Sitewide INL Hydrogeological Setting – Conceptual Model

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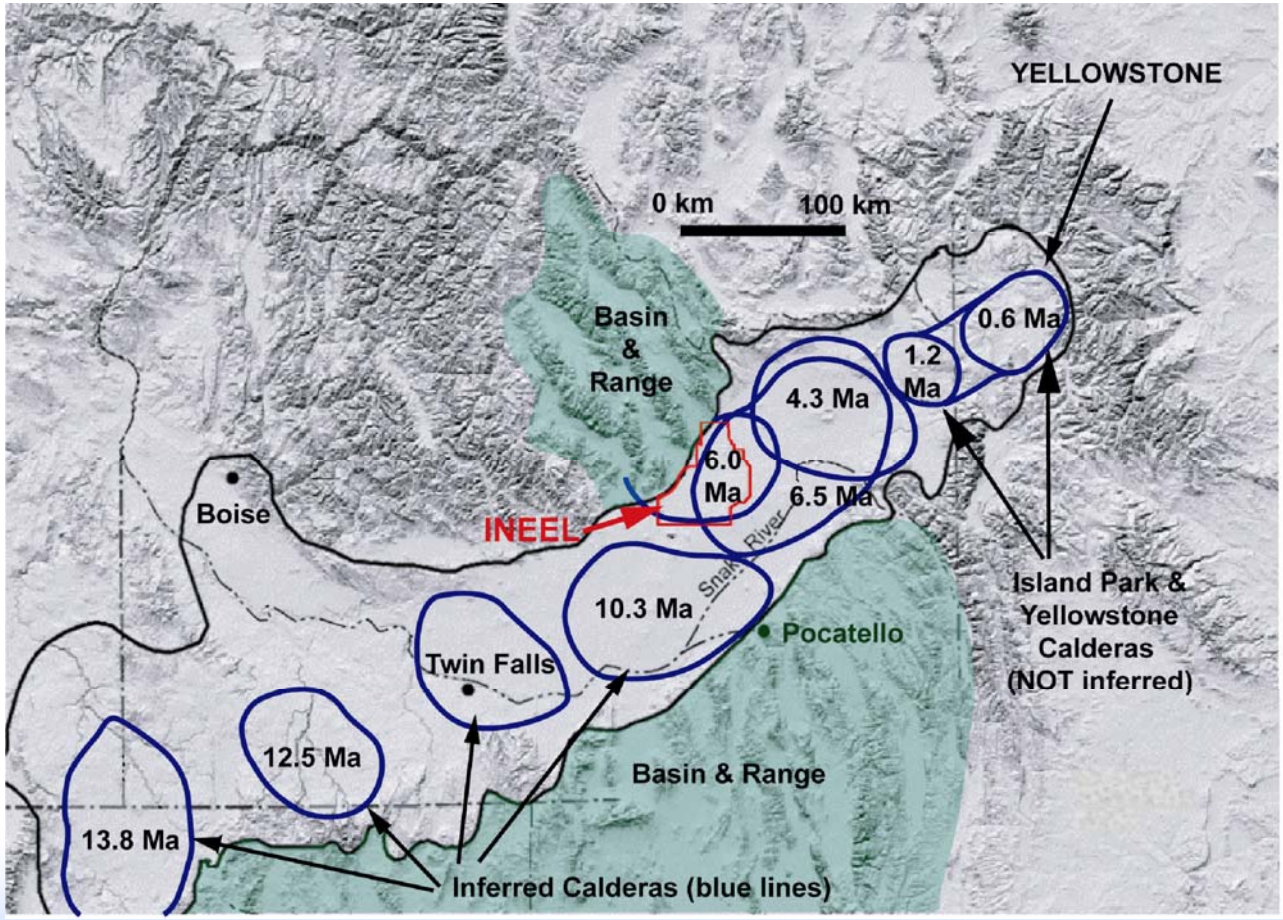
Presentation Outline

