

# David B. Vance

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## Summary

Broad in-depth expertise in the practical application of:

- Biogeochemistry and physical chemistry to multiple geologic and surface/waste water systems
- Deep injection well development/operation managing groundwater hydrology and geochemistry
- Historical focus on groundwater resources, remediation and surface water treatment
- Current focus on application of those skills to climate change mitigation by CCUS with geologic sequestration associated with enhanced oil recovery and Class VI injection wells

## Skills & Abilities

### TECHNICAL

- Technology expertise of breadth and depth that includes broad chemical systems, microbiology, and geosciences that allow for the management of complex multi-disciplinary projects with diverse staff and technical requirements, often focused on unique one-off problems
- Areas of practice include:
  - All aspects of the abiotic/biological chemistry of nitrogen, sulfur, iron and carbon systems
  - CO<sub>2</sub> utilization and sequestration in Residual Oil Zone (ROZ) EOR systems defining:
    - Bio-diagenetic processes that control the character of the mineral matrix
    - Physical and chemical dynamics of hosted hydrocarbon/gas/water/mineral phases
    - Carbon dioxide sequestration and retention of economic oil concentrations in ROZs
  - Oxyanions including arsenic, selenium, chromium, and manganese
  - Injection Wells: Class I, II, III, V (ASR), and VI (CO<sub>2</sub>)
  - Groundwater assessment and remediation, and surface water treatment systems

### COMMUNICATION, MARKETING AND SALES

- Articulate at the personal level, as well as written and in public settings
- Multilevel national sales experience in diverse markets supporting management and training
- Experienced in developing new technical market areas, examples include:
  - Reactive Nano-Scale Zero Valent Iron Colloids – Two Patents
  - Anaerobic bio-oxidation – Sulfate and Iron Reduction
  - Carbon Dioxide Sequestration – Three Patents
    - Biogenesis in target formations and effects on CO<sub>2</sub> injection and sequestration
    - Natural controls on microbial process responsible for petroleum retention in ROZs
    - Data collection/management for all stages of CO<sub>2</sub> injection into Residual Oil Zones

## Education

**MS Geology - Washington State University**   **BS Geology - New Mexico State University**

## Recent Job History

**Principal Scientist | Arcadis | May 1998 to May 2015**

**Associate VP – Technical Expert | Arcadis | May 2015 to Present**

## Focus on Geologic CO<sub>2</sub> Sequestration

### INJECTION WELLS

- Design and permitting of two 10,000-foot Class II injection wells in Dimmit County Texas
- Design and permitting of a Class III brine mining well in Ector County Texas
- Performed a root cause failure analysis for five Class I injection wells located at an industrial site in the New Orleans Louisiana Area
- Operations evaluation of two Class I injection wells at an industrial Complex in Pasadena, Texas
- Operational cycle analysis of three Class I injection wells located in Galveston, Texas
- Preparation of two hydrogen sulfide contingency plans for acid gas injection wells
  - At a location in West Texas that included the gas plant and two injection wells
  - At a location in Gulf Coast Texas, utilized the Canary model to develop an area of concern more refined than that available using the standard Texas Railroad Commission protocols
- Prepared a Class V ASR permit under the new 2015 Texas UIC rules requiring an AOR with a detailed hydrogeological and geochemical evaluation
- Biofouling assessment/resolution in Class II water flood well from ammonia in oxygen scavenger
- Assessment/resolution of biofouling in Class II SWD well due to sulfate reduction in the presence of petroleum hydrocarbons and fouling with biofilms/biomass/iron sulfide
- Assessment of the mode and location of failure in a Class II SWD well that impacted a fresh water alluvium aquifer in West Texas

### CARBON DIOXIDE

- Groundwater modeling and geochemical assessment of 250-mile-long fairway hosting Residual Oil Zones in the San Andres Formation, with a focus on targets for CO<sub>2</sub> EOR programs
- Designed, implemented and evaluated the sampling and analysis of produced water associated with the start-up of a carbon dioxide EOR program in Ector County Texas
- Solved problem with core analysis by an upstream operator assessing the economic viability of a green field (not associated with primary oil production) ROZ carbon dioxide flood program. Cores contained elemental sulfur which interfered with Dean Stark Extractions to evaluate the degree of petroleum saturation. This CO<sub>2</sub> greenfiled project was implemented and still active
- Developed protocols for the evaluation of biodiagenesis processes that control hydrodynamic conditions, petroleum retention and CO<sub>2</sub> injection dynamics in the San Andres Formation. Retention includes assessment of microbial inhibition of petroleum biodegradation and modifications of mineral surfaces and petroleum character making the systems oil wet
- Currently working through protocols for permitting Class II and Class VI injection wells for CO<sub>2</sub> sequestration, focus on educating technical, sales and marketing, and management staff
  - Pipelines and to a limited degree capture systems are also part of this program
- Evaluating the potential for fresh water recovery and strategic mineral production (primarily lithium) from potential brine recovery associated with injection of CO<sub>2</sub> into moderately overpressured formations.

## Select Areas of Practice

### NITROGEN SYSTEM

- In Situ Stimulated Nitrification of Ammonia - Carbon Substrate Injection for Carbon Dioxide; Air/Oxygen Sparging
  - Anammox Conversion of Ammonia to Nitrogen - Demonstrated Natural Attenuation Processes; Stimulated Systems using Carbon Dioxide for Autotrophic Growth
- Denitrification - In Situ Soluble Carbon Substrates; Ferrous Iron and Sulfide Reactions
- Physical and water chemistry of anhydrous ammonia

### SULFUR SYSTEM

- Sulfate Reduction Stimulation and Inhibition; Hydrogen and Metal Sulfides; Elemental Sulfur – Cryptic Sulfur Cycle; pH Effects

### ISOTOPIC FORENSICS

- Carbon and Chlorine in CVOCs; Carbon in Production Methane Releases; Nitrate Nitrogen and Oxygen; Differentiation of Native and Anthropogenic Ammonia Nitrogen; Sulfate Sulfur and Oxygen

### CORROSION AND FOULING

- Water Treatment Systems; Cooling Tower Systems; Recovery and Injection Wells
- Biological Processes – Sulfate and Iron Reducers; Microbial Biofilms
- Abiotic Processes - Iron Oxidation; Electrochemical Cells; Calcium Carbonate; Calcium Sulfate; Effects of Aeration; Compatibility of Formation and Injected Fluids

### REAGENT INJECTION FOR IN SITU REMEDIATION

- Soluble Carbon Substrates – CVOCs; Nitrate; Chromate
- Chemical Oxidation - Fenton's Reagent; Activated Persulfate; Permanganate for CVOCs; Petroleum Hydrocarbons; and Arsenite
- Anaerobic Bio-Oxidation Systems – Sulfate; Ferric Iron
- Abiotic Reductive Dehalogenation - Reactive Iron Sulfides via Ferrous Iron/Sulfate/Carbon Substrate Injection; Nano Scale Elemental Iron Colloids

### WATER RESOURCES

- Physical and Chemical Character - Fresh Water; Brackish Water; In Situ Formation Waters; Produced Waters; Frac Backflow Waters; Water Production from Gas Drive Stimulation of Residual Oil Zones

### MISCELLANEOUS

- Evaluation of Native Organic Carbon in Groundwater systems - Source and Concentration
- Antimony; Electro/Physical Chemistry of Bromine/Zinc Batteries; Arsenic/Arsenite; Selenate/Selenite/; Chromium; Vanadium; Nickel; Extreme Alkaline and Acidic Conditions; Aluminum; Fluorine; Phosphorus; Radionuclides
- Microbial Inhibition Conditions Controlling - Ammonia Nitrification Anammox Processes; Sulfate Reduction; Iron Reduction; Methanogenesis; Microbial Reductive Dehalogenation; Acid Mine Drainage; Degradation of Petroleum Hydrocarbons and Xenobiotic Compounds