Hydrogeology of the Hanford Site Vadose Zone

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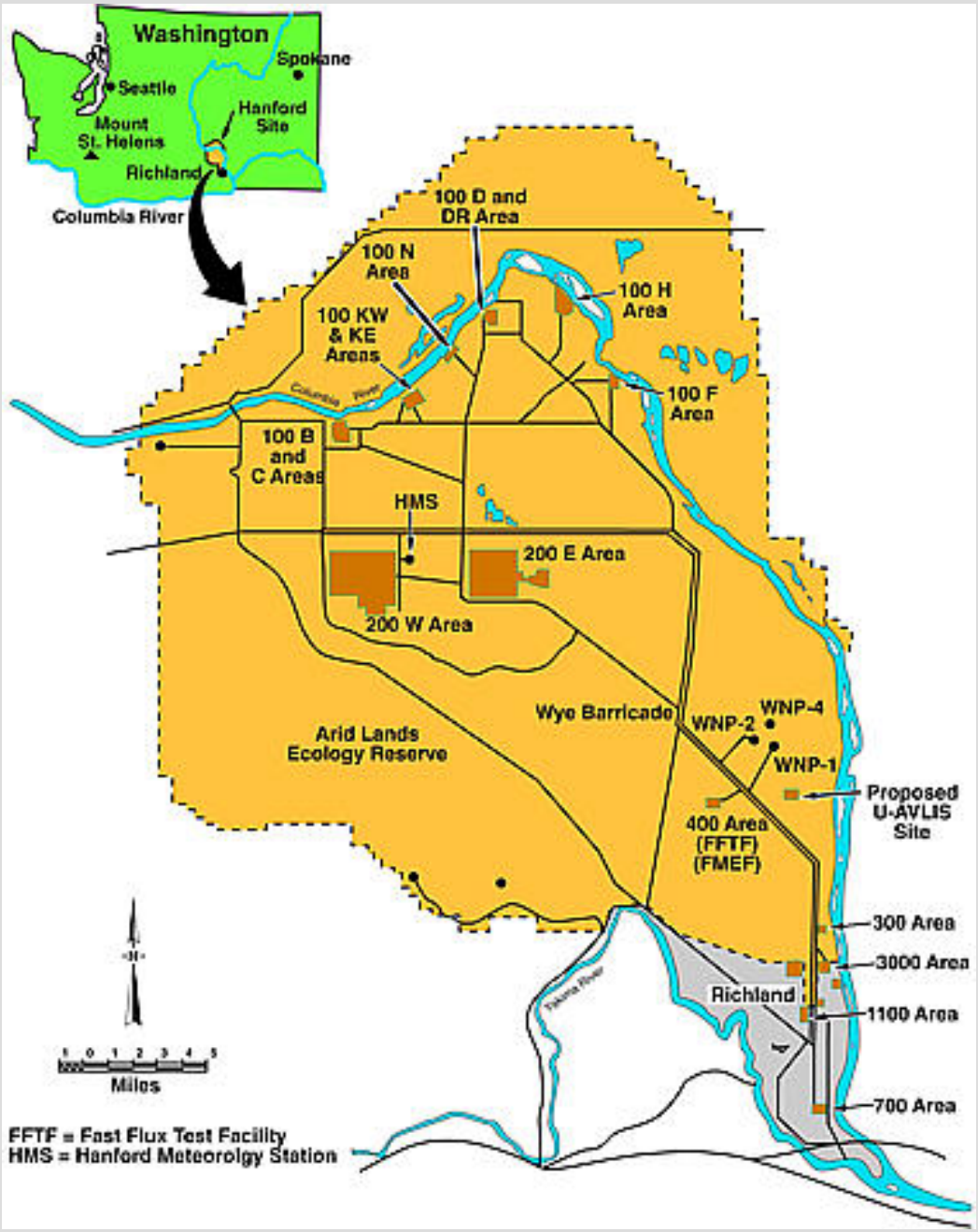
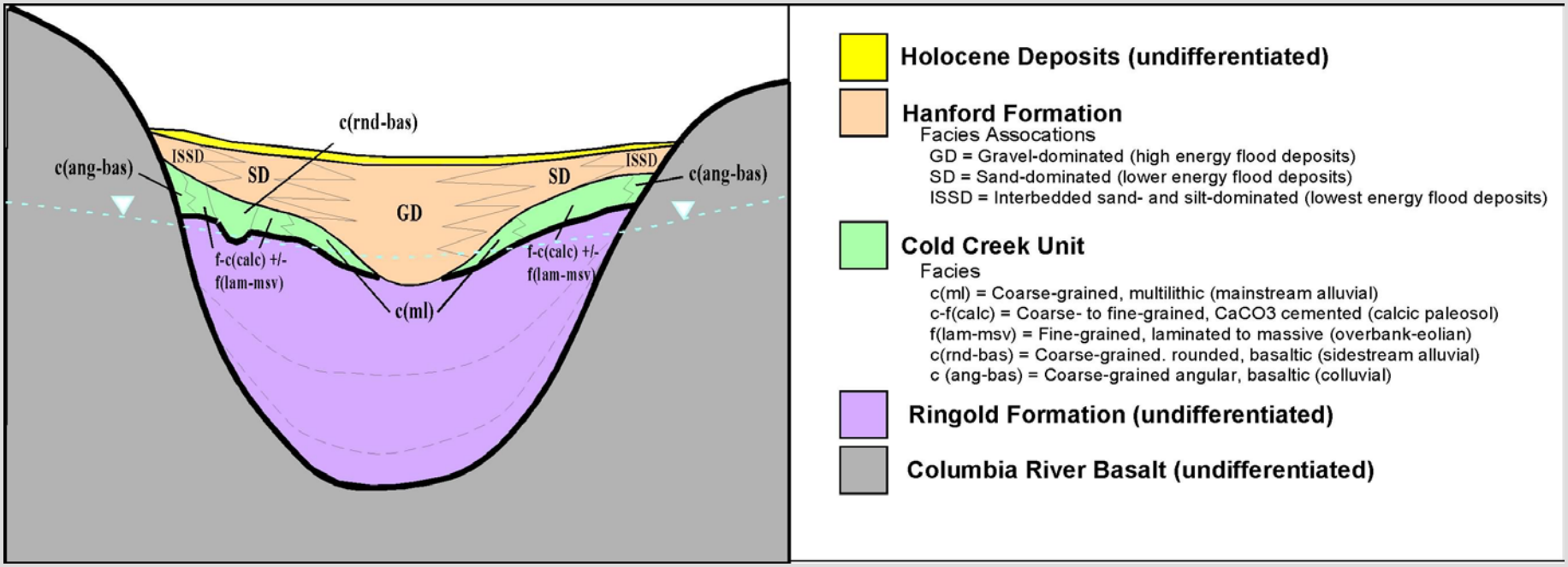
Location Map



