichiometry. The bimodal annual precipitation regime of AZ and NM implies that formation of observed porous geomedia structure, solid phase (bio)geochemical composition, fluid flowpaths, etc., occurs disproportionately during brief episodes of water and carbon throughflux and/or disturbance, and our measurements support this hypothesis. Sub-catchment locations with elevated reaction rates appear to control overall system behavior, and the type of precipitation input is key; snowmelt pulses contribute to CZ weathering at depth, whereas flashy summer monsoon rains during peak biological activity generate hydrochemical discharges enriched in organic ligand-metal complexes and nanoparticles from near surface flow paths.

## Role of Black Carbon for Radioactive Iodine Sorption

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Natural organic matter (NOM) plays an important role in determining the fate and transport of iodine species such as iodide (I<sup>-</sup>) and iodate (IO<sub>3</sub><sup>-</sup>) in groundwater system. Although NOM exists as diverse forms in environments, prior iodine studies have mainly focused on sorption processes of iodide and iodate to humic materials. This study was firstly conducted to determine the iodide and iodate sorption potential for a particulate NOM (i.e., black carbon [BC]). A laboratory-produced BC and commercial humic acid were used for batch sorption experiments to compare their iodine sorption properties. The BC exhibited >100 times greater sorption capability for iodide than iodate, while iodide sorption was negligible for the humic acid. The sorption properties of both adsorbents strongly depend on the initial iodine aqueous concentrations. After sorption of iodide to the BC, X-ray Absorption Fine Structure (XAFS) spectroscopy results indicated that the iodide was converted to electrophilic species and chemically interacted with carbon atoms of polycyclic aromatic hydrocarbons present in the BC (Figure 1). The computed distribution coefficients (i.e.,  $K_d$  values) suggest that the BC materials retard significantly the transport of iodide in environmental systems containing even a small amount of BC.

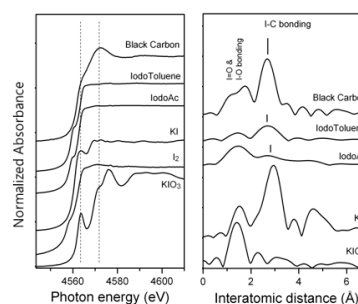


Figure 1. XAFS results.