- **Geologic Setting**
- **Aquifer**
- **Vadose Zone**

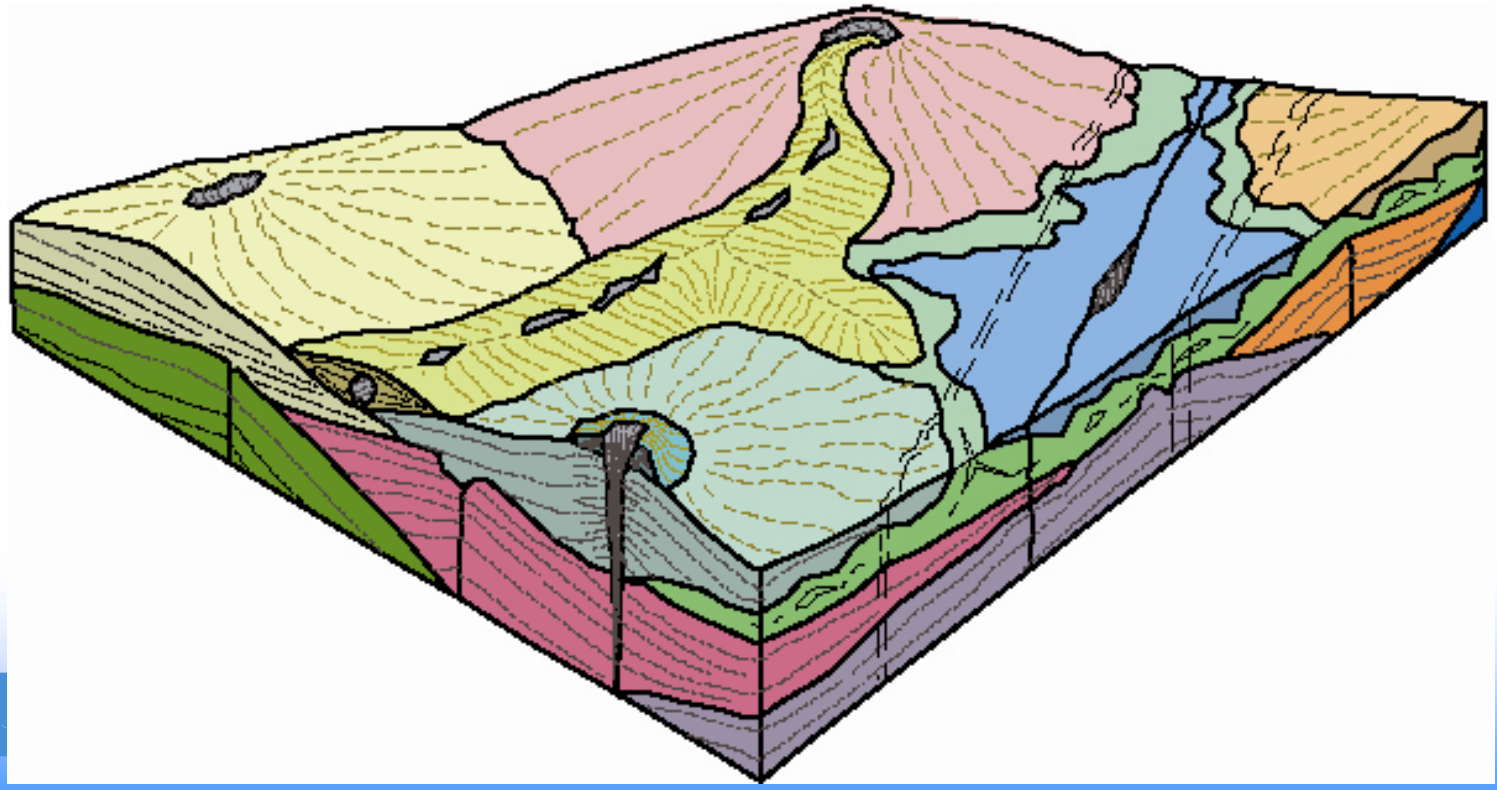
Yellowstone Hotspot Track

- Eastern Snake River Plain forms by subsidence in its wake

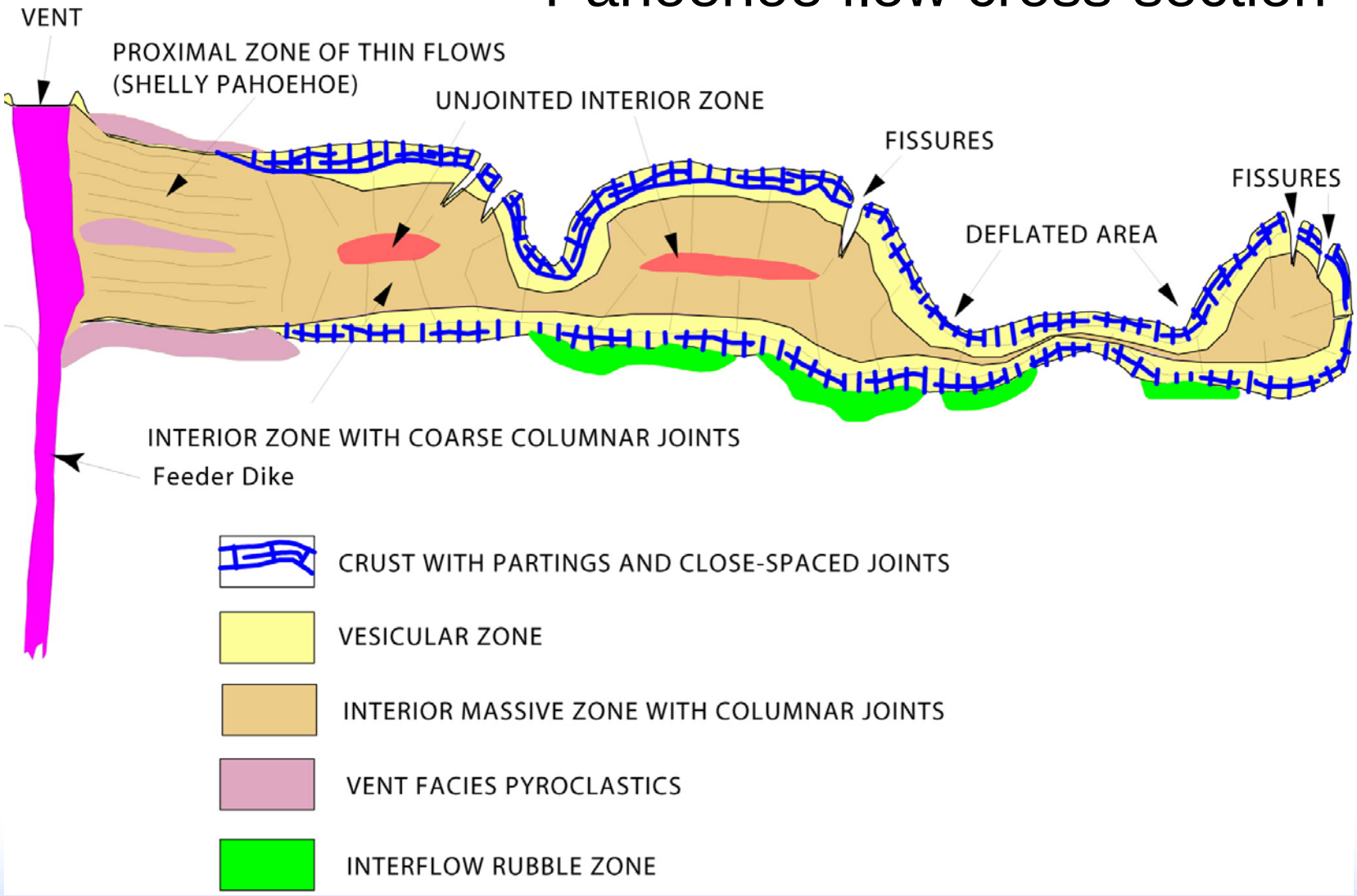


Eastern Snake River Plain Basalts

ESRP basalts form short tongue-like flows and small low-angle shield volcanoes. Average thickness 7 m, maximum lateral extent <50 km.

