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@INPROCEEDINGS{Li2021-gu,
  title     = "The shallow and deep hypothesis: linking flow paths,
               biogeochemical reactions, and stream chemistry in the Critical
               Zone",
  author    = "Li, Li and Zhi, Wei and Stewart, Bryn and Wen, Hang and Xiao,
               Dacheng and Barnard, Holly and Kirchner, James and Perdrial,
               Julia and Shanley, James and Sullivan, Pamela and Williams,
               Kenneth",
  abstract  = "How does the physical and chemical structure of the Critical
               Zone (CZ), defined as the zone from treetops to the bottom of
               groundwater, govern its hydro-biogeochemical functioning?
               Multiple lines of evidence from past and newly emerging research
               have prompted the shallow and deep partitioning
               concentration-discharge (C-Q) hypothesis. The hypothesis states
               that in-stream C-Q relationships are shaped by distinct source
               waters from flow paths at different depths. Base flows are often
               dominated by deep groundwater and mostly reflect groundwater
               chemistry, whereas high flows are often dominated by shallow
               soil water and thus mostly reflect soil water chemistry. The
               contrasts between shallow soil water versus deeper groundwater
               chemistry shape stream solute export patterns. In this context,
               the vertical connectivity that regulates the shallow and deep
               flow partitioning is essential in determining chemical
               contrasts, biogeochemical reaction rates in soils and parent
               rocks, and ultimately solute export patterns. This talk will
               highlight insights gleaned from multiple lines of recent studies
               that include collation of water chemistry data from soils,
               rocks, and streams in intensively monitored watersheds,
               meta-analysis of stream chemistry data at the continental scale,
               and integrated reactive transport modeling at the hillslope and
               watershed scales. The hypothesis underscores the importance of
               subsurface vertical structure and connectivity relative to the
               extensively studied horizontal connectivity. It also alludes to
               the potential of using streams as mirrors for subsurface water
               chemistry, and the potential of using C-Q relationships to infer
               flow paths and biogeochemical reaction rates and the response of
               earths subsurface to climate and human perturbations. Broadly,
               this simple conceptual framework links CZ subsurface structure
               to its functioning under diverse climate, geology, and land
               cover conditions.",
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  volume    =  2021,
  pages     = "H51D--04",
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