Generalized Stratigraphy at Hanford*



*After DOE (2002)

Purpose

- How does subsurface geology influence moisture and contaminant distribution in the vadose zone?
- Translation of lithofacies to hydrogeochemical facies for assessment of long-term contaminant transport

Characteristics Used to Distinguish Sedimentary Facies at Hanford

- Grain-size distribution
- Sedimentary structure/fabric
- Roundness (gravel fraction)
- Mineralogy
- Color
- Calcium-carbonate content
- Alteration
- Induration
- Natural-gamma activity

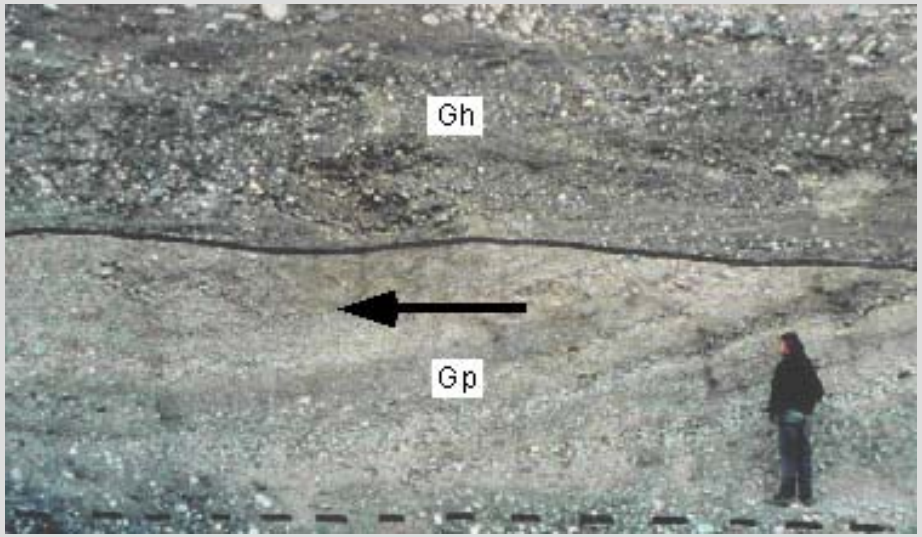
Hanford Formation

- Informal name for all Pleistocene-age, cataclysmic-flood and intercalated deposits within the Pasco Basin
- Comprise bulk of vadose zone beneath waste sites at Hanford
- Divided into three facies associations and 11 textural-structural lithofacies
- High-degree of inherent heterogeneity and anisotropy

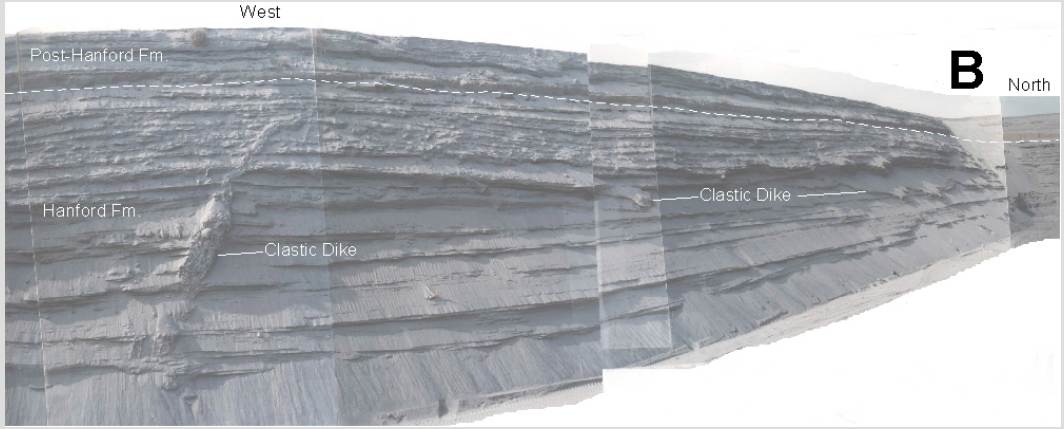
Hanford Formation Lithofacies

1. *Fm* - Massive, silt to fine sand
2. *Fl* - Horizontally laminated, silt to fine sand
3. *Sm* - Massive, fine to coarse sand +/- silt
4. *Sr* - Ripple-laminated sand
5. *Sh(f)* - Horizontally laminated, silty fine to medium sand
6. *Sh(c)* - Horizontally laminated, medium to coarse and pebbly sand
7. *Sp* - Planar-tabular cross-stratified, medium to coarse and pebbly sand
8. *St* - Trough cross-stratified, medium to coarse and pebbly sand
9. *Gm* - Massive, silty sandy pebble to boulder gravel
10. *Gh* - Horizontally bedded,silty sandy pebble to boulder gravel
11. *Gp* - Planar-tabular cross-bedded, silty sandy pebble to boulder gravel

