Use of multiple tracers and geochemical modeling to assess vulnerability of a public supply well in the karstic Floridan aquifer

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Fifth National Monitoring Conference
May 8-11, 2006
San Jose, CA

U.S. Department of the Interior
U.S. Geological Survey

Take Home Messages

- *Public supply well in the karstic Floridan aquifer system is highly vulnerable to contamination due to short circuiting of water from surficial material through a highly transmissive zone in the limestone.*

- *Mixing of water in the PSW from the surficial and Floridan aquifers results in elevated concentrations of pesticides, VOCs, nitrate, radon, arsenic and uranium, compared to monitoring wells in the Floridan aquifer.*

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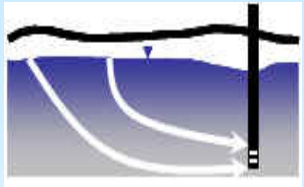
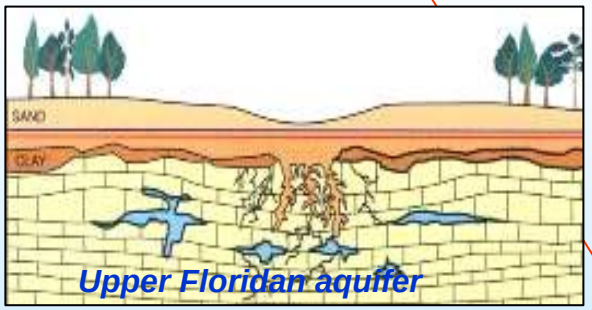
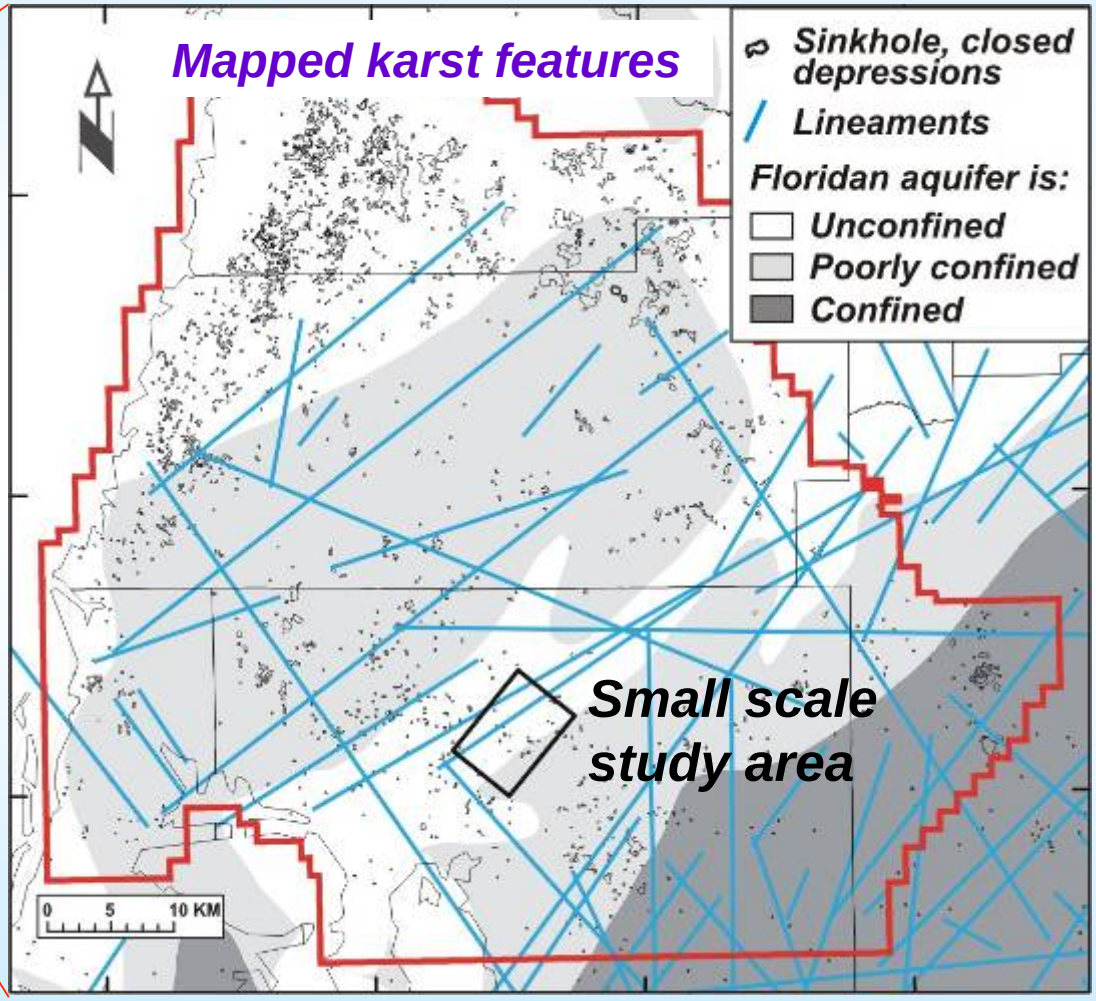
Floridan Aquifer System- Highly Susceptible to Contamination



