Local versus Regional Approach in Fractured-Rock Studies: Lawrenceville, Georgia, and North Carolina Piedmont/Mountains Studies

Melinda Chapman
Ground-Water Specialist
USGS Raleigh, North Carolina
mjchap@usgs.gov

USGS
science for a changing world

DIVISION OF WATER QUALITY
DWQ

Lawrenceville, Georgia Study

-initiated in 1995 - ongoing

-Focus: GW supply/exploration

---Hydrogeo setting of fracture zones

-- Study area 44 sq. mi

---2000 exploration -4 sq miles

---Current USGS test-well drilling ongoing

Lawrenceville Study - Approach

- Surface geologic mapping- basis for subsurface correlation
- Well inventory – yield/construction data
- Extensive borehole geophysics – fracture delineation and orientation
- Ground-water-level monitoring

  --response to br aquifer pumpage
- Recent – gw exploration activities
  - Geologic mapping
  - 2D resistivity surveys
  - Test-well drilling

Well Characterization

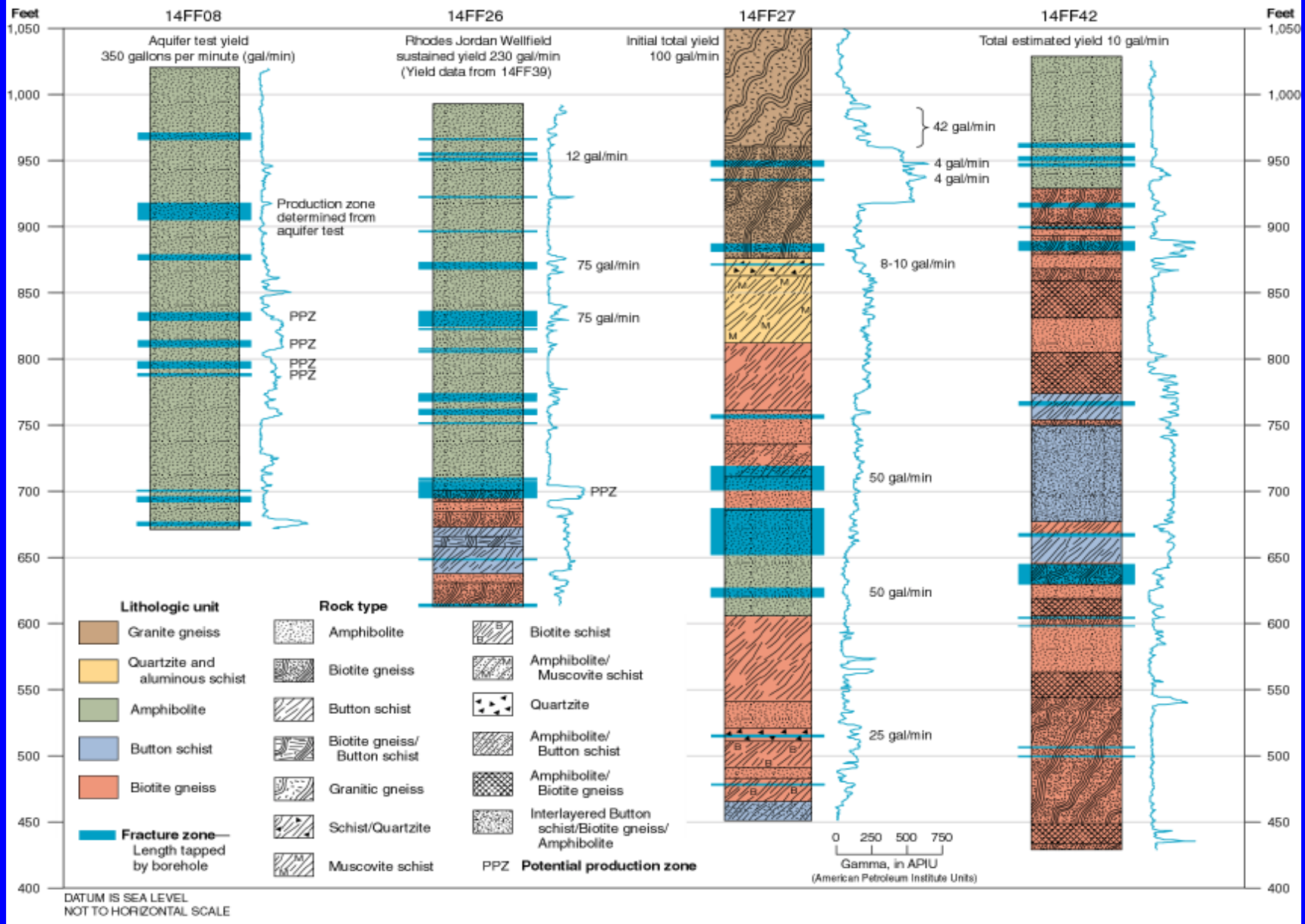
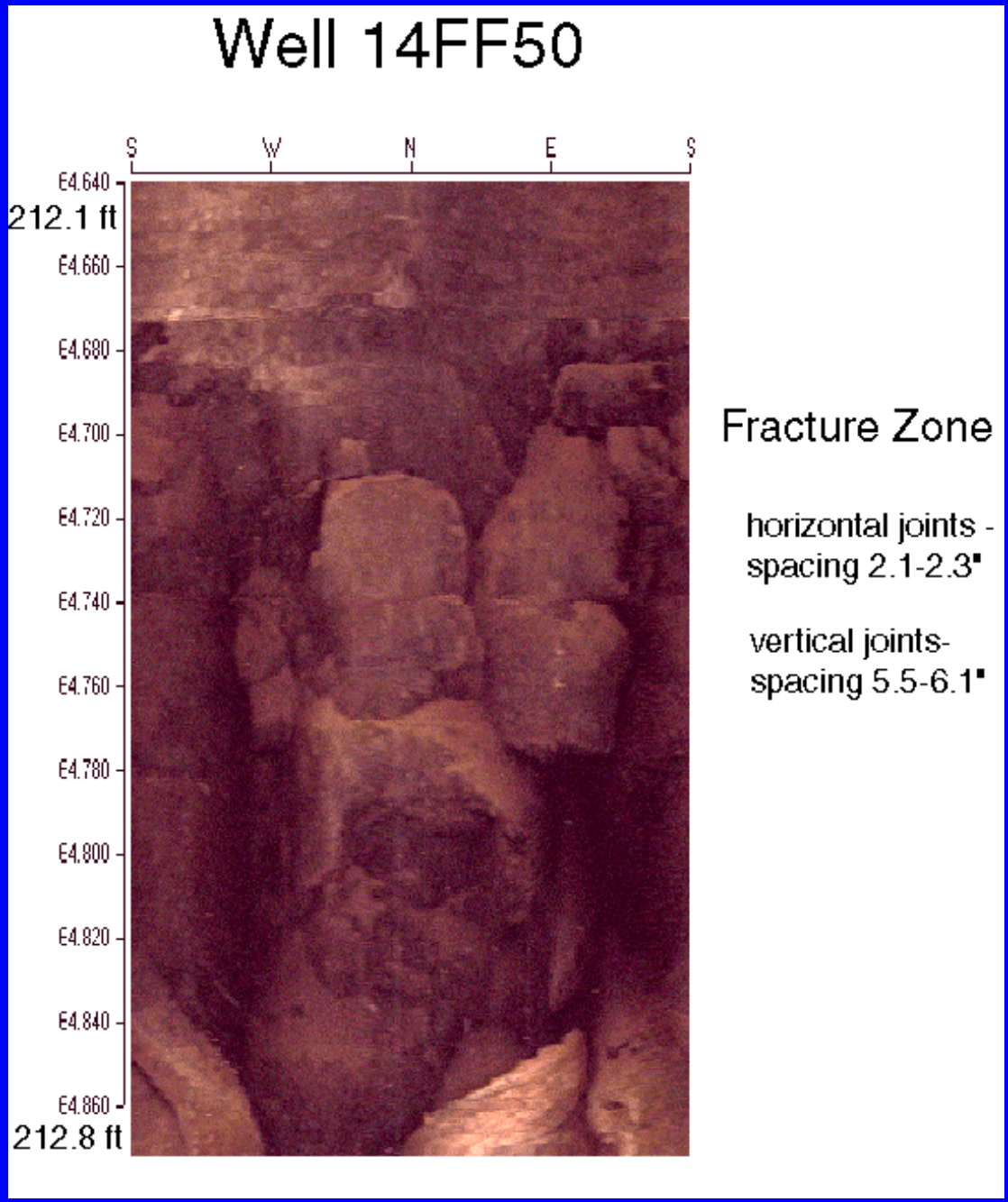
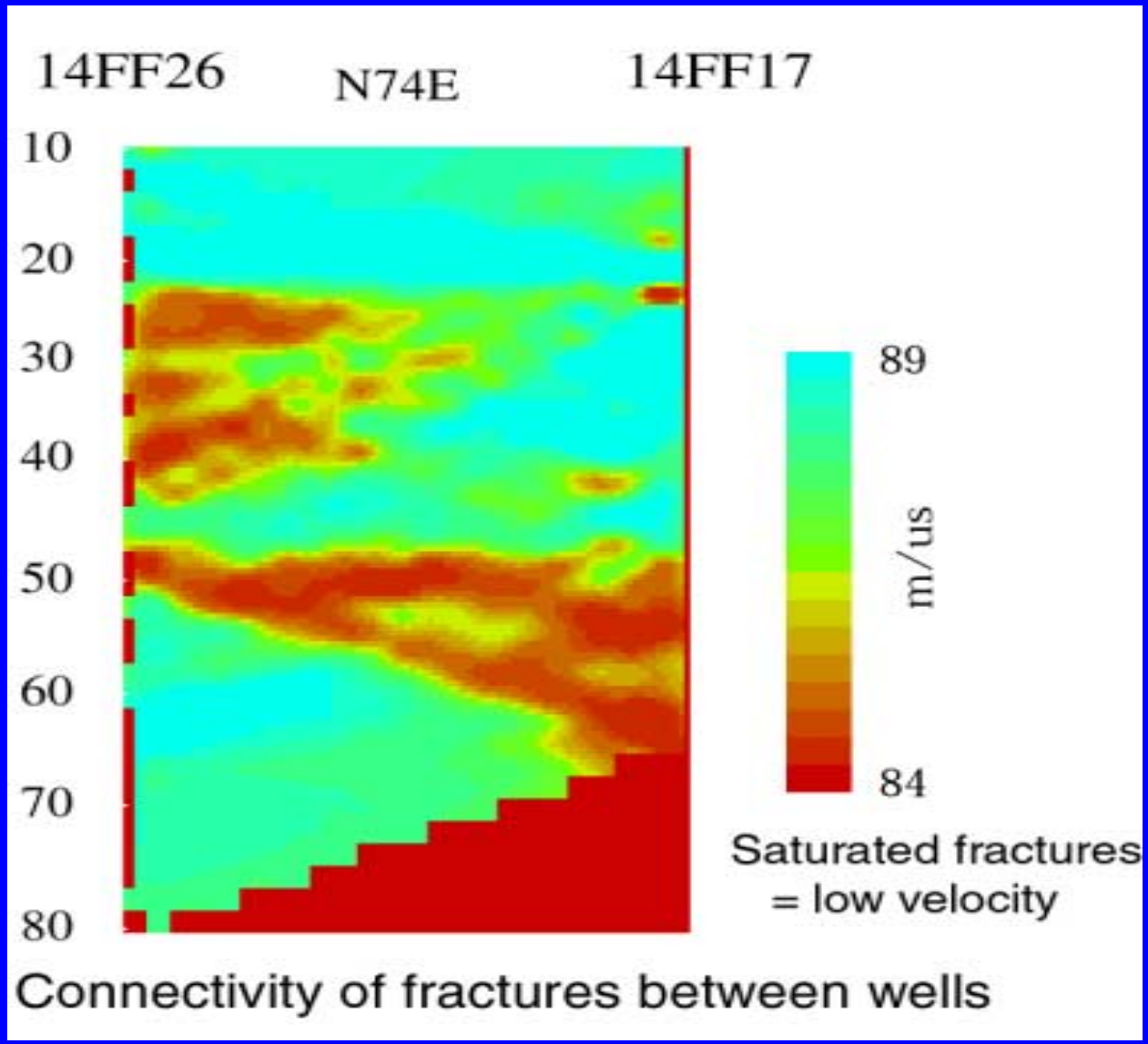


Figure 2. Subsurface lithologic characteristics and fractures tapped by wells 14FF08, 14FF26, 14FF27, and 14FF42. Fracture zones interpreted from well 14FF26 and 14FF42.