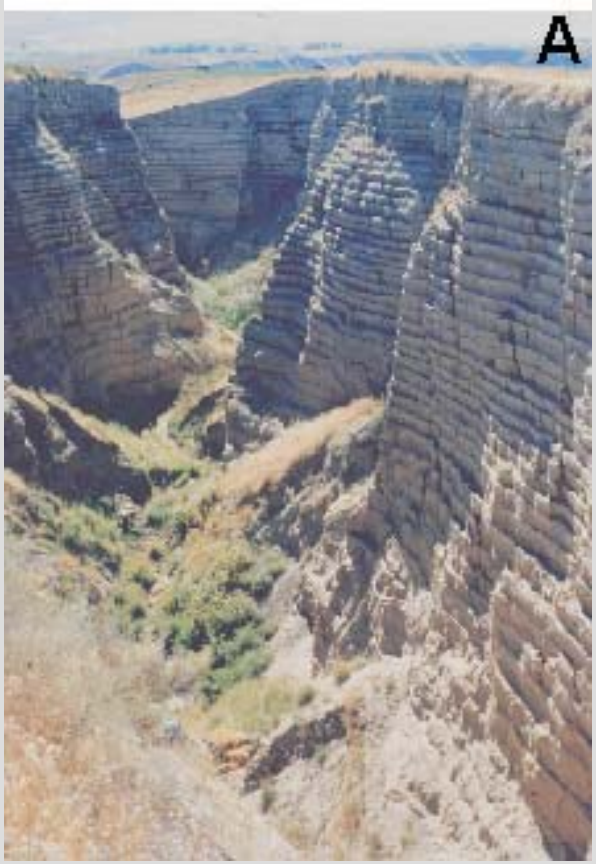
Hanford Formation Facies Associations



Gravel-dominated (GD)



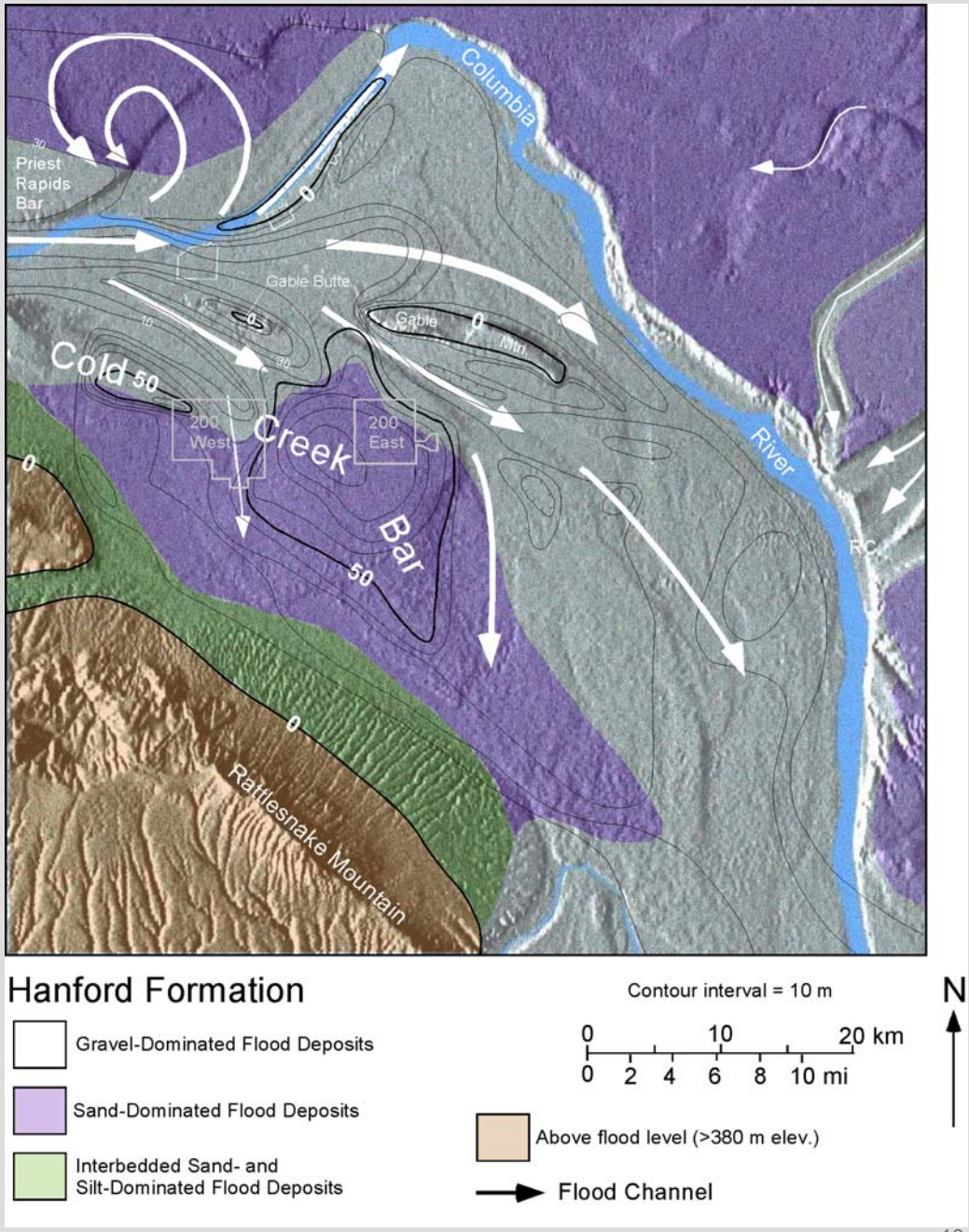
Sand-dominated (SD)



Interbedded sand-
and silt-dominated (ISSD)