Tampa, FL





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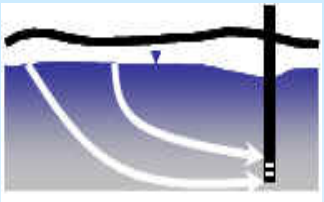
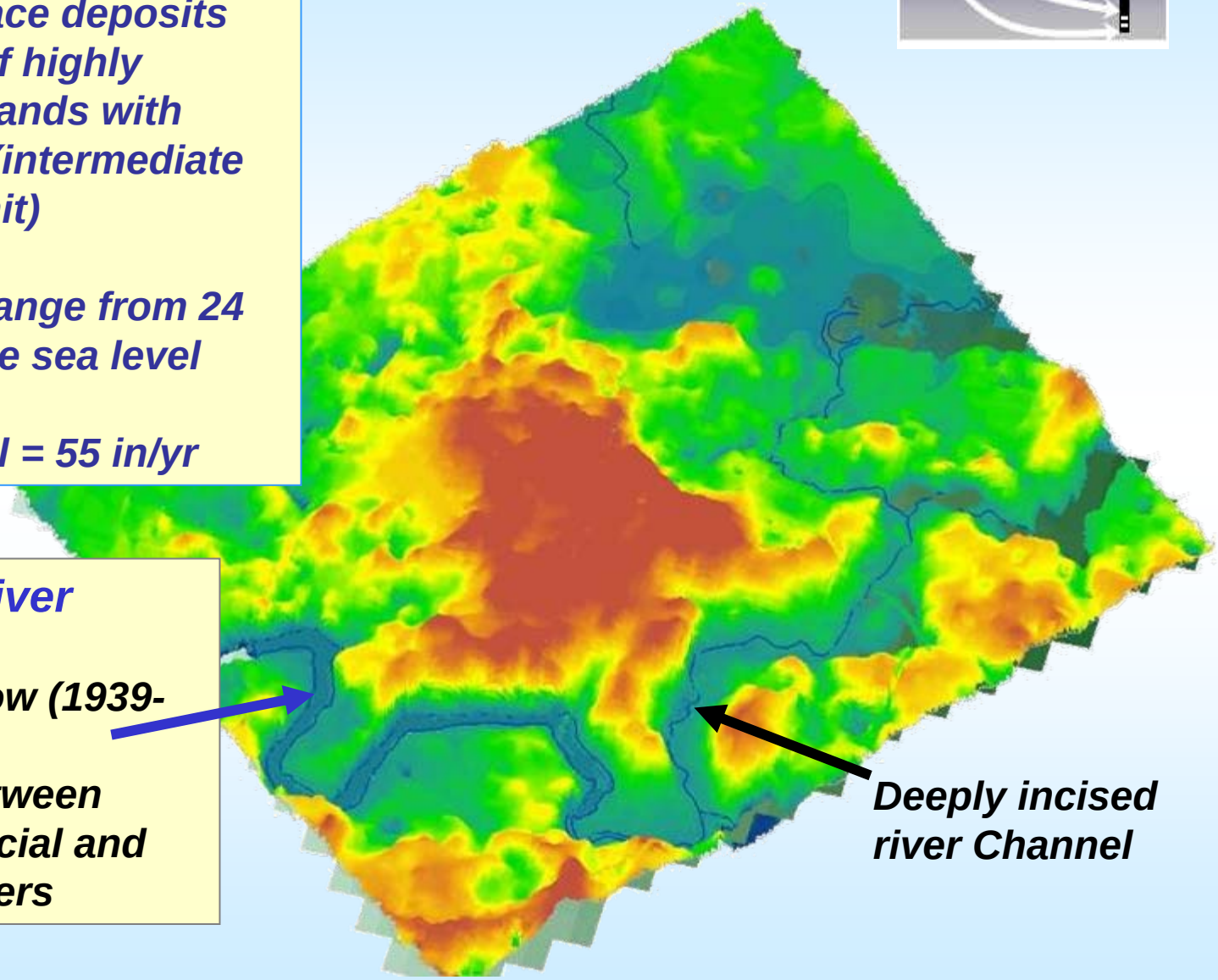
Highly Permeable Surficial material



- *Marine Terrace deposits consisting of highly permeable sands with some clays (intermediate confining unit)*
- *Elevations range from 24 to 80 ft above sea level*
- *Mean rainfall = 55 in/yr*



Hillsborough River

- ***Mean annual flow (1939-2000): 450 cfs***
- ***Interactions between river and surficial and Floridan aquifers***

Deeply incised river Channel

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