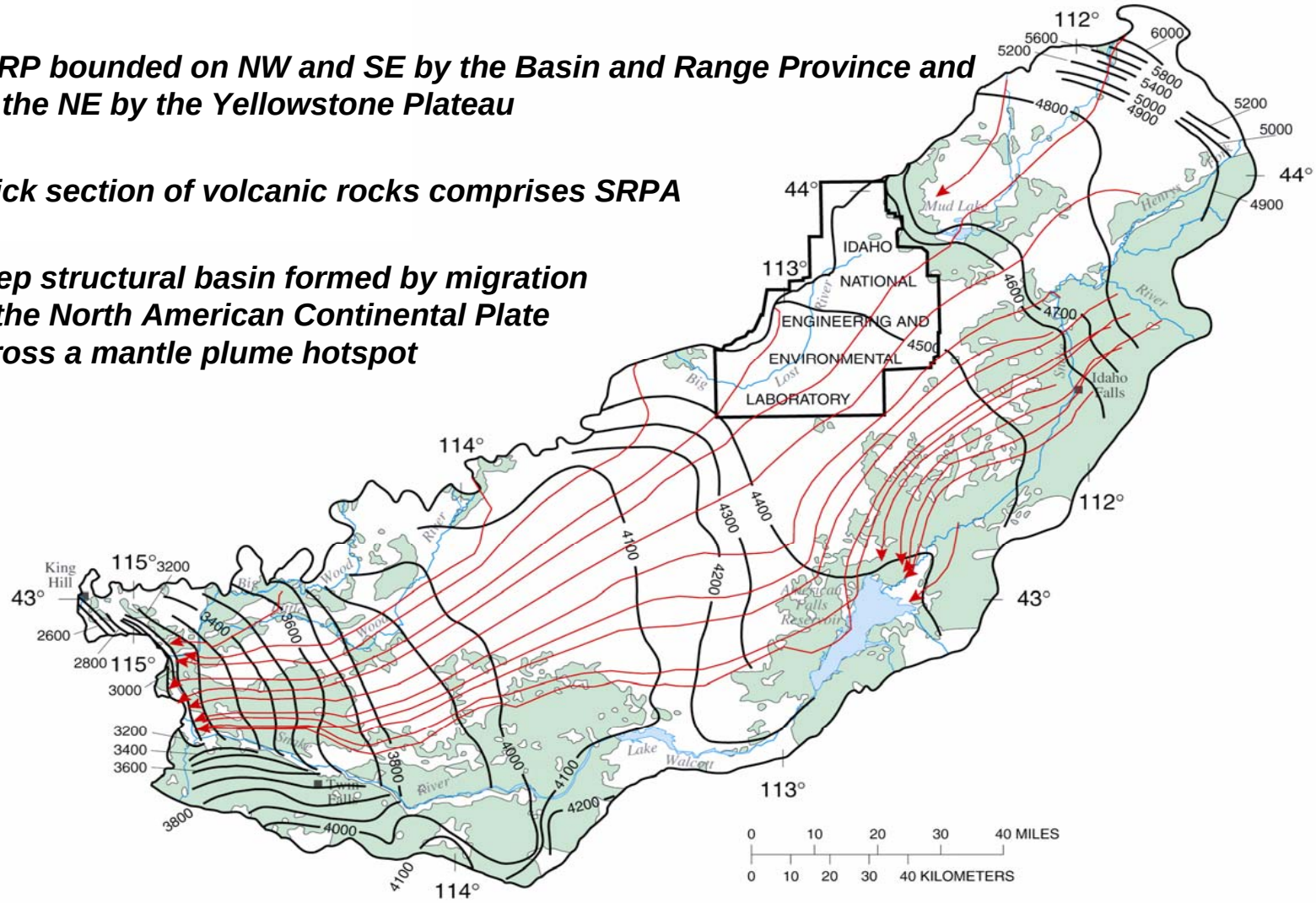


Pahoehoe flow cross-section



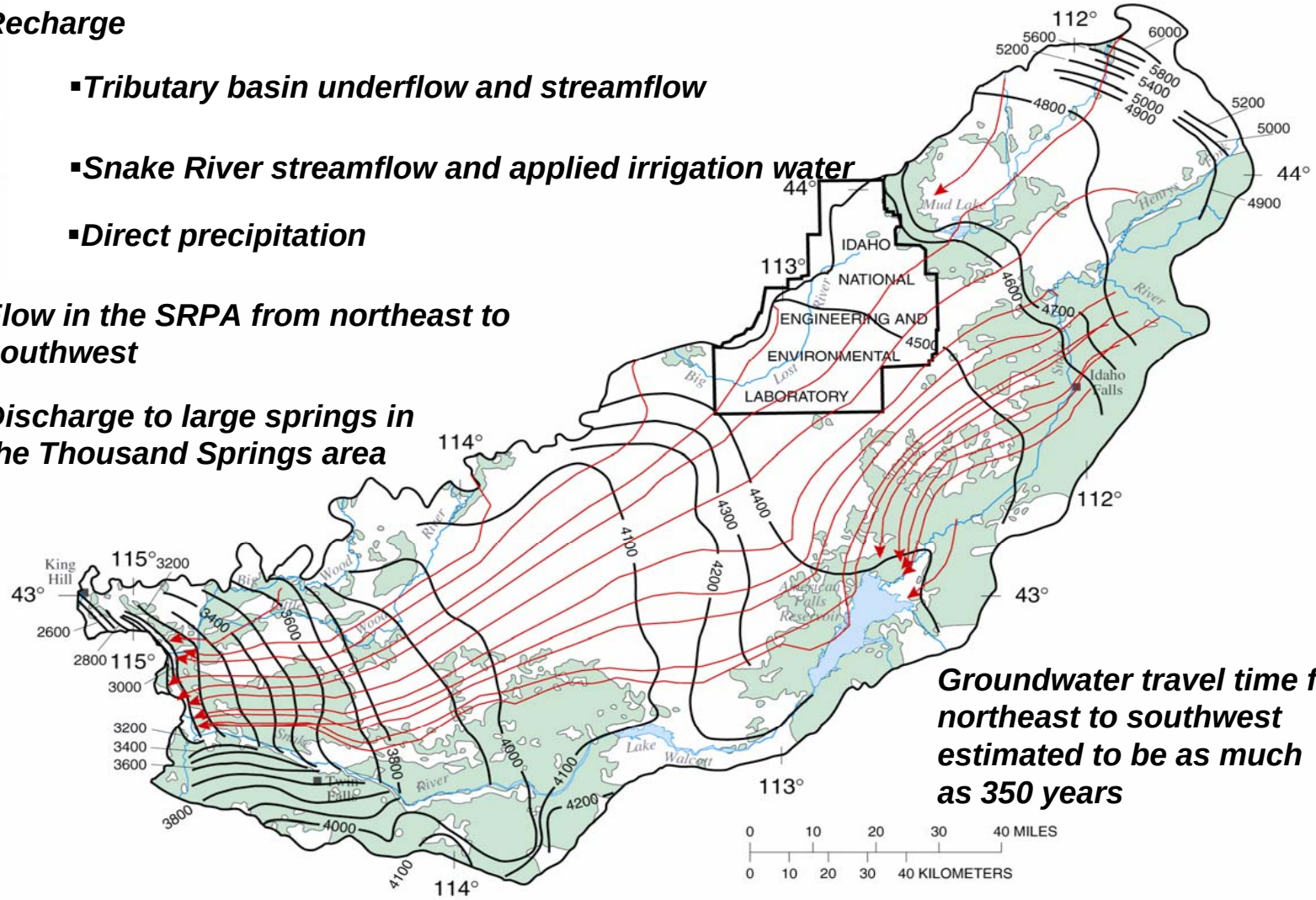
Regional Hydrogeology

- *ESRP bounded on NW and SE by the Basin and Range Province and on the NE by the Yellowstone Plateau*
- *Thick section of volcanic rocks comprises SRPA*
- *Deep structural basin formed by migration of the North American Continental Plate across a mantle plume hotspot*



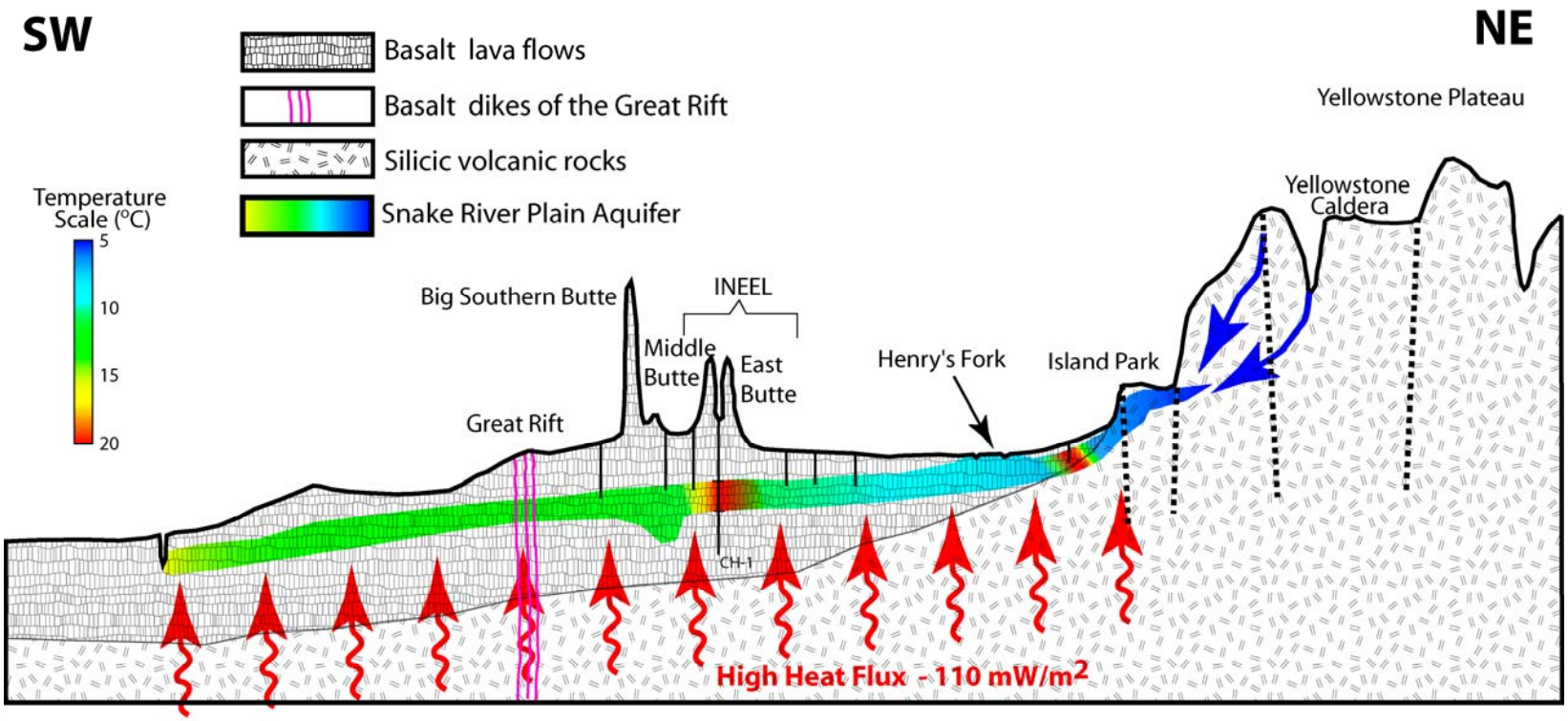
Regional Hydrogeology

- ***Recharge***
  - ***Tributary basin underflow and streamflow***
  - ***Snake River streamflow and applied irrigation water***
  - ***Direct precipitation***
- ***Flow in the SRPA from northeast to southwest***
- ***Discharge to large springs in the Thousand Springs area***



Groundwater travel time from northeast to southwest estimated to be as much as 350 years