General Distribution of Hanford Formation Facies Associations

I. Gravel-Dominated (GD)
II. Sand-Dominated (SD)
III. Interbedded Sand- and Silt-Dominated (ISSD)



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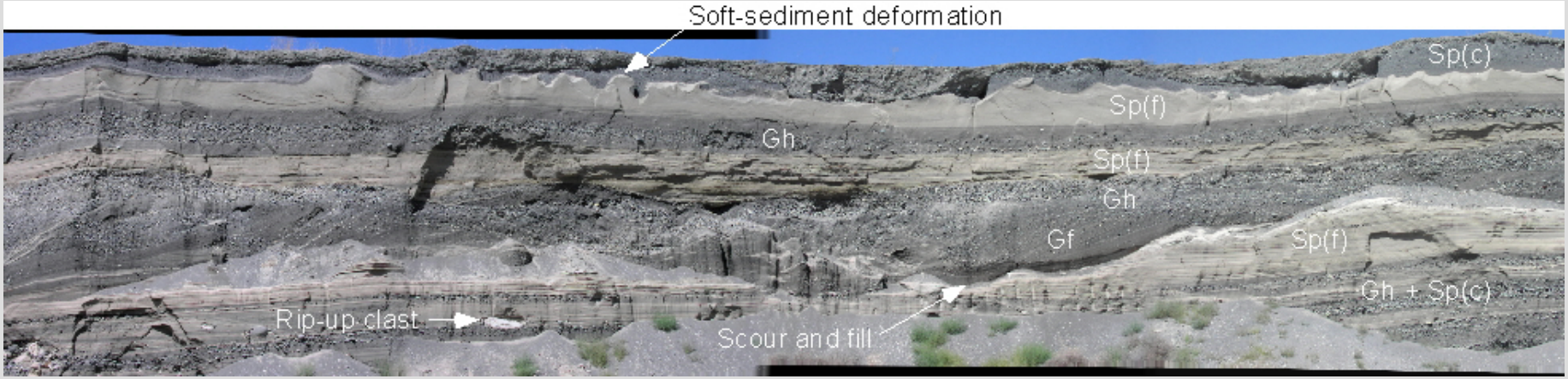
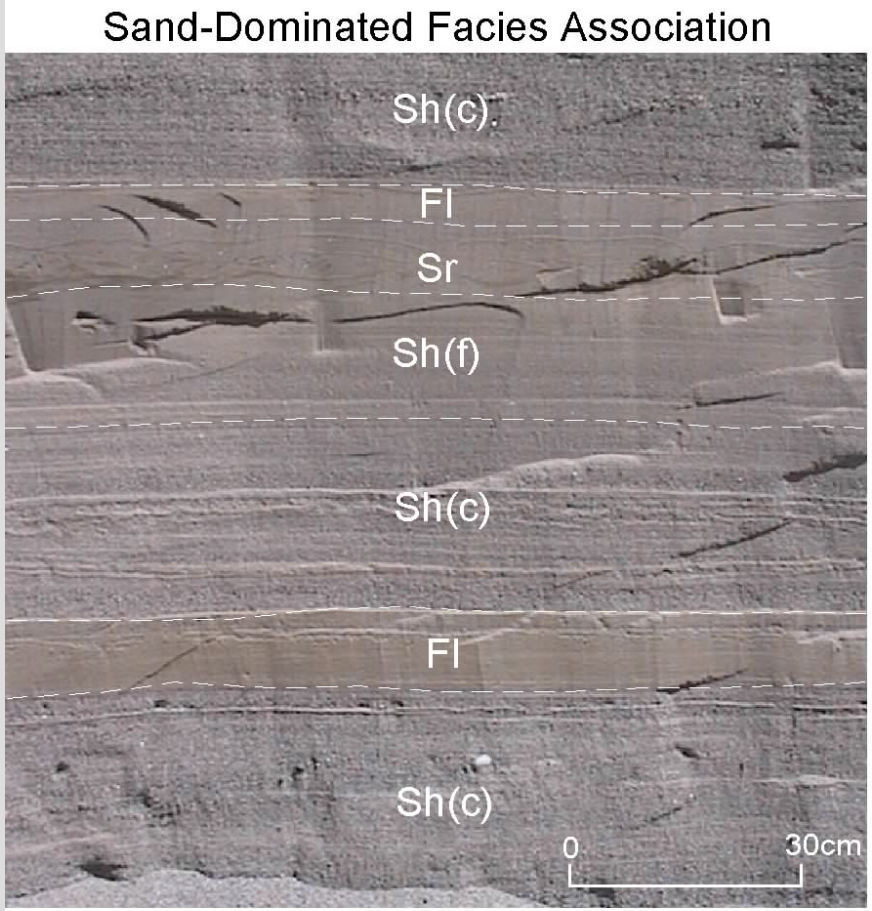
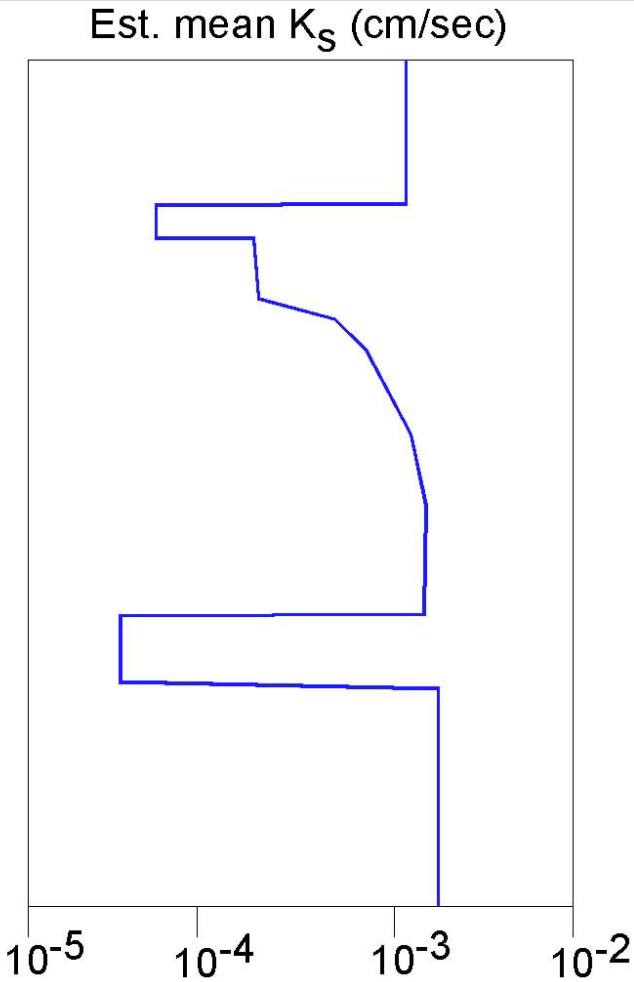
Large-Scale Heterogeneities Within the Hanford Formation