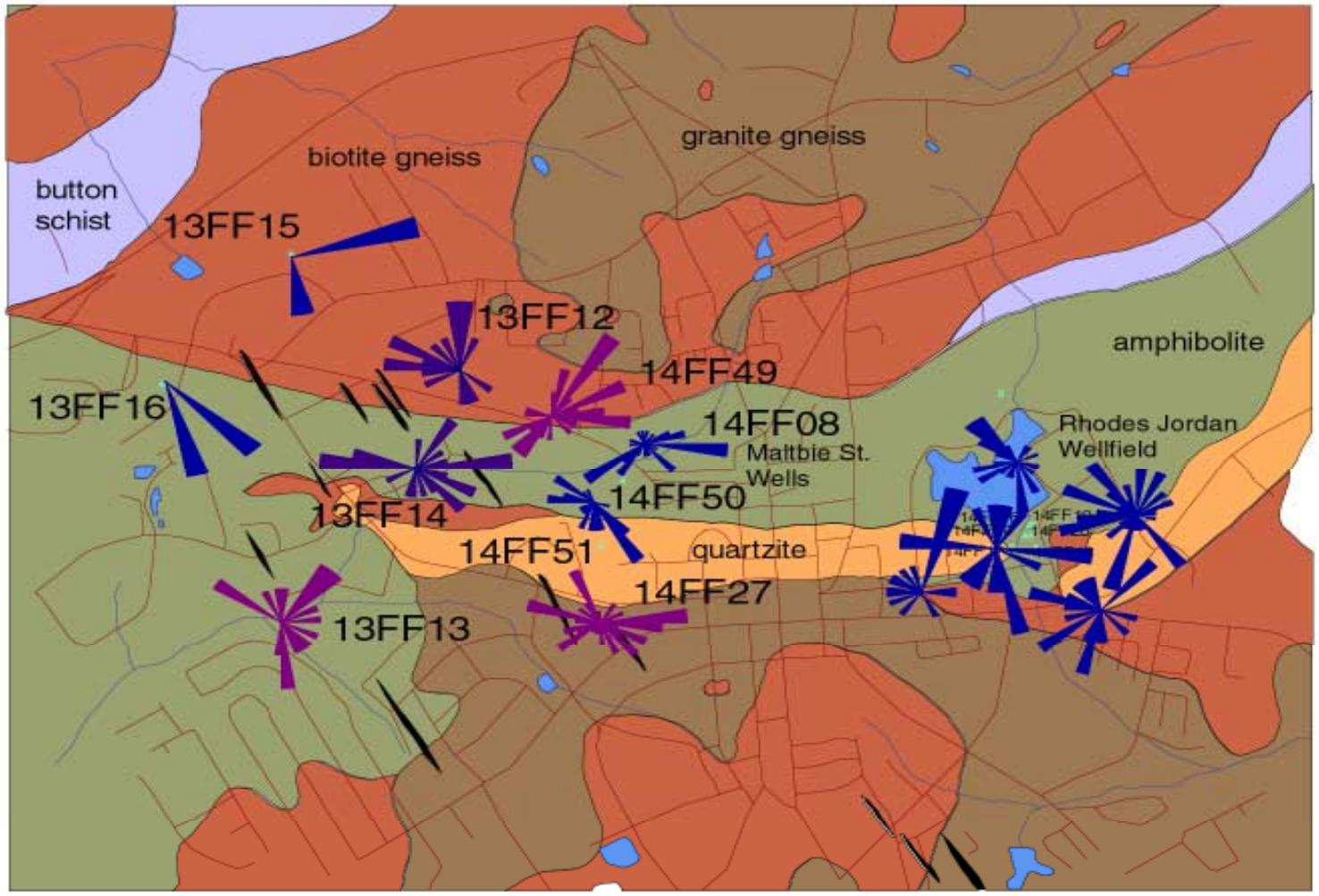
Maltbie St. Well – At least 2-3 fracture sets w/in the 212 ft production zone

Borehole Radar Tomography



Well Name	Yield (gpm)	Fractures (ft bls)	Geologic setting
RJWF	350	130,175, 300	1) w/in amp.; 2) contact- a/bg
Maltbie St	300+	100,230	Contacts: a/bs & a/bg
York Casket	150	130, 210	Contacts: bg/bs & a/bg
Pike Blvd	150+	270	Contact: bg/a
Knollwood Apts	100+	220	w/in amp.
K-mart	200	200	Contact: bg/bs
Chick-fil-A	75	200	Contact: bg/bs