Regional Hydrogeology

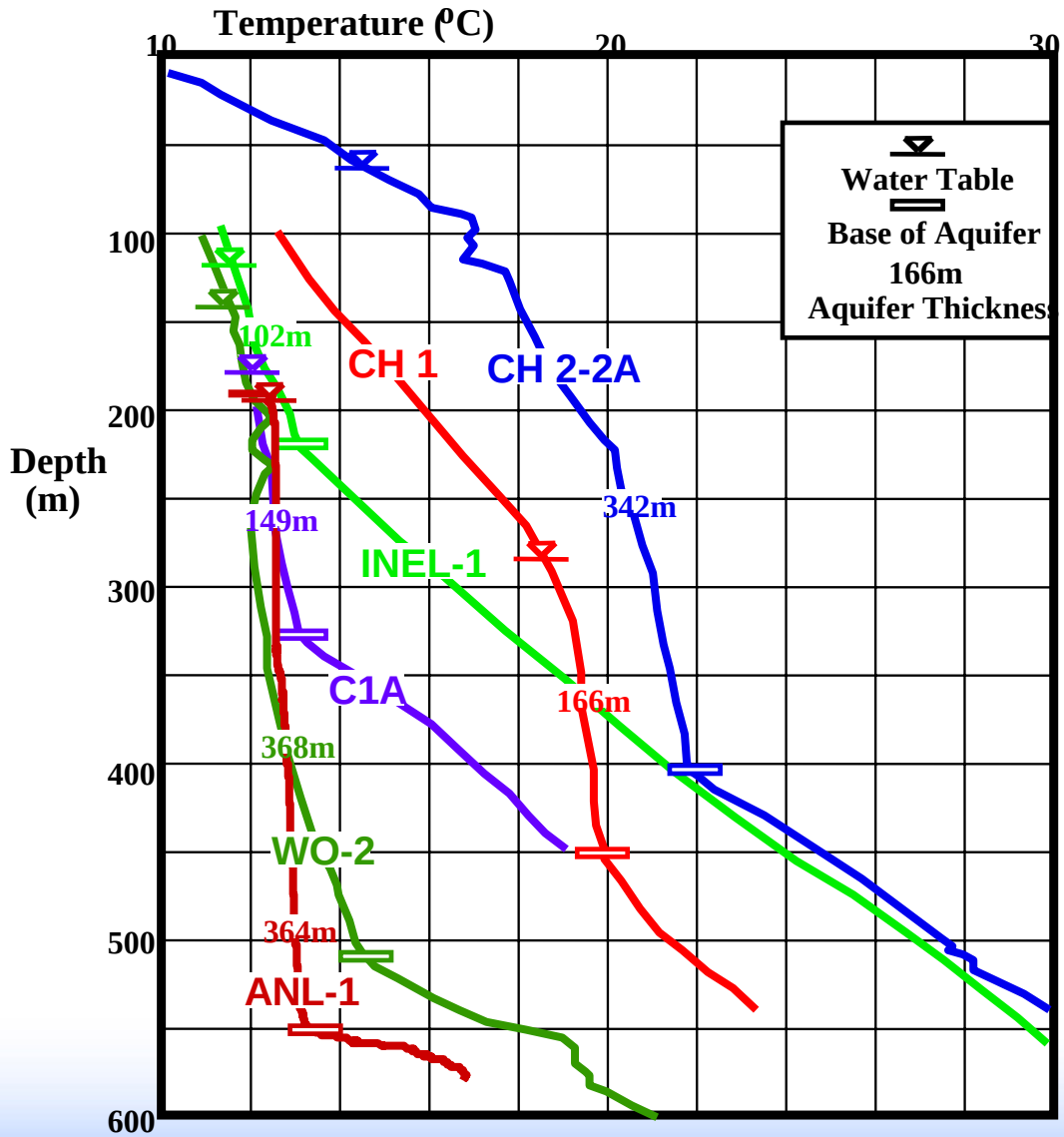


SW to NE Longitudinal Section, Snake River Plain Aquifer

0 100

Scale (km)

Extreme Vertical Exaggeration



Temperature logs of wells that penetrate the base of the aquifer

Hydrologic Framework

- LARGE-SCALE HYDROGEOLOGIC FRAMEWORK FEATURES INFLUENCING GROUNDWATER FLOW

Complex system of highly permeable interconnected basalt interflow zones

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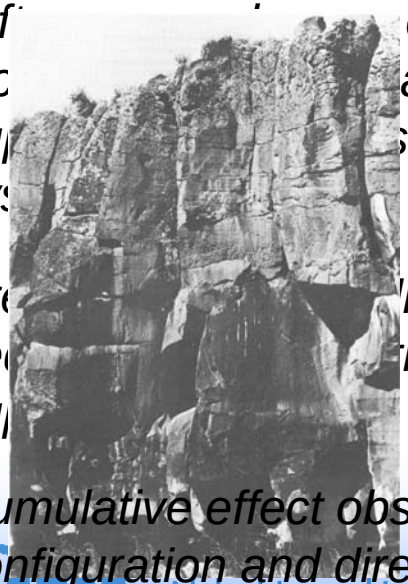
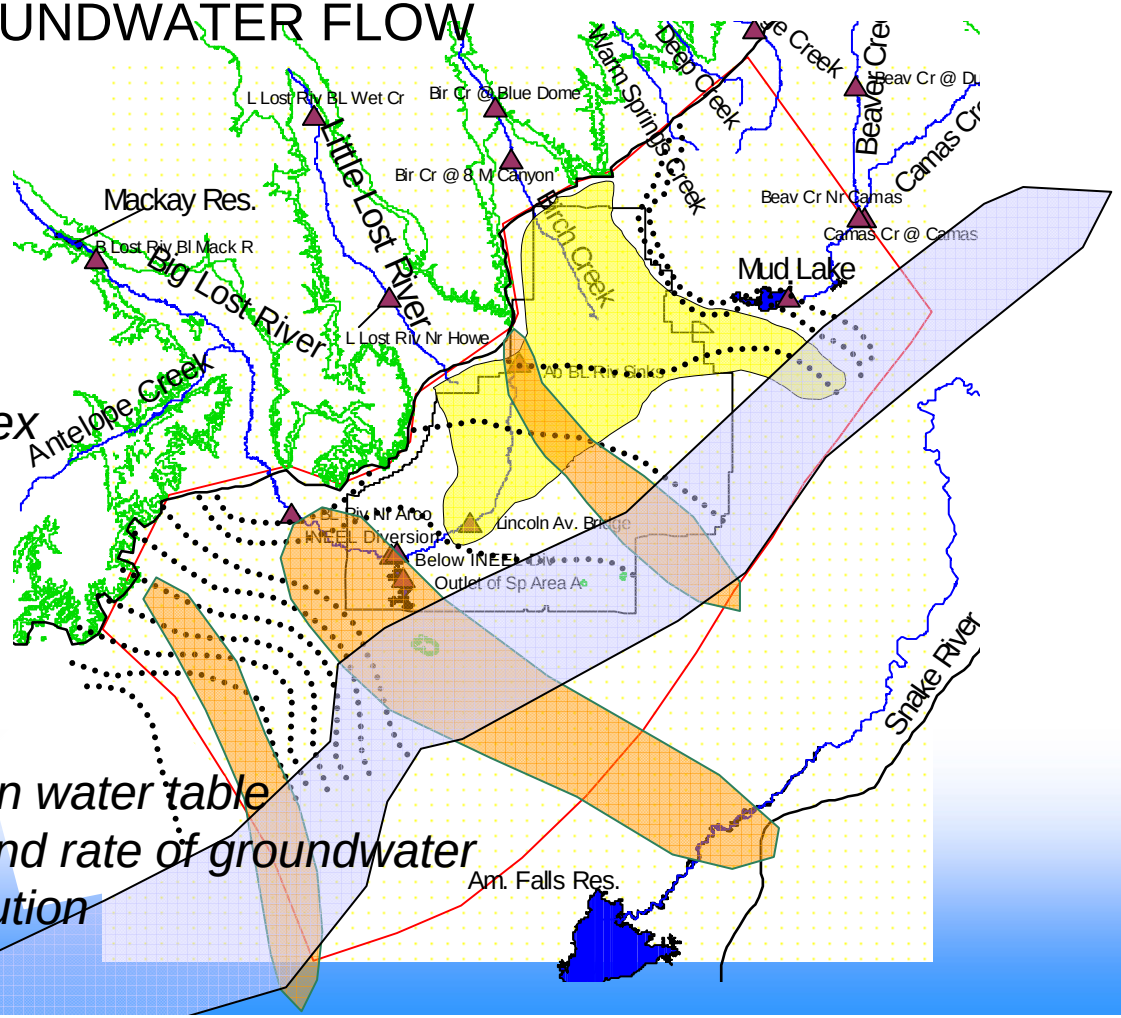
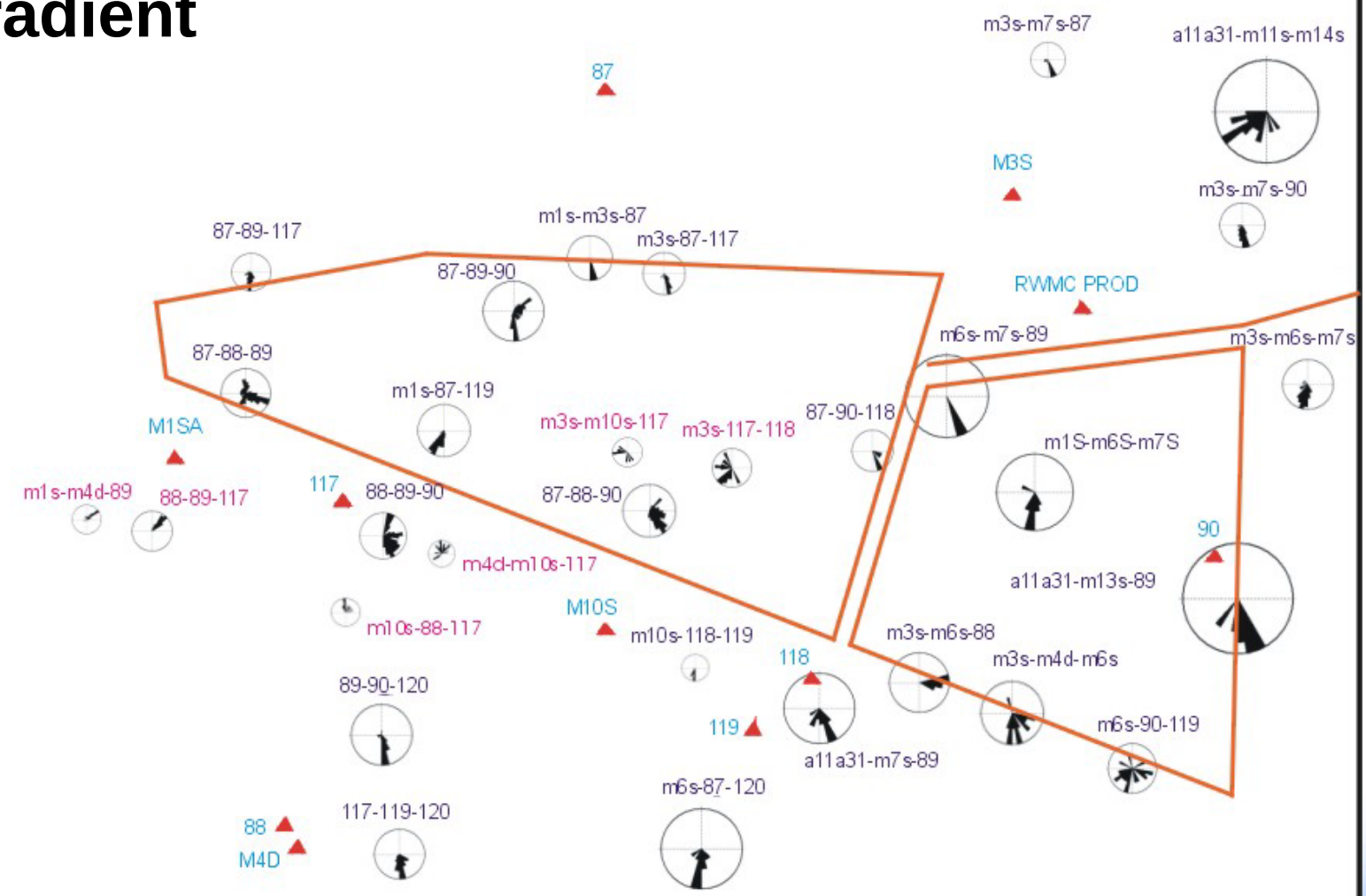


Cumulative effect observed in water table configuration and direction and rate of groundwater flow and contaminant distribution



Flow Directions Vary Locally From Regional Gradient



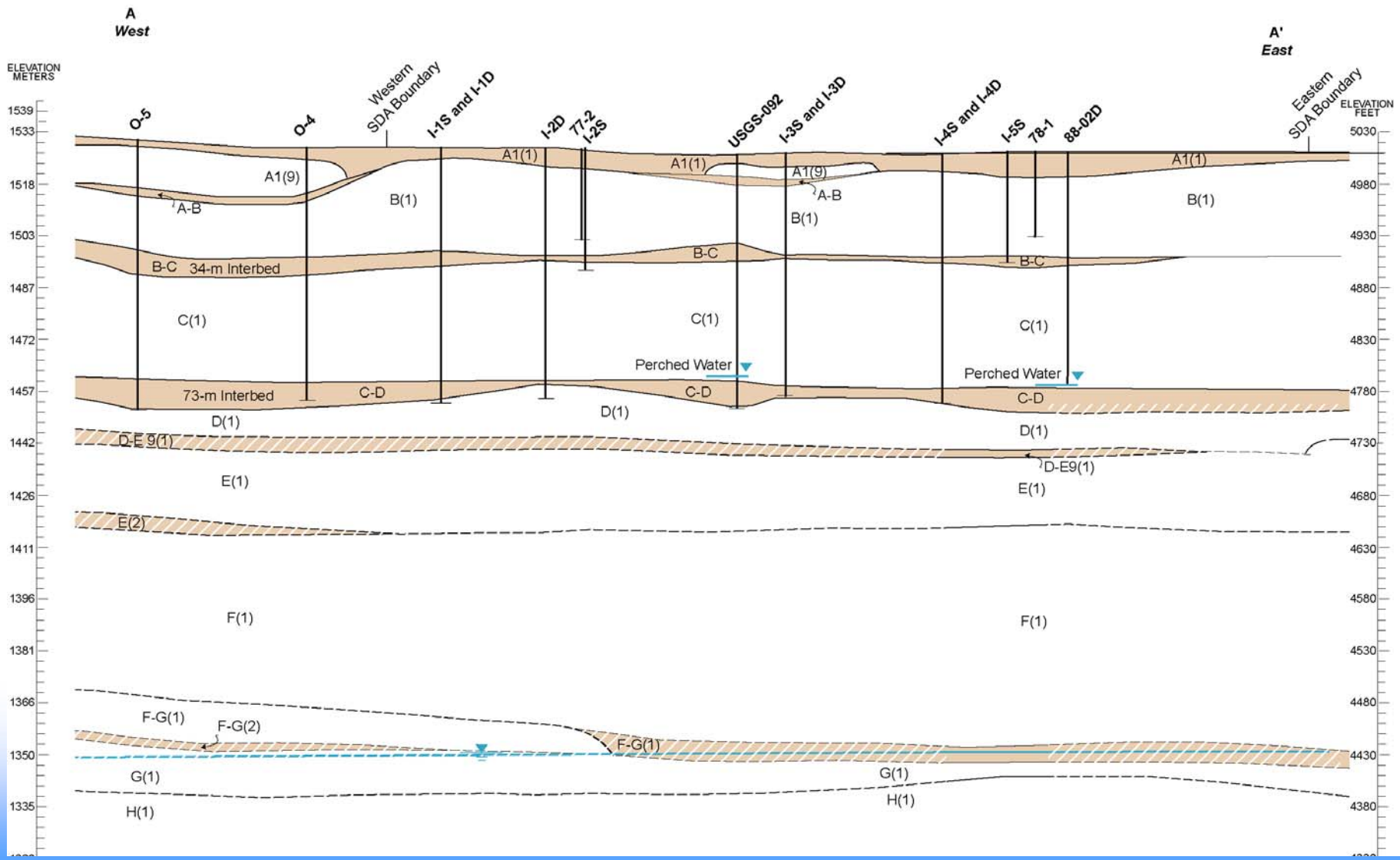
Key Elements of the Aquifer Conceptual Model

- *Groundwater flow predominantly in fractured interflow zones*
- *Interflow zones highly transmissive, massive flow interiors are not*
- *Large-scale heterogeneity*
- *Highly layered anisotropic flow at all scales*
- *Flow and transport affected by presence of sedimentary interbeds*
- *Flow and transport affected by rift zone features*

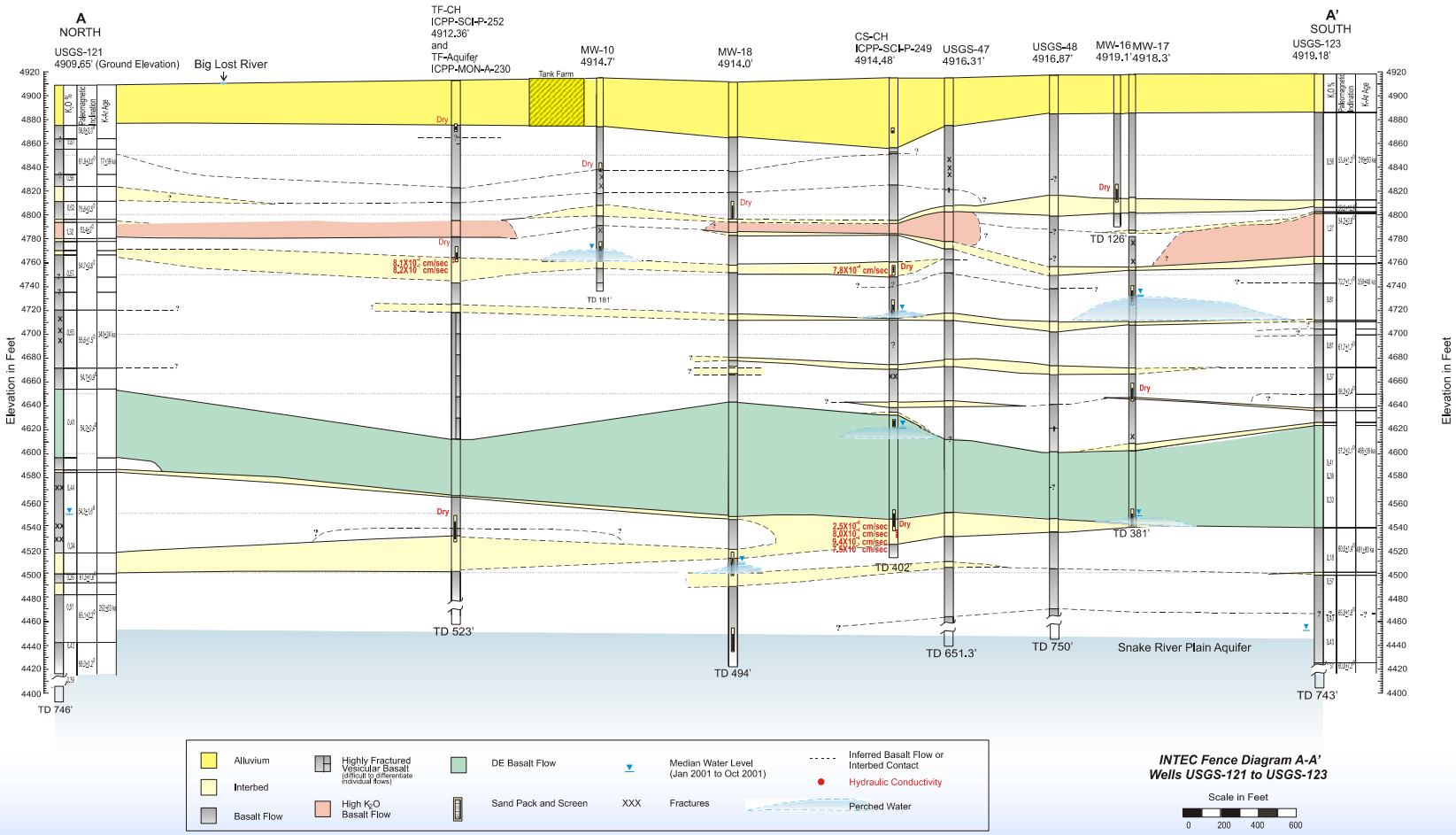
Stratigraphy

- Based on wells/interpretation
- Surface sediments vary in thickness
- Interbeds deposited during periods of volcanic quiesence
- Sub-horizontal, variable topography, variable length

SDA Stratigraphy



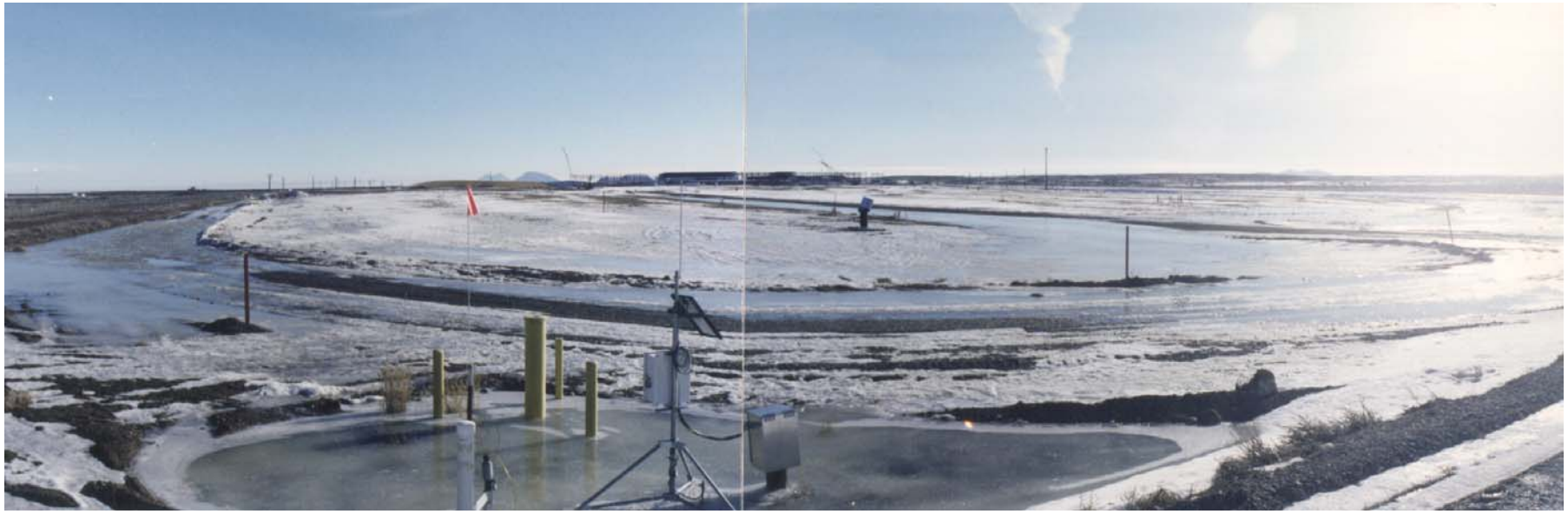
INTEC Stratigraphy



Sources of Water Impacting Subsurface

- Infiltration
  - Direct precipitation/snowmelt
  - Anthropogenic sources
    - Process water
    - Discharge to ponds
  - Big Lost River
    - Channel loss
    - Spreading area discharge

SDA Spring 1995



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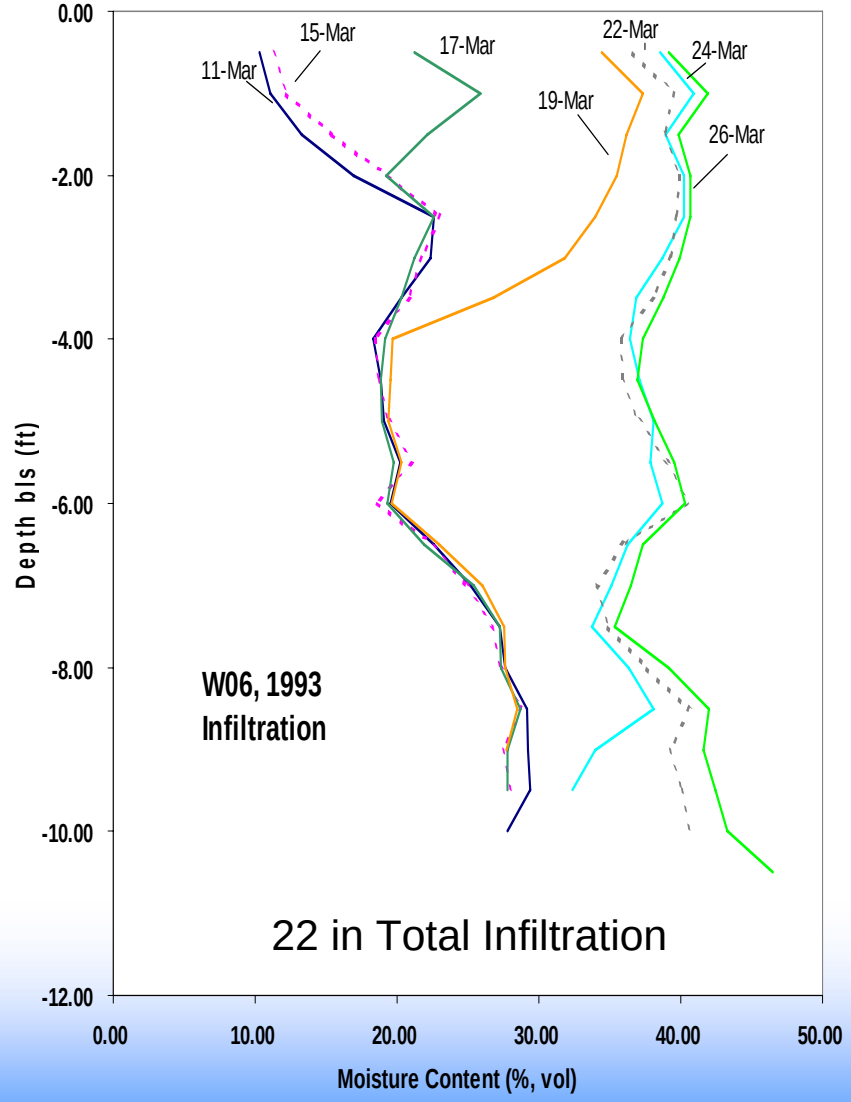
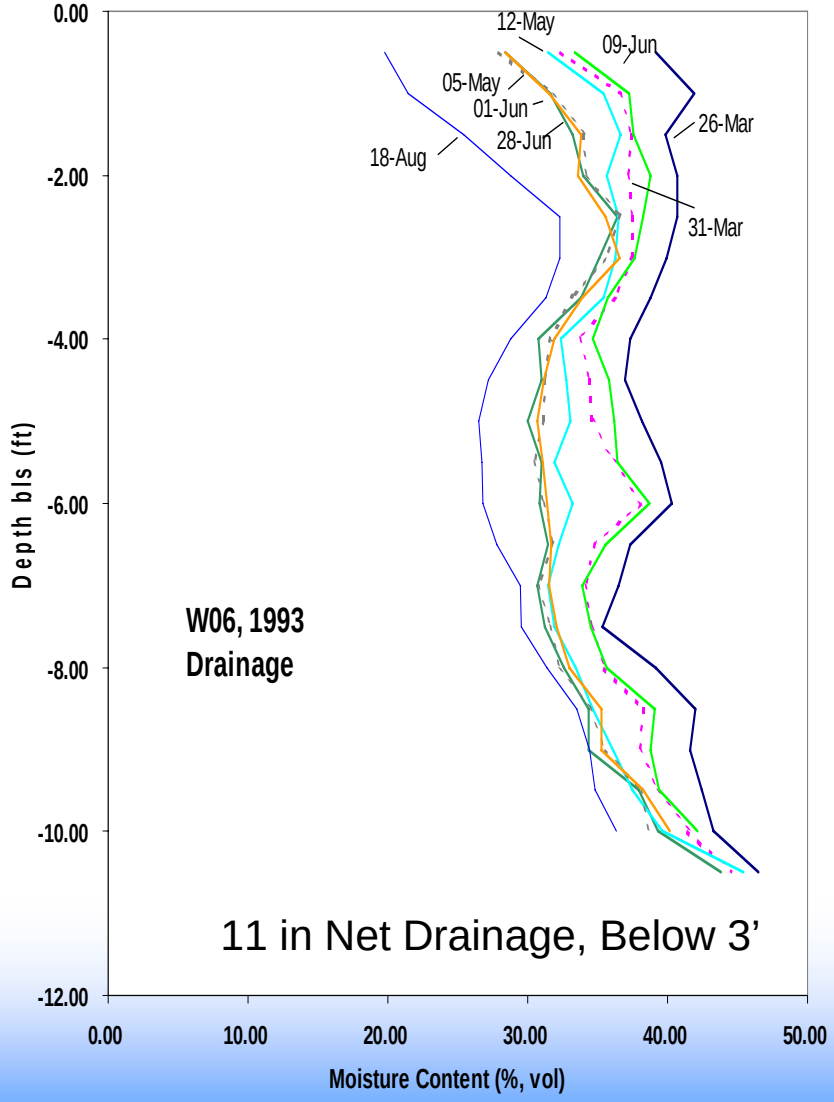
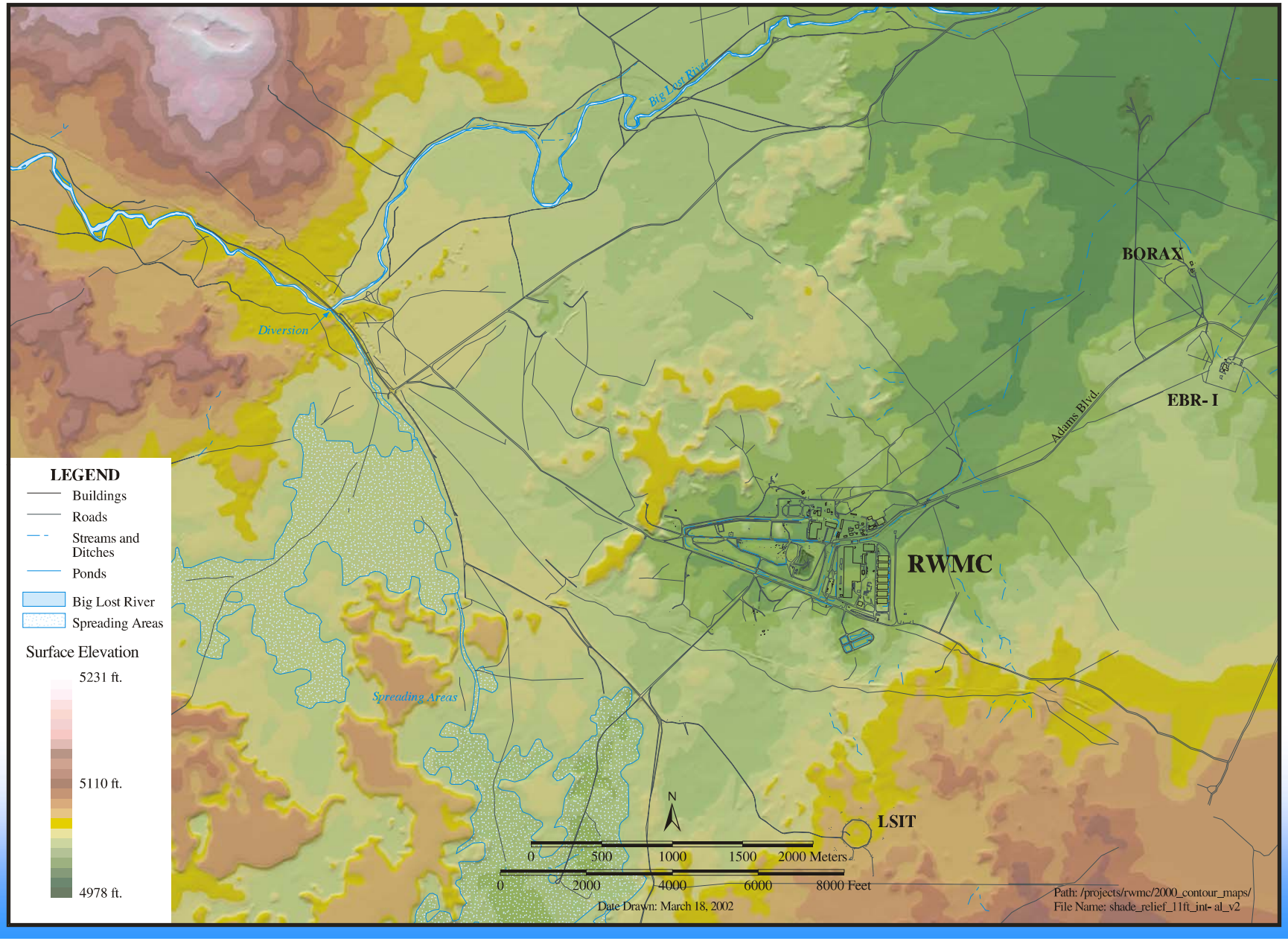
NAT Moisture Monitoring

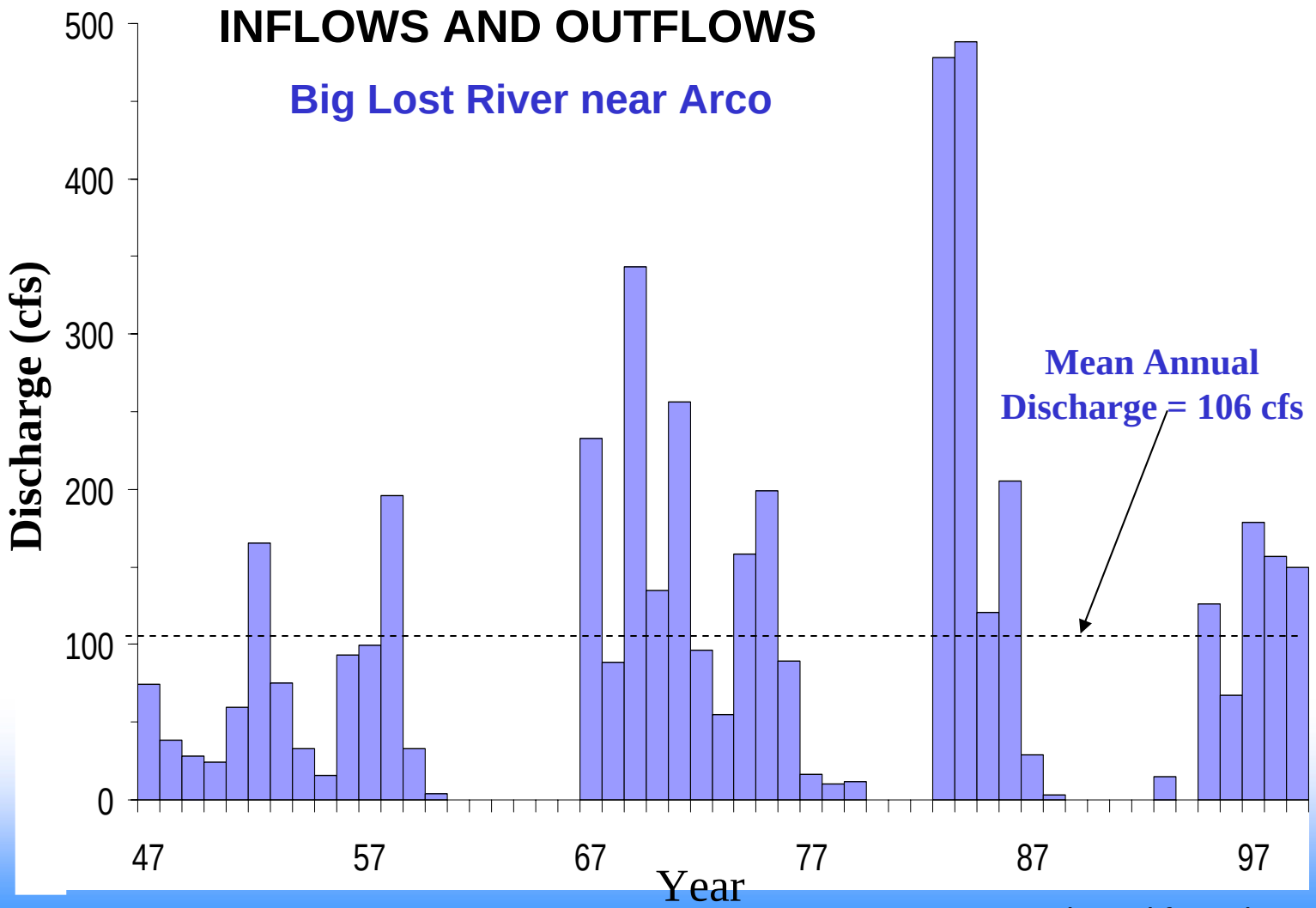
McElroy (1993)





Spreading Areas



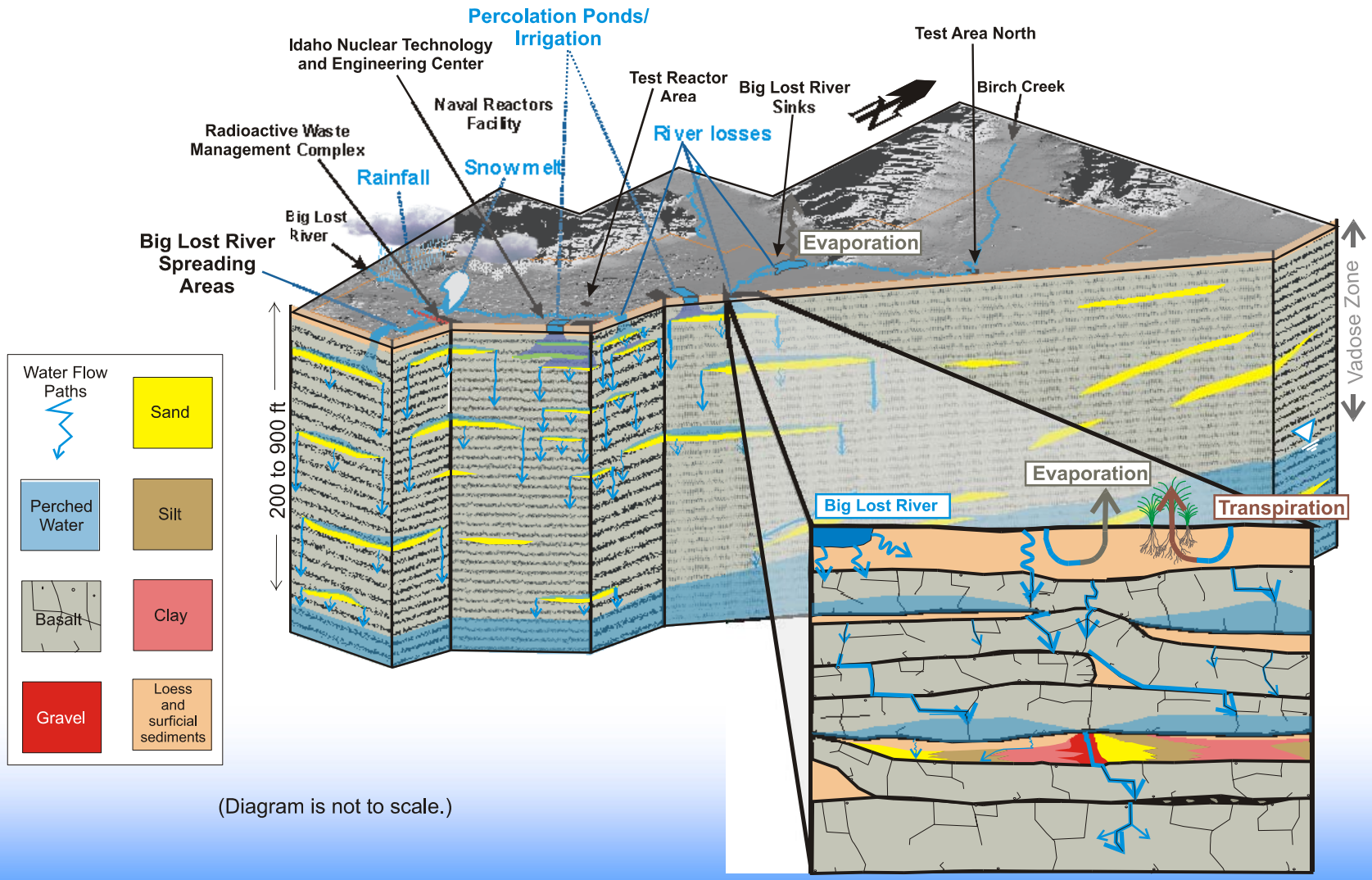


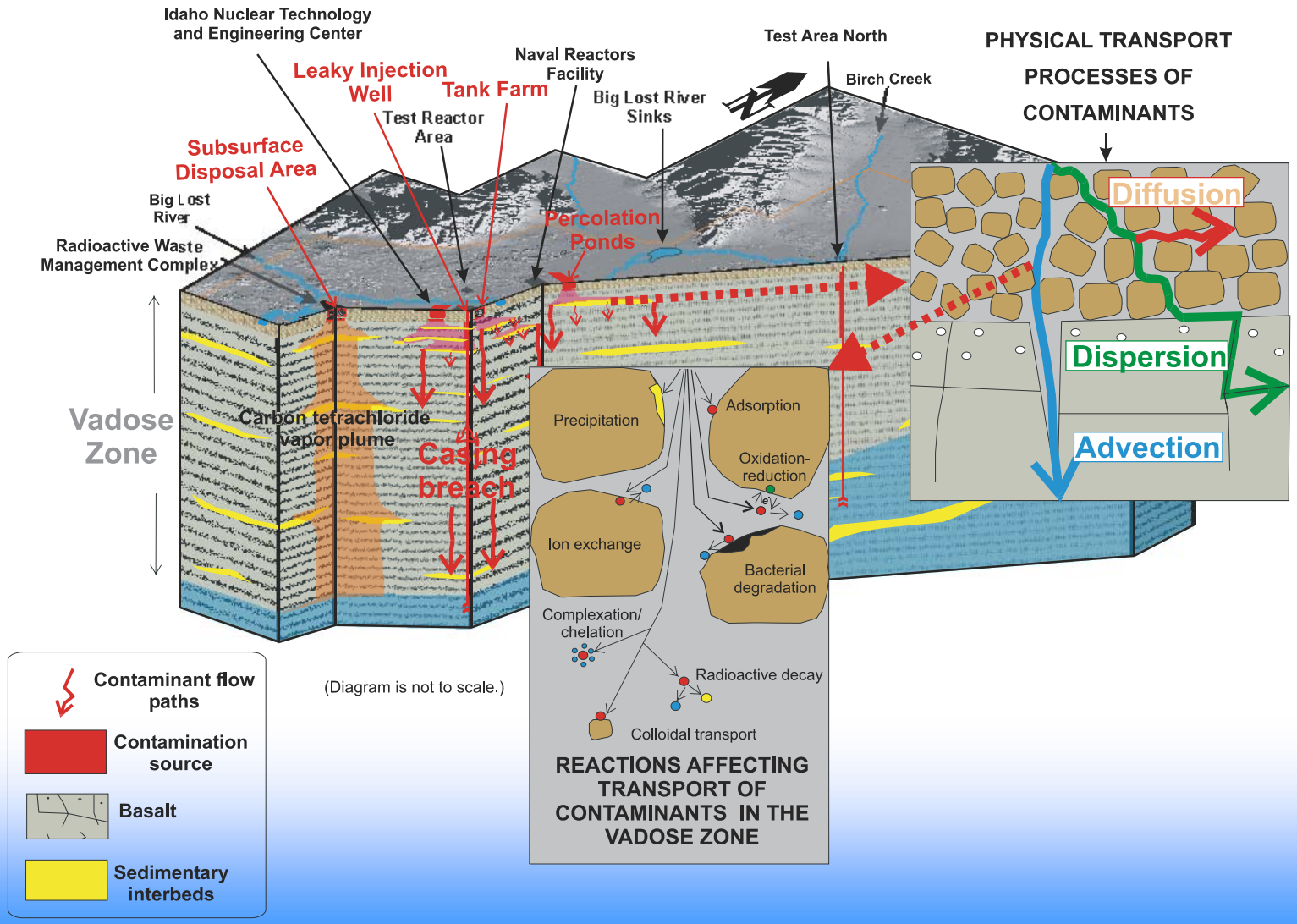
Adapted from the USGS

Direct Monitoring in Vadose Zone Investigations Provides Evidence for Water and Tracer Movement

- *Perched water and advanced tensiometer networks at facilities*
- *Large-scale Infiltration Test (1994)*
- *USGS Tracer Test (1999)*

Vadose Zone Conceptual Model



(Diagram is not to scale.)

Vadose Zone Transport Conceptual Model