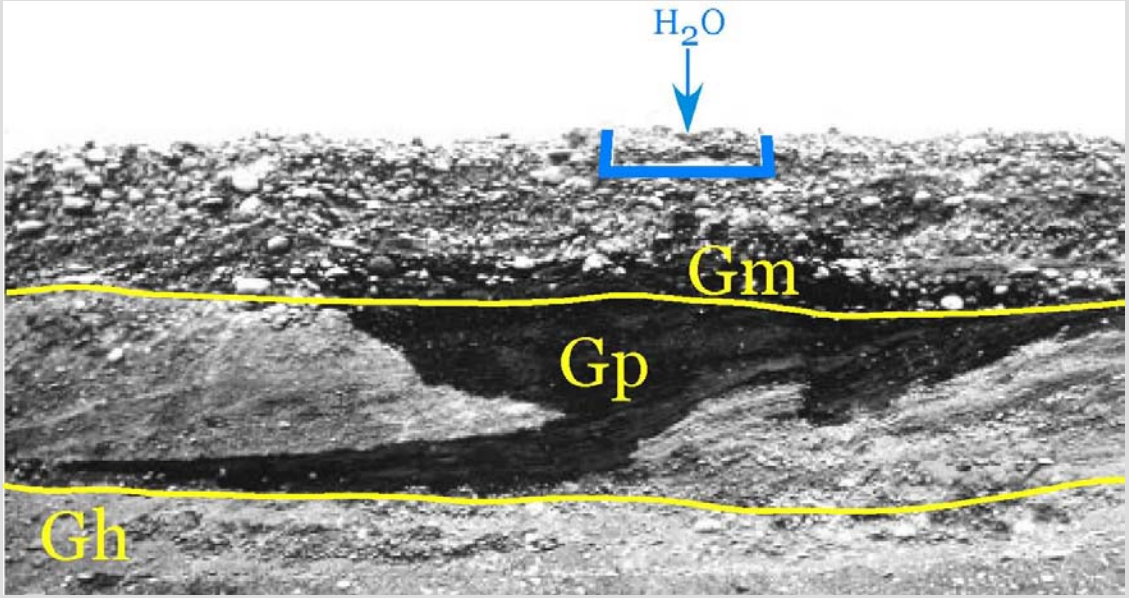


Small-Scale Heterogeneities Within the Hanford Formation





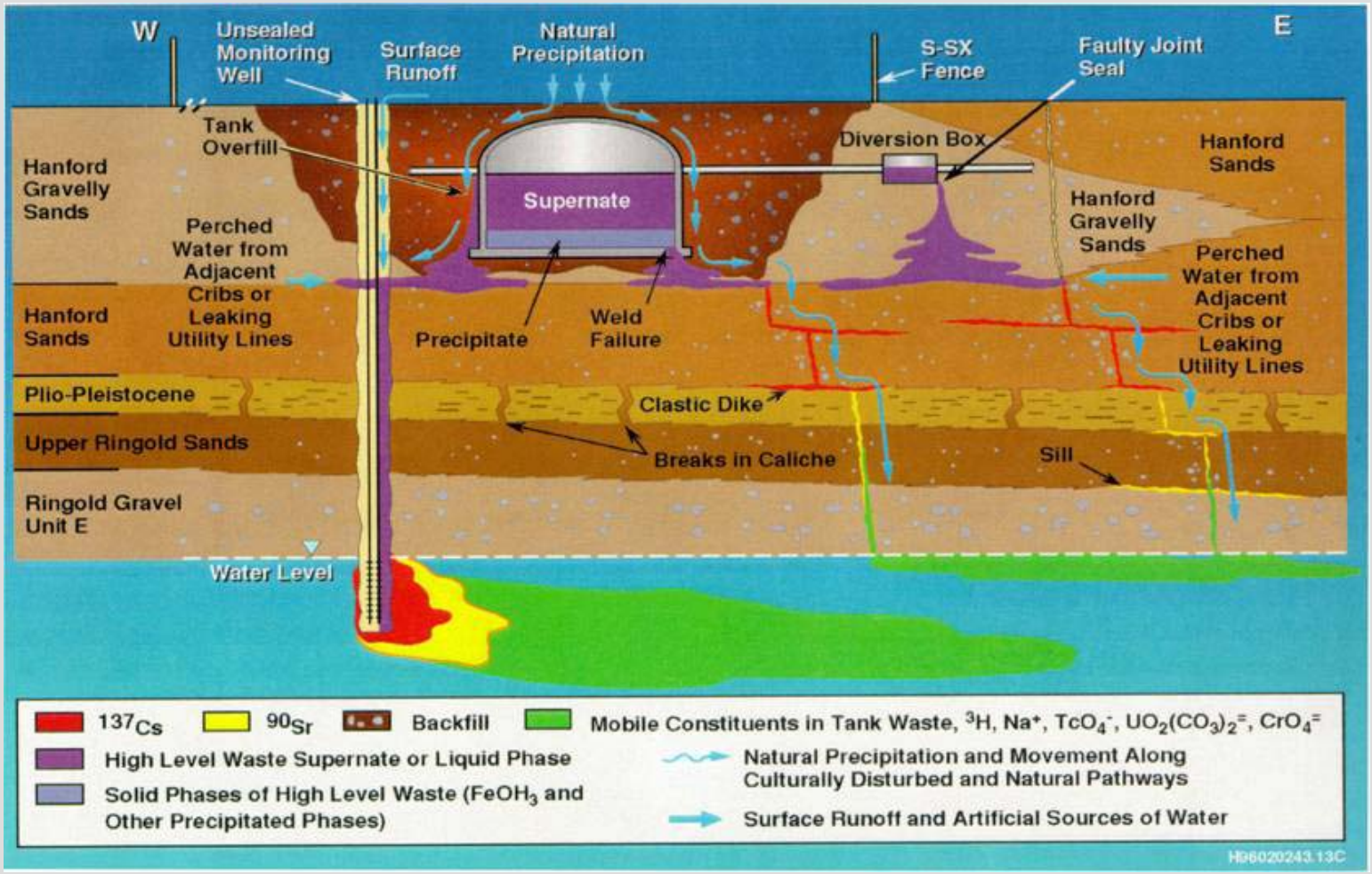
Geologic Controls on Moisture Distribution



