

2023 Birdsall-Dreiss Distinguished Lecturer



[Dr. Kenneth Belitz](#) is a Research Hydrologist in the Water Resources Mission Area of the United States Geological Survey (USGS). He received his B.A. in Geology from Binghamton University, and Ph.D. in hydrogeology from Stanford University in 1985. His dissertation examined the evolution of large-scale groundwater flow in the Denver

Basin under the direction of Dr. John Bredehoeft. Throughout his career, Ken has simultaneously pursued two fronts: improving the fundamental hydrogeologic framework of the conterminous U.S., and employing numerical models – and, most recently, machine learning – in novel ways to better understand regional-scale groundwater quality and to project our current understanding into unsampled space.

Upon completing his Ph.D., Ken joined the USGS California Water Science Center, where he constructed a model of the western San Joaquin Valley; this model and its underlying framework became the gold standard and basis for subsequent models of this critically important aquifer system. From 1990-1997 Ken taught at Dartmouth University and Queens College of New York, before returning to the USGS in 1998 to lead an interdisciplinary team studying the water quality of the intensely urbanized Santa Ana River Basin as part of the USGS National Water Quality Assessment (NAWQA) Program. In this capacity, Ken began to develop a systematic approach to large-scale groundwater-quality assessment founded on a deep understanding of groundwater flow. From 2003-2012, Ken up-scaled this approach to obtain representative, unbiased water-quality data for the groundwater resources of the entire state of California. This work yielded new insights into the processes behind the spatial distribution of critical contaminants including perchlorate, pharmaceuticals, and hexavalent chrome. Ken then led the design and implementation of the groundwater component for the USGS NAWQA Program’s third decade. The design characterizes water quality in the most productive principal aquifers, cumulatively representing 85 percent of the Nation’s GW-derived drinking-water supplies. Ken’s work has given us an unbiased and surprising perspective on the relative risks of geogenic and anthropogenic contaminants, while evaluating constituents not previously sampled for at the national scale. Ken is a GSA Fellow and has received numerous USGS awards for his publications and service.

The subjects of Ken’s 2022 Birdsall-Dreiss are “The Quality of Groundwater Used for Public Supply in the Continental United States”, and “Old problems, new approach: Applications of Ensemble-Tree Machine Learning to Hydrogeology”.

1: The Quality of Groundwater Used for Public Supply in the Continental United States

What is the quality of groundwater used as a source of public supply in the continental United States (CONUS)? More specifically: Which constituents are most prevalent at elevated concentrations? How many people are potentially affected? What are the hydrogeologic and geochemical characteristics of the aquifers where elevated concentrations are observed? These questions were addressed by evaluating the quality of groundwater in 25 Principal Aquifers (PAs) that account for 84% of the groundwater used for public supply in the CONUS (89.6 million people on a proportional basis). PAs are regionally extensive aquifers or aquifer systems that can provide large volumes of water for human use. Each PA was sampled across its lateral extent using an equal-area grid, typically with 60 wells per PA. Samples were analyzed for 502 constituents, of which 374 had either a regulatory or non-regulatory human-health benchmark. In all but three PAs, the most frequently detected constituent at elevated concentrations was a geogenic constituent. At the CONUS scale, geogenic constituents are more prevalent (based on area) and potentially affect more people than anthropogenic constituents. The occurrence of elevated concentrations is affected by aquifer type (lithology, location, and climate), pH, redox, groundwater age, and land use. The findings from this study (Belitz and others, 2022) can be used by managers responsible for providing safe drinking water, regulators considering which constituents might require additional scrutiny, and researchers seeking to identify groundwater quality issues of relevance to human health.

Belitz and others, 2022, "Quality of Groundwater Used for Public Supply in the Continental United States: A Comprehensive Assessment," Environmental Science and Technology – Water. doi.org: 10.1021/acsestwater.2c00390

2: Old problems, new approach: Applications of Ensemble-Tree Machine Learning to Hydrogeology

Ensemble tree modeling is a machine learning method well suited for representing complex non-linear phenomena. As such, ensemble tree modeling can be applied to a wide range of questions in hydrogeology, including questions related to hydrogeologic mapping. Some questions are problems of regression in which one seeks an estimate of a continuous variable. For example, what is the depth to the water table across a region of interest? Other questions are problems of classification. For example, across a region of interest and over a range of depths, is groundwater oxic or reduced?

The U.S. Geological Survey National Water Quality Assessment project (NAWQA) has used ensemble tree methods to address questions related to groundwater quality at regional and national scales. Some of our models evaluate the three-dimensional distribution of factors that can affect groundwater quality, such as pH, redox, and groundwater age. In turn, the modeled factors were used in subsequent models to map the three-dimensional distribution of contaminant concentrations. In our experience, ensemble tree models are a powerful tool for answering difficult questions. They can be used as a complement to process-based modeling and to make predictions at scales that preclude the use of process-based approaches.

Schedule 2023 lecture:

Institutions can schedule a visit by completing the request form at [2023 Birdsall-Dreiss Distinguished Lecture Request Form: Ken Belitz, United States Geological Survey \(google.com\)](#)