Hanford Site

Groundwater/Vadose Zone Integration Project

Advanced Vadose Zone Characterization Workshop

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Background

- 67 of 149 single-shelled high level waste tanks are known or suspected leakers
- immobile contaminants “deeper than be expected”
- episodic occurrences of some species in the groundwater

Needs

Detailed field data and observations to support:

- enhancement of conceptual and numerical models
- interpretation of existing contaminant distributions
- prediction of future migration
- risk assessment

Vadose Zone Transport Field Study

- focus on tank-leak issues
- identify dominant transport processes
- improve vadose zone monitoring capability
- generate data sets for model verification

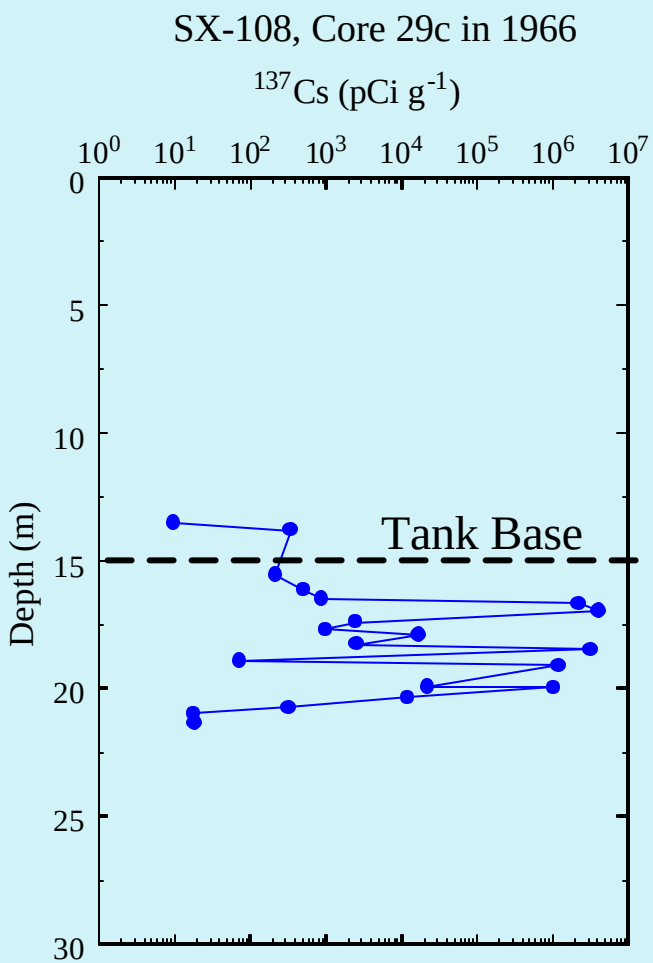
Data Requirements

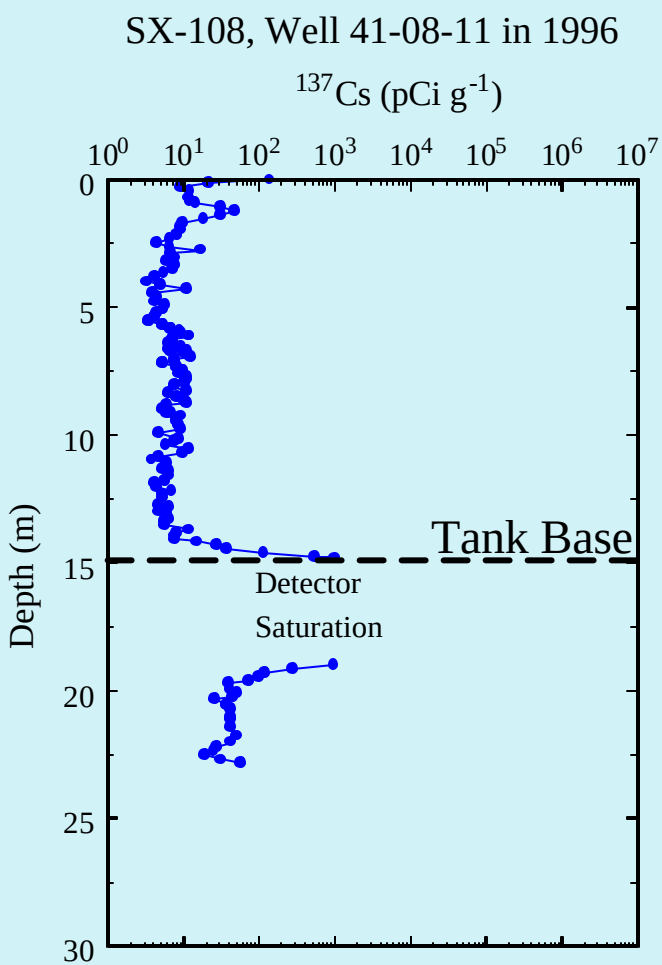
- Boundary conditions
  - recharge rates
  - release rates
- Physical properties
- Water flow (non-isothermal)
  - hysteretic relationships ? (?), K(?)
  - transport volumes
- Solute Transport
  - retardation
  - dispersivities
- Scale dependence (upscaling)
- Uncertainty in parameters and conceptual models

Tank-farm Specific Issues

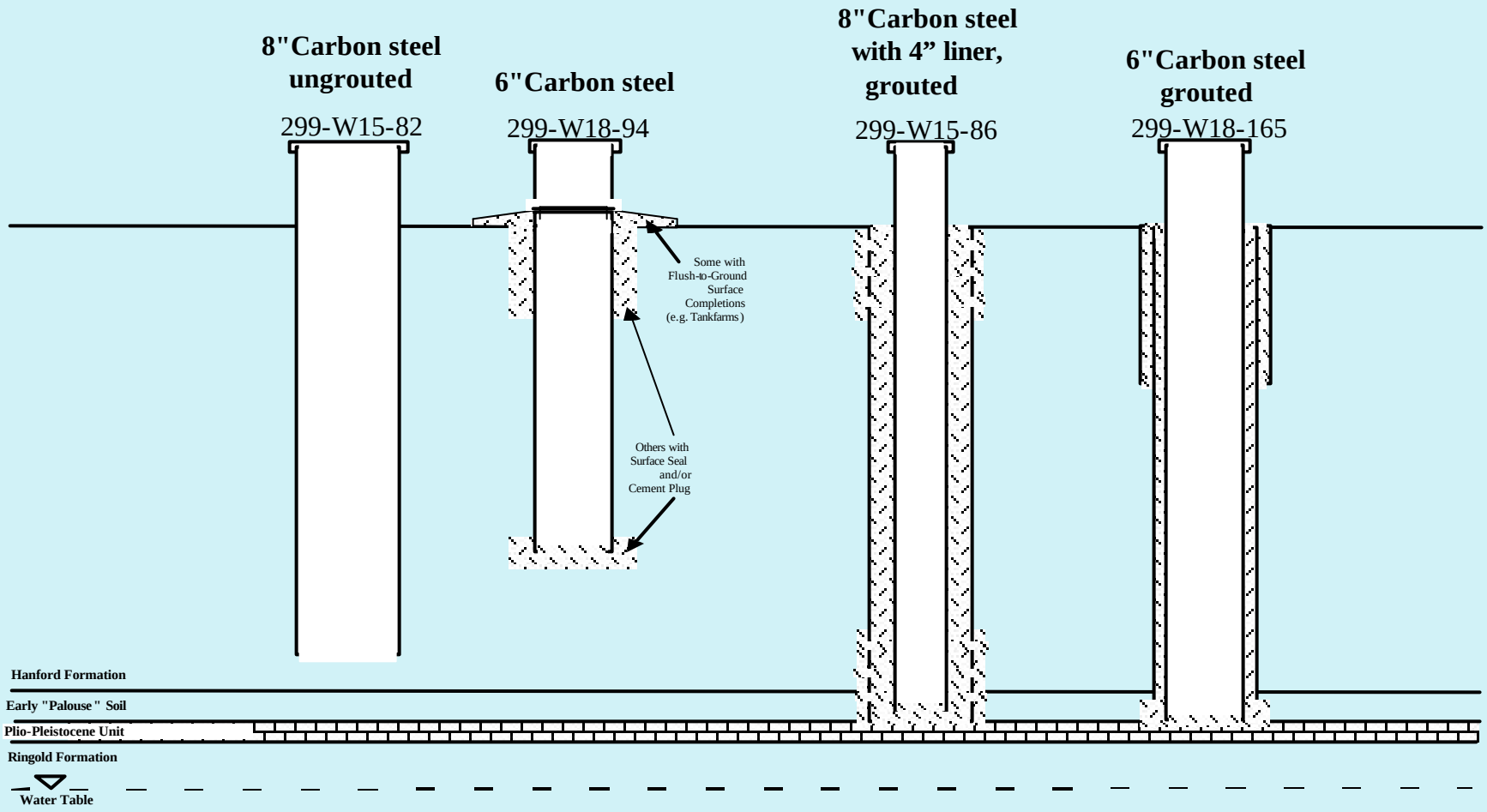
- “Non-ideal” waste fluids
  - caustic, 10 < pH < 14
  - saline, 6 ? N ? 12
  - dense, specific gravity ? 1.5
- metallic infrastructure
- radionuclides
  - ? ? emitters by spectral-? methods
  - ? ? and ? emitters not detectable in situ
- sediments generally difficult to instrument

Depths of Interest





Typical Vadose Zone (dry) Wells



Site Characterization Wish List

- Improved drilling, well completion, sampling and retrieval
  - elimination of drag down and cross contamination
  - maintenance of sample integrity (physical & chemical)
- downhole and surface logging methods
  - improved characterization of radionuclide profiles
  - 3D imaging of lithological features, physical and chemical properties
- sensors
  - T, ?, chemicals (aqueous and vapor phase)
  - passive
  - leak detection

Limitations of Current Vadose Methods

- mostly invasive
- provide only point (local scale) measurements
  - upscaling issues
- limited to the near surface due to their origin

geophysical methods

- many noninvasive or minimally intrusive
- potential to address characterization problems
- interrogate large volumes
- guide upscaling issues

Advanced Vadose Zone Characterization

- Deep measurements of hydraulic properties
  - suction, ? ?(deep tensiometers)
  - water content (radar, TDR)
  - K(?)
  - surface NMR (extend recent advances to ? and pore size distribution in larger volumes)
  - Cone penetrometer
- Distribution of contaminant/surrogates
  - 3D ERT (through casing ERT)
    - saline contaminants
  - induced polarization tomography (IPT)
    - 3D DNAPL concentrations

Advanced Vadose Zone Characterization

- Geological features
  - surface wave tomography, SWT(3D shear velocity and depth to interfaces)
  - P-wave refraction tomography, PWRT, (3D compression velocity and depth to interfaces)
  - SWT + PWRT for ? and porosity
- Seismic Anisotropy Tomography
  - fractures, fast paths
- conversion of geophysical measurements to hydrological parameters

Planning Needs

- Identify candidate technologies
- Pros and cons of candidate technologies
- preliminary thoughts on experimental design