Hanford formation (Gravel-dominated facies association)

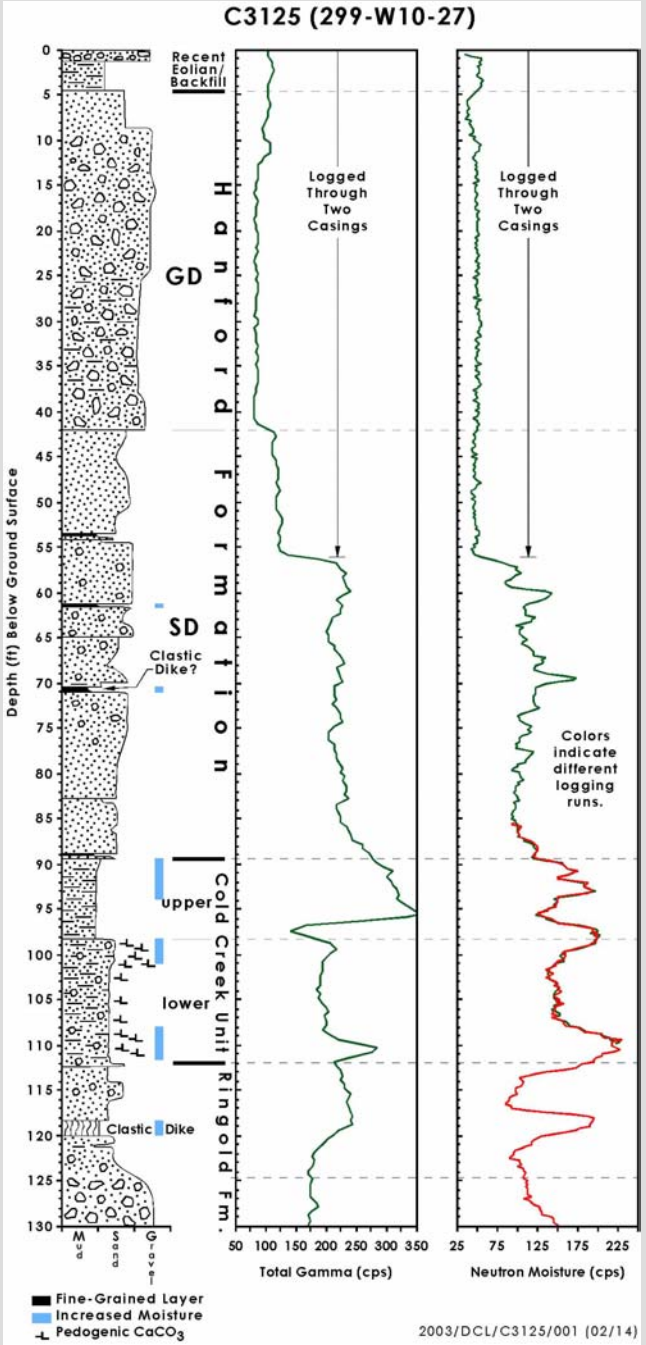
1. Moisture may collect and move laterally:
   - Within finer-grained layers
   - Along interfaces between highly contrasting facies
   - Along primary sedimentary structures
2. Migrate vertically along discordant clastic dikes

Model for Moisture/Contaminant Distribution in Vadose Zone, Southern 200W Area



Vadose-Zone Moisture Distribution in Continuous Corehole

- Higher moisture contents are associated with some, but not all, fine-grained layers within the Hanford fm.
- Highest moisture contents:
  1. toward the top of the fine-grained upper Cold Creek unit
  2. near the top and bottom of the lower Cold Creek unit (i.e., caliche)
  3. along two clastic dikes intersected during drilling



