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Isabelle Cozzarelli, U.S. Geological Survey

Talk title: Evolution of geochemical process understanding gained from long-term investigations of the Bemidji, MN, terrestrial crude oil spill

Abstract: The accidental release of petroleum products to aquifers alters groundwater and sediment geochemical composition for decades to centuries. These alterations are driven by the influx of biodegradable hydrocarbons that are oxidized coupled to reduction of aqueous and solid phase electron acceptors. The USGS and collaborators have been investigating geochemical alterations at the site of a 1979 crude-oil pipeline spill. These long-term investigations showed that residual hydrocarbon source zone processes are spatially and temporally heterogeneous. Geochemical evolution at the source zone drives downgradient changes in groundwater chemistry that should be accounted for in natural attenuation studies where residual source zones persist.

As aromatic hydrocarbons are dissolved into groundwater from the oil phase, and transported downgradient, they are degraded by methanogenic and iron-reducing processes. The more complex branched alkylbenzenes, such as 1,3-dimethyl-2-ethyl benzene, persist in groundwater. The persistence of longer-chain alkylbenzenes in both the more degraded source-zone oil and the furthest downgradient groundwater indicate these types of compounds will become increasingly abundant groundwater components over time. Degradation of residual oil has created a plume of nonvolatile dissolved organic carbon (NVDOC) that reaches concentrations of 72 mg C/L near the source compared to 2 mg C/L in the background groundwater. Concentrations of NVDOC near the source have doubled over a 36-year period. This NVDOC includes a complex mixture of numerous partially oxidized hydrocarbons, whose structure and toxicity are largely unknown, although toxicity assays with waters from this site had a positive correlation between the NVDOC concentration and a subset of molecular targets.

The long-term effects of the aquifer geochemical reactions also include contamination of groundwater by arsenic (As) and trace metals released during reductive dissolution of oxides and hydroxides present in the sediment (such as ferric (Fe(III))-oxides) to which they are bound. These geogenic contaminants greatly exceed USEPA drinking water standards in the contaminant plume. The As plume at this site is predicted to pose a greater longer-term water-quality threat than benzene. When assessing potential risks of exposure at the many legacy petroleum spill sites, the combined stressors of all these contaminants should be considered to better evaluate ecological and health effects.

Biosketch: Isabelle is a Research Hydrologist, with the USGS Geology, Energy & Minerals Science Center in Reston, VA. She received a Ph.D. and M.S. from the University of Virginia in Environmental Sciences with emphasis on Geochemistry and a B.S. from the University of Rochester. At the USGS, her specialty is interdisciplinary long-term research on the fate and effects of organic contaminants in surface and subsurface environments. Currently her focus is on coupled hydrogeological, microbiological, and geochemical processes controlling reactions in hydrogeologic systems and fundamental understanding of biodegradation and contaminant biogeochemical cycles in order to protect water quality and ecosystem health.

Geoffrey Gilleaudeau, George Mason University

Talk title: Perspectives on Neoproterozoic continental weathering and ocean oxygenation and its effect on the evolving biosphere

Abstract: The Neoproterozoic Era (100-538 Ma) marks a key transitional interval in Earth history characterized by the 'Snowball Earth' glacial events and the evolution of complex, multicellular life. In this presentation, I investigate two key parameters that may have played a substantial role in Earth's biogeochemical evolution during this critical interval: continental weathering and ocean oxygenation. Constraints on these processes come from novel lithium and uranium isotope data derived from marine carbonates of Siberia, South China, and Australia. Ultimately, we find that the Ediacaran Shuram negative carbon isotope excursion (the largest carbon cycle perturbation in Earth history) was characterized by a pulse of intense congruent weathering of the continents and a shift towards well-oxygenated oceans, with both of these processes potentially related to new discoveries of early animal biomineralization on multiple continents across this interval. In contrast, the subsequent terminal Ediacaran and Ediacara-Cambrian transition were characterized by widespread ocean anoxia despite major innovations in the biosphere.

Biosketch: Dr. Geoff Gilleaudeau is an assistant professor in the Department of Atmospheric, Oceanic, and Earth Science at George Mason University in Fairfax, VA. Geoff grew up in Queens, NY and went to college at Binghamton University, after which he obtained a PhD from the University of Tennessee. After his PhD, he was a visiting assistant professor at Bucknell University, followed by a Carlsberg Foundation postdoctoral fellow at the University of Copenhagen (Denmark) and a NASA Astrobiology postdoctoral fellow at Arizona State University before starting at George Mason in 2018.

Ben Kligman, Smithsonian Institution

Talk Title: Searching for the hidden origins of living tetrapods in Triassic equatorial Pangaea

Abstract: Following the end-Permian Mass Extinction, the Triassic Period (~252 to 201.5 million years ago) witnessed transformative changes in continental biotas exemplified by the rise of tetrapod groups familiar from the present-day including frogs, salamanders, caecilians, mammals, lizards, the tuatara, turtles, crocodilians, and dinosaurs. Despite fossil and molecular evidence suggesting that all these groups underwent their first evolutionary radiations in the Triassic, the scarcity of fossil caecilians, frogs, salamanders, lizards, and turtles largely obscures their evolutionary origins and the early anatomical transitions that facilitated their survival to the present day. The small, delicate skeletons typical of these animals make them unlikely to fossilize and even less likely to later be discovered by paleontologists - to find them I have focused on collecting data from microvertebrate bonebeds, layers formed in depositional settings that concentrate and preserve the delicate bones of small-bodied vertebrates that are rare elsewhere. A series of newly discovered microvertebrate bonebeds deposited in the tropical

rivers and lakes of equatorial Pangaea (present day Arizona) during the Late Triassic have produced fossils that fill key gaps in the early evolution of living tetrapods, and raise new questions about the initial assembly of modern tetrapod communities and their survivorship over the end-Triassic Extinction.

Biographical sketch: Inspired to become a paleontologist through fossil hunting Triassic and Cretaceous outcrops of Pennsylvania and New Jersey as a teenager, Ben applied this interest to his PhD at Virginia Tech and as a paleontologist at Petrified Forest National Park where he helped lead the discovery of Triassic fossil biotas that are revealing key insights into the origins of living tetrapods. Now as a Smithsonian Postdoctoral Fellow he continues to explore Mesozoic strata across North America with the goal of discovering ancient animals, ecosystems, and biotic events that help answer outstanding questions about the history of life previously obscured by gaps in the fossil record.