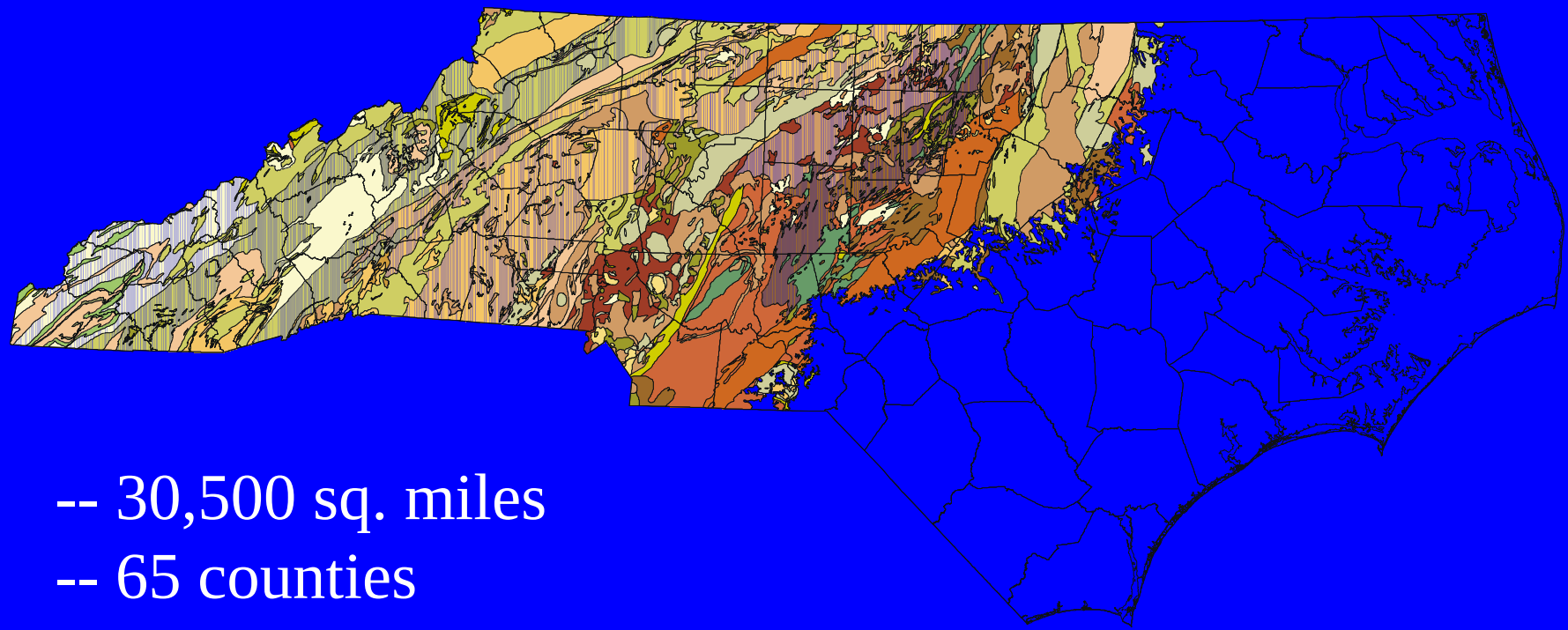
Regional Fracture Strike



Quality and Availability of Ground Water in Piedmont and Mountains

- Major initiative for State Cooperator - DWQ
- Controls affecting ground water quality and flow on local scale
- GW/SW interactions
- Availability and sustainability of resource
- Transferability of local-scale project data to regional scale

NC Piedmont/Mtns Regional Study Area



-- 30,500 sq. miles
-- 65 counties
-- Regional geologic formations and hydrogeologic terranes

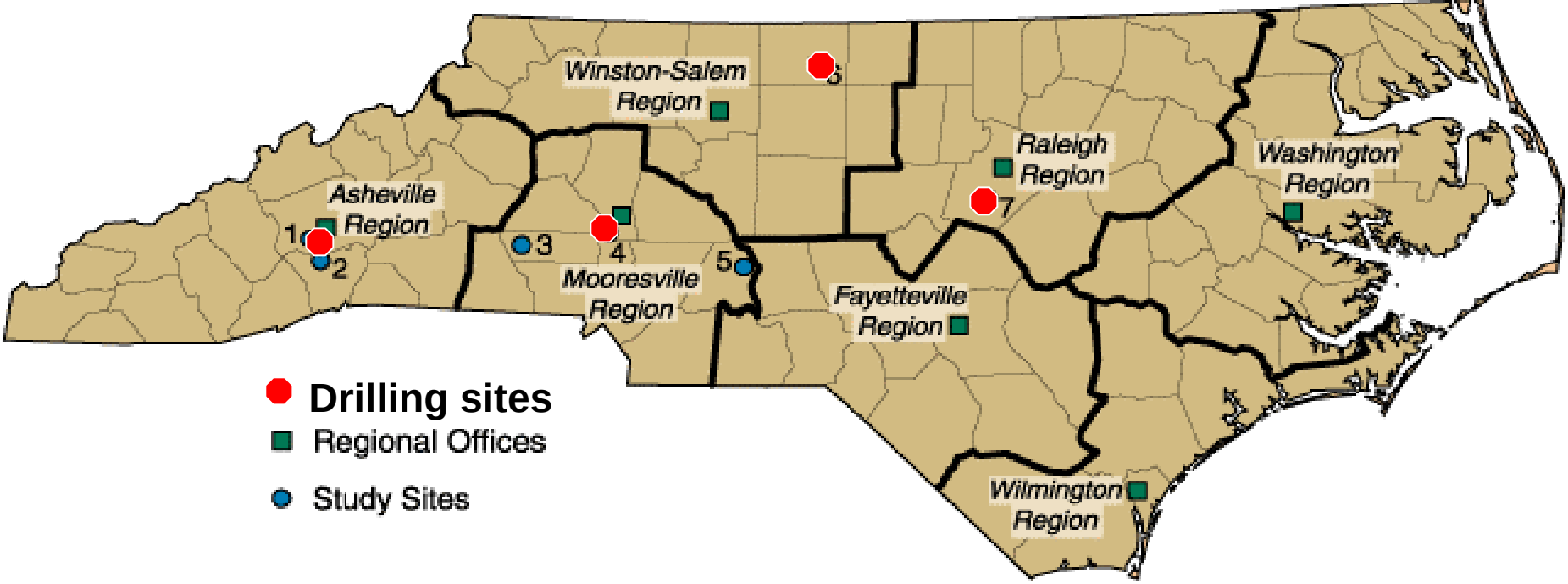
Local scale “Type Area” studies – few 10’s acres to watershed scale

Project Personnel & Technical Advisory Team

- DWQ hydrogeologists/drillers and USGS hydrologists working together - team approach - field work/monthly meetings
- GD BRASS -- surface geologic mapping - lithologies, fractures
- USGS Scientific advisory group - Regional GW Spec., NRP, BGAS, other SE/NE region fractured-rock hydrologists

Plan of Action

- 4 “type areas” identified for intensive, local research; drilling has begun at all 4 sites
- Characterize type areas. Conduct applied fractured-rock research: borehole/surface geophysics; geochemistry/age dating/isotope work for flowpath analyses; open-hole vs. packer measurements – vert. gradients/gwq
- Establish long-term research stations - collect ambient ground-water levels & quality
- Transfer “type area” findings to regional scale



Map#	Potential Study Site	County	DENR Region
1	Bent Creek Demonstration Forest	Buncombe	Asheville
2	NCSU Mountain Horticultural Crops Research Station	Henderson	Asheville
3	Indian Creek Basin	Lincoln	Mooresville
4	Langtree Peninsula at Lake Norman	Iredell	Mooresville
5	Morrow Mountain State Park	Stanly	Mooresville
6	NCSU Upper Piedmont Agricultural Research Station	Rockingham	Winston-Salem
7	National Training center for Land-Based Technology and Watershed Protection (Located at the NCSU Lake Wheeler Field Research Laboratory)	Wake	Raleigh

Research Station study site selection

- Characteristics of representative hydrogeologic units and geologic formations in variable topographic settings
- Evaluate weak/strong - low angle/vertical foliation affects on the development of the transition zone and fracture system
- Depth of weathering/topographic setting
- Basin/sub-basin approach where accessible; gw contribution to sw

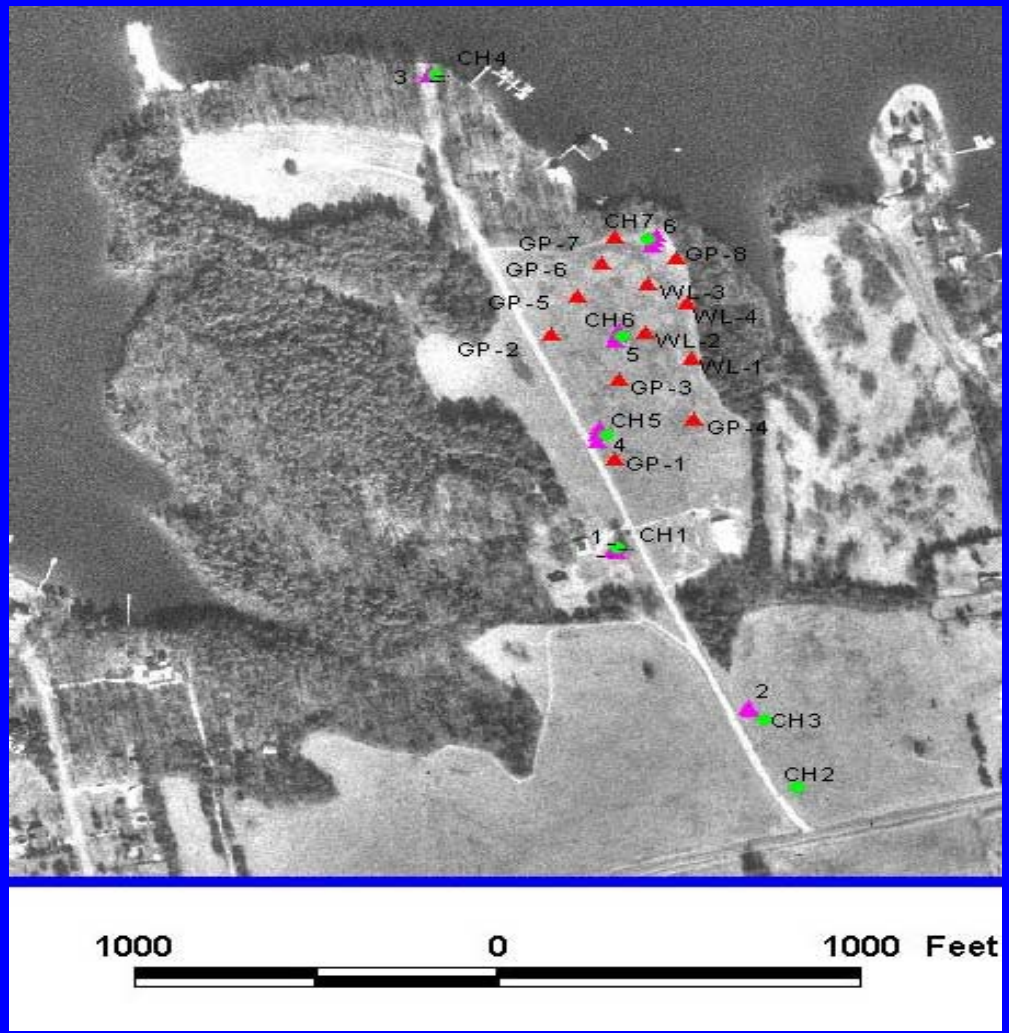
USGS

Type Area Approach

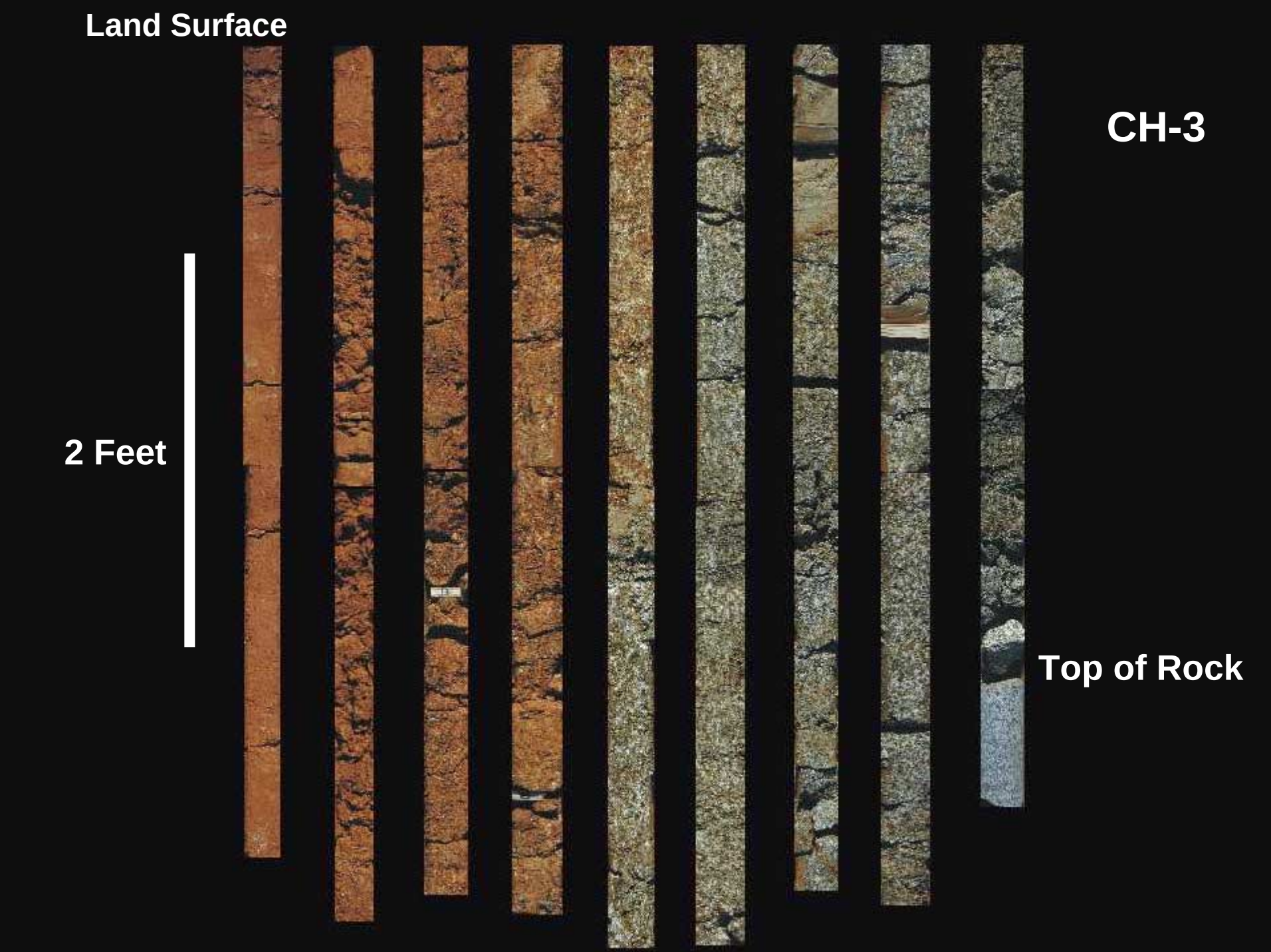
- Study site selected; drilling access obtained
- Local surface geologic mapping - lithologies/fractures (GD)
- Surface geophysical surveys - 2D resistivity, square array resistivity, other methods?
- Drilling sites selected - topo high to low setting; conceptual shallow flow path
- Continuous core collected through regolith, transition zone, and bedrock (200 ft)
- Install clustered wells into 3 zones
- DCP platform installed – gwl/gwq monitoring @ 1 cluster/site; gage site if avail.
- Ground-water sampling - major ions, metals, isotopes, age-dating

USGS

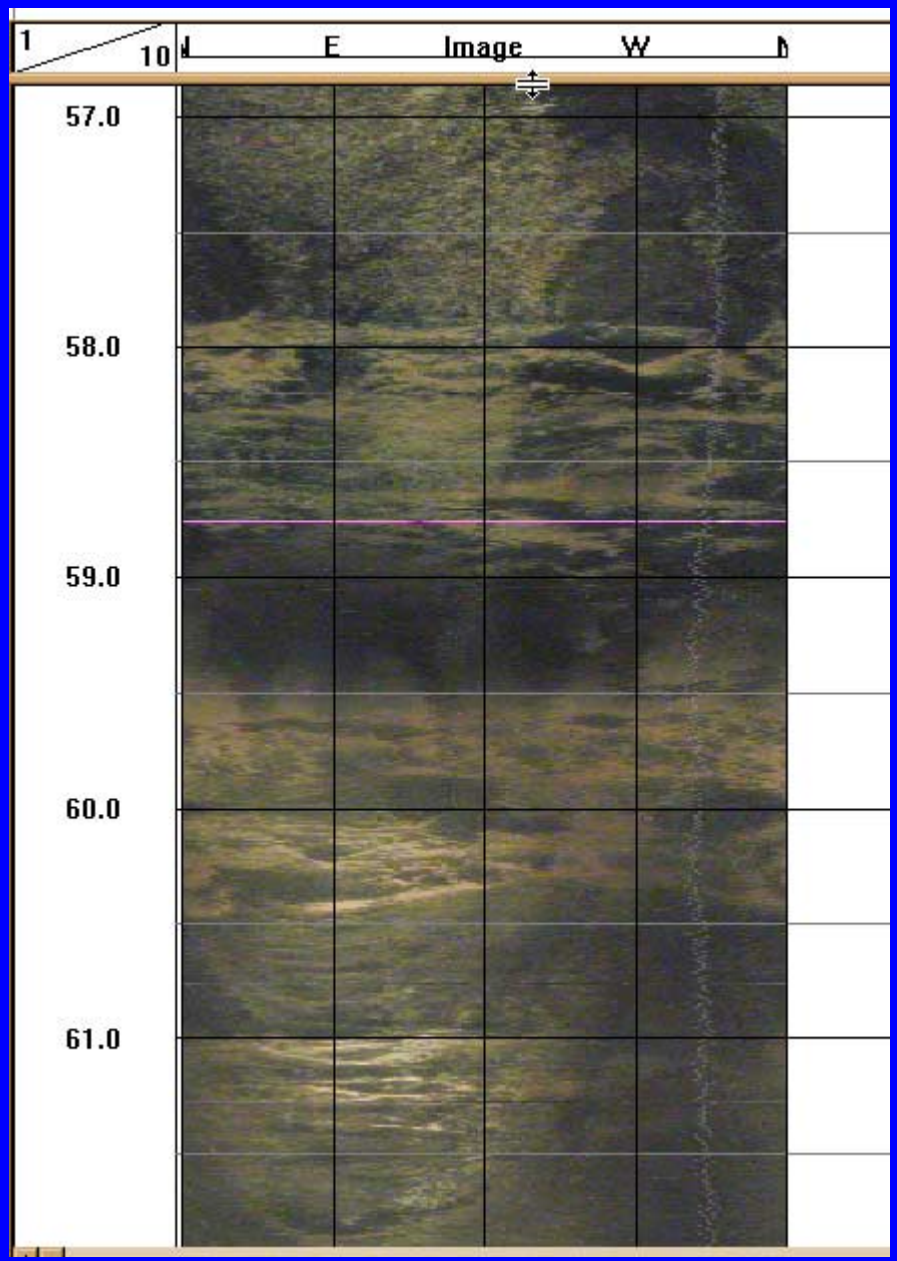
Langtree Peninsula Research Site



- 20 acre study site- 2,000 ft & 750 ft flow scales
- 6 well clusters (3 wells each) - regolith, transition zone, bedrock - 18 wells total—(3 br wells collapsed)
- 12 shallow regolith wells - grid layout


Land Surface
CH-3
2 Feet
Top of Rock

Ft bls



Langtree MW-1D
59 ft fracture

Quartz Diorite bedrock

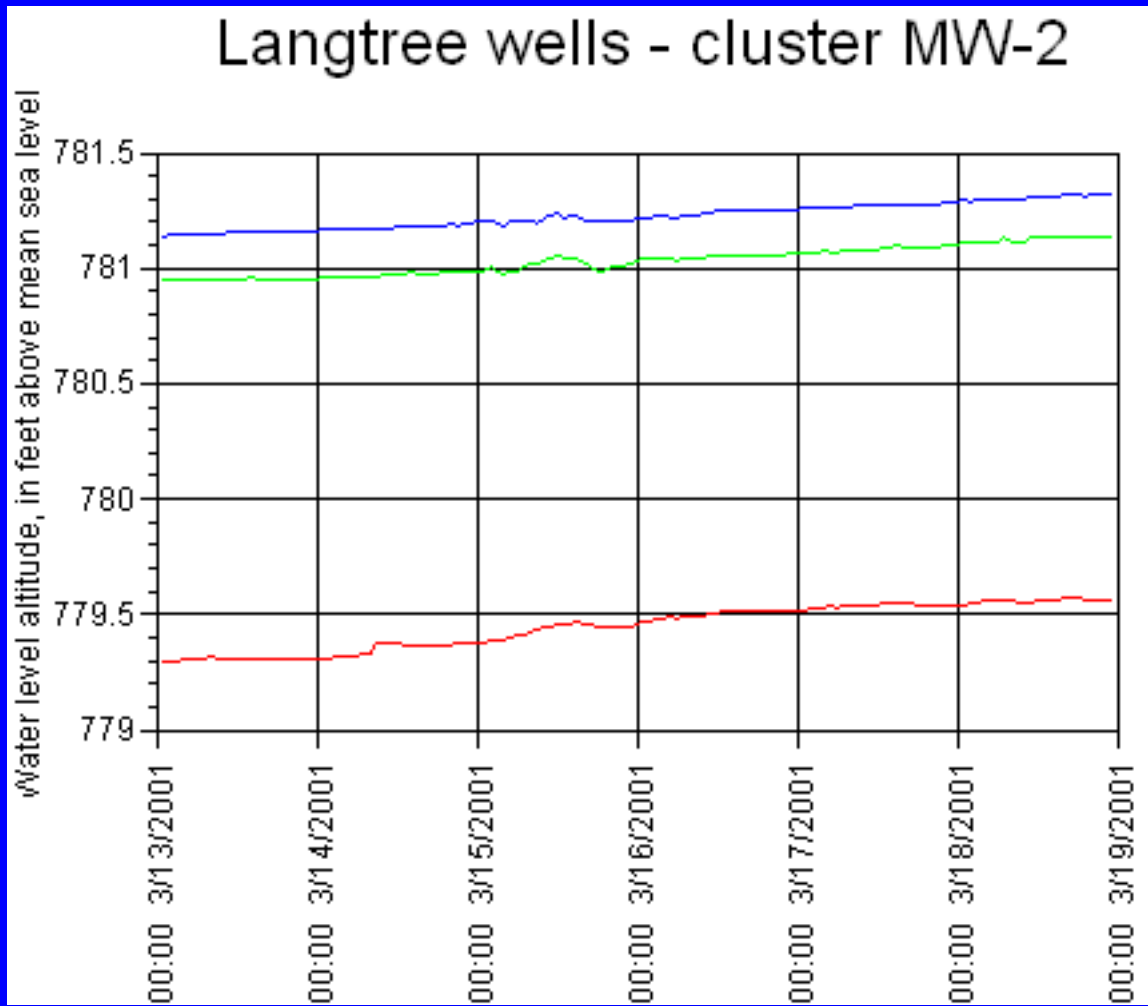
ALT Obi40 image

Langtree Data

- Quartz Diorite bedrock - weak foliation; variable depth of weathering - 30-80 ft;
- Fractures - few shallow stress-relief; small fractures delineated up to 500 ft; low (3 gpm) to medium (50 gpm) air-lift yields
- Transition zone delineation difficult – >screen lengths
- Bedrock well completion problems -- probable surface seal failure – (no mud/grout used); prob. solved at Lake Wheeler site

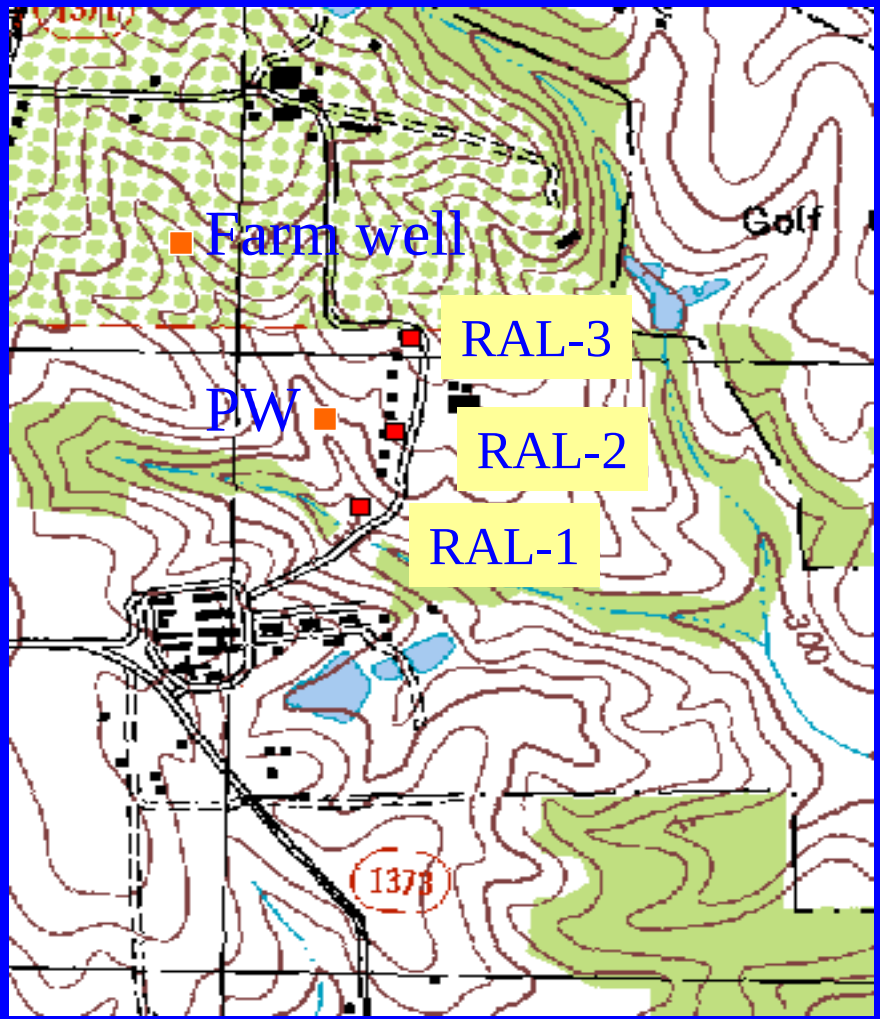
  --well remediation planned

Real-time DCP GWL data



MW-4, -5 clusters- similar vertical gradients (short interval recorded), Downward regolith>trans.>br;

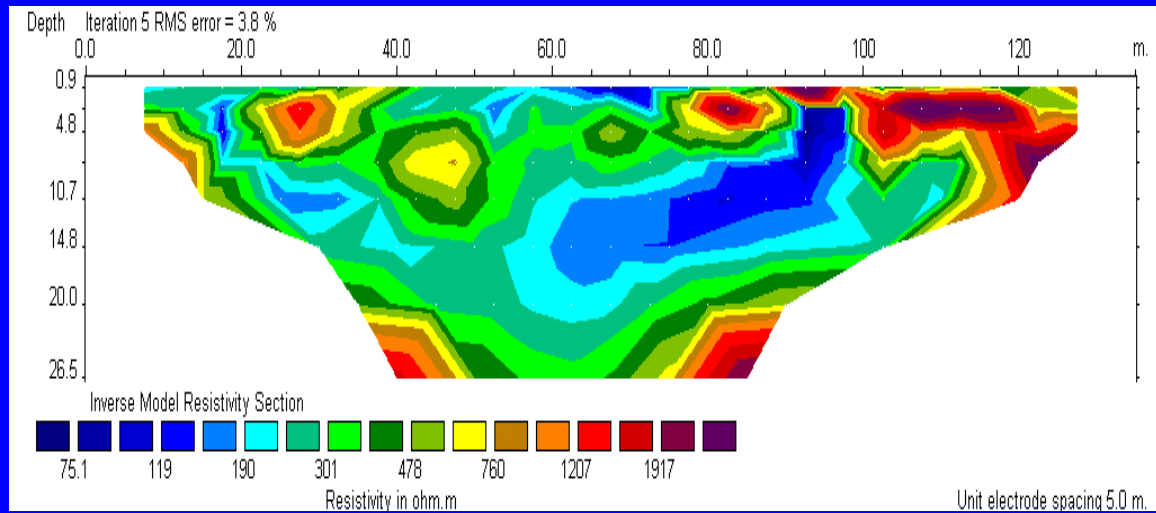
Lake Wheeler Research Site



- 3 well clusters (3-4 wells each) +

  br pumping well drilled
- DCP will include continuous WQ monitoring in 3 zones
- Raleigh Gneiss – vertical foliation – shallow and deep fractures

Reidsville Research Site

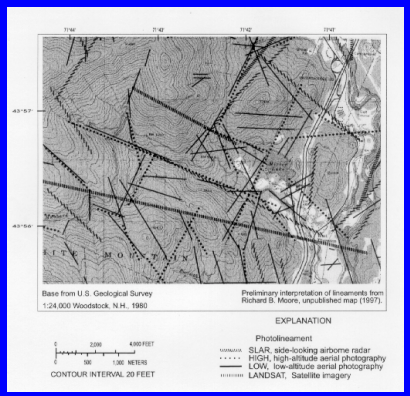


--Highly fractured granite gneiss

-- Geologic controls to be evaluated:

- dip slope vs. cut slope (foliation)

Remote Sensing



Surface Geophysics

Geologic Mapping

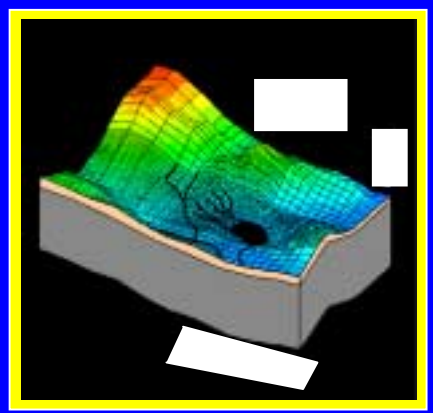
Fracture Mapping

Regional Hydrology

Borehole Geophysics

Geochemistry

Ground-Water Modeling



Hydrologic Testing