Method for Developing Hydrogeochemical Facies at Hanford

Sample and Raw Data Collection

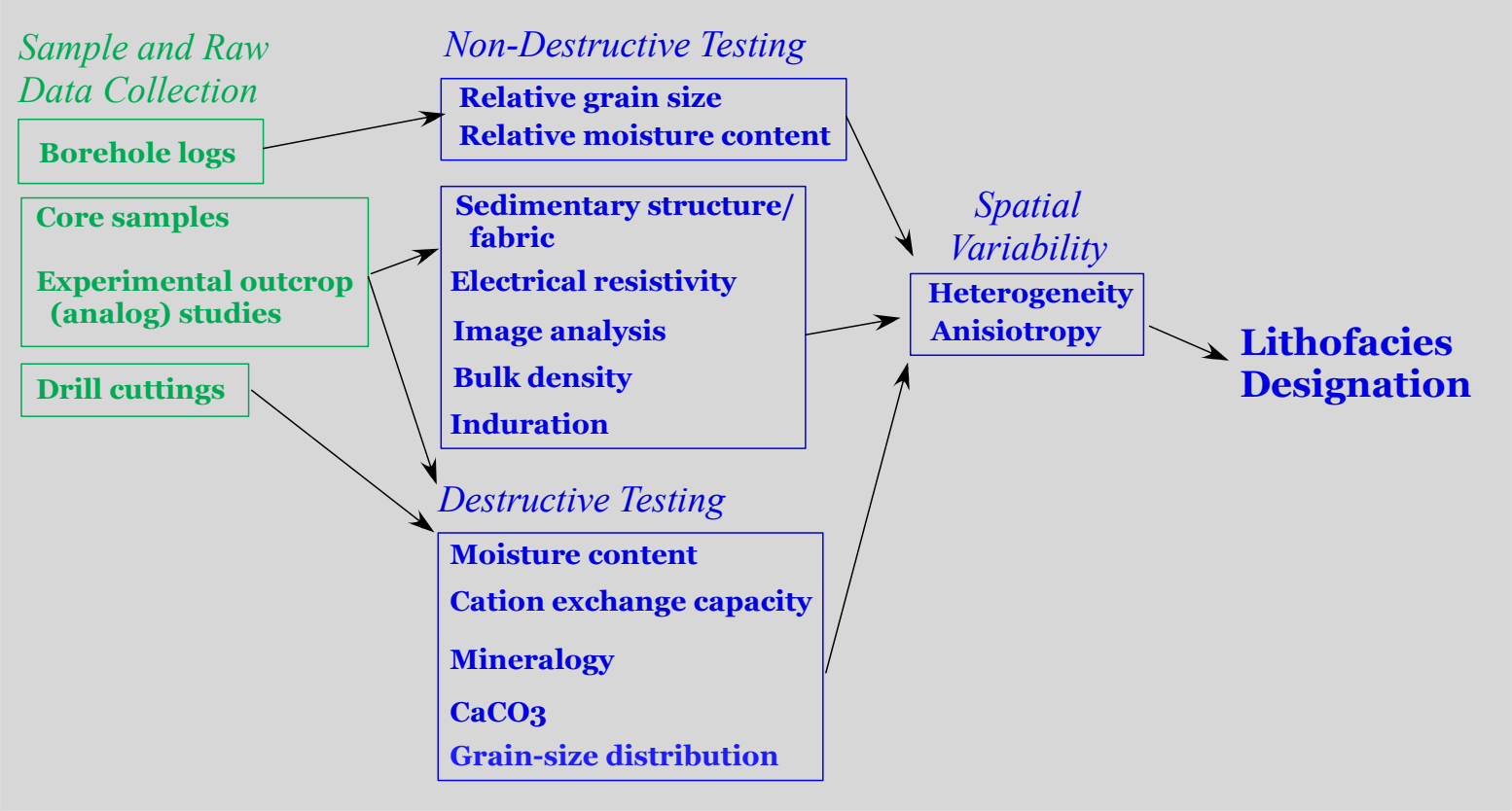
Borehole logs

Core samples

Experimental outcrop (analog) studies

Drill cuttings

Method for Developing Hydrogeochemical Facies at Hanford



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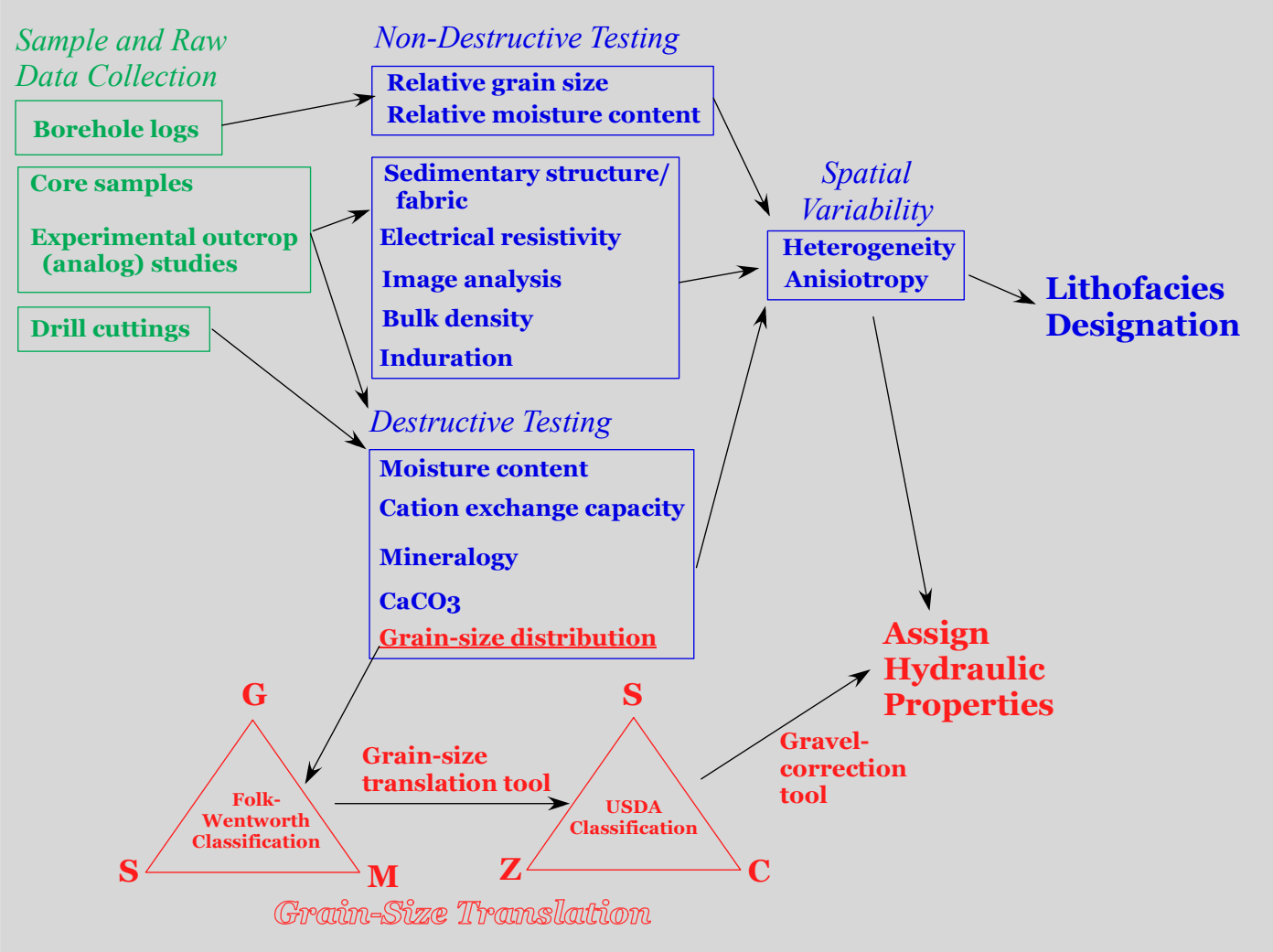

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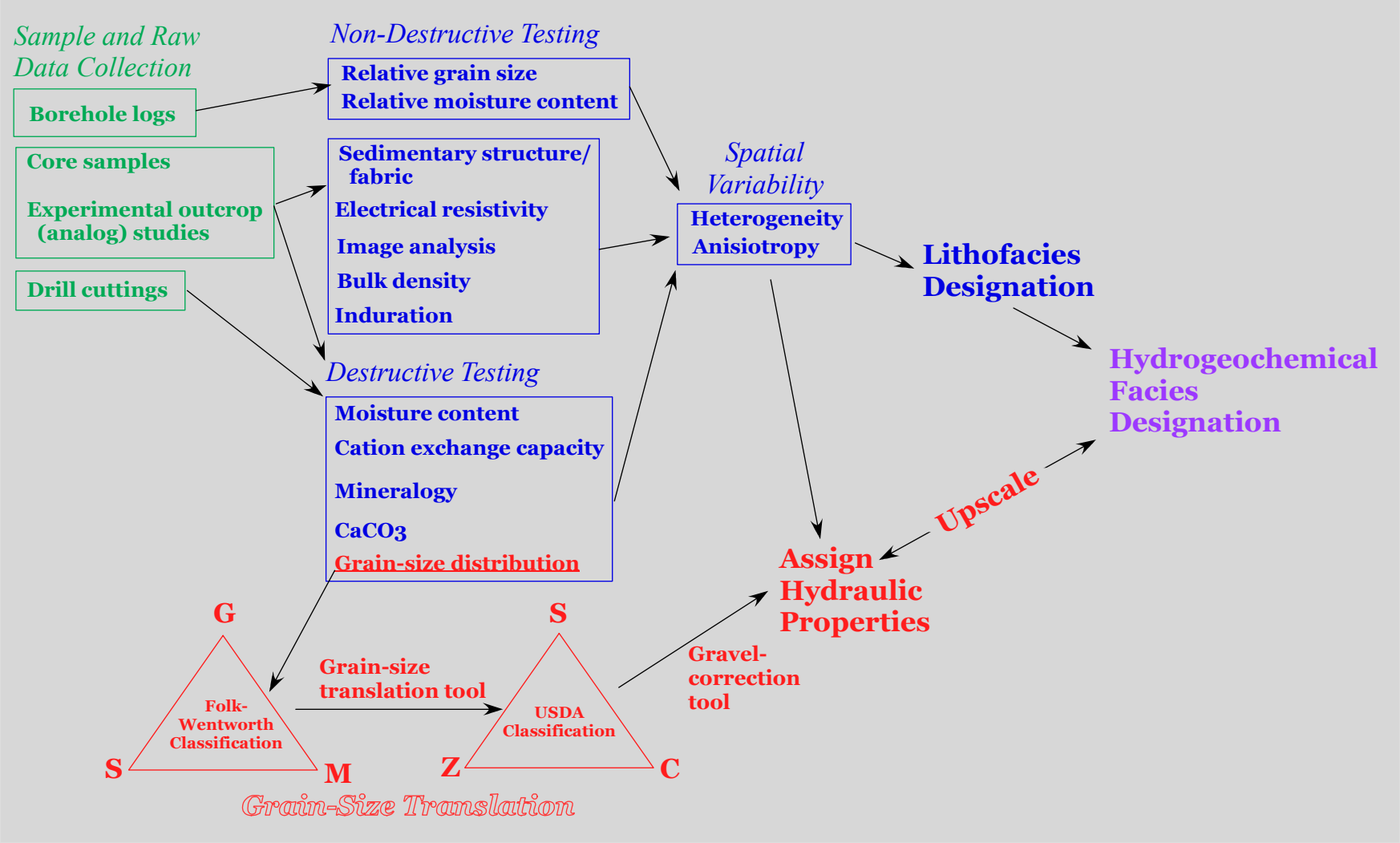

Summary

- Distribution of moisture/contaminants in the vadose zone is highly controlled by geology and water-flux rate
- The bulk of the vadose zone beneath waste sites at Hanford lies within Pleistocene, cataclysmic flood deposits of the Hanford fm.; locally, the underlying Cold Creek unit and Ringold Formation also lie within the vadose zone
- The Hanford fm. is particularly heterogeneous and anisotropic; three facies associations and 11 lithofacies are identified
- Vadose-zone moisture and contaminants tend to concentrate:
  - ✓ Within finer-grained strata of the Hanford fm SD and ISSD facies associations and the Cold Creek unit
  - ✓ Along interfaces between highly contrasting lithofacies
  - ✓ discordant clastic dikes
- Work is ongoing to relate lithofacies to hydrogeochemical facies needed for stochastic modelling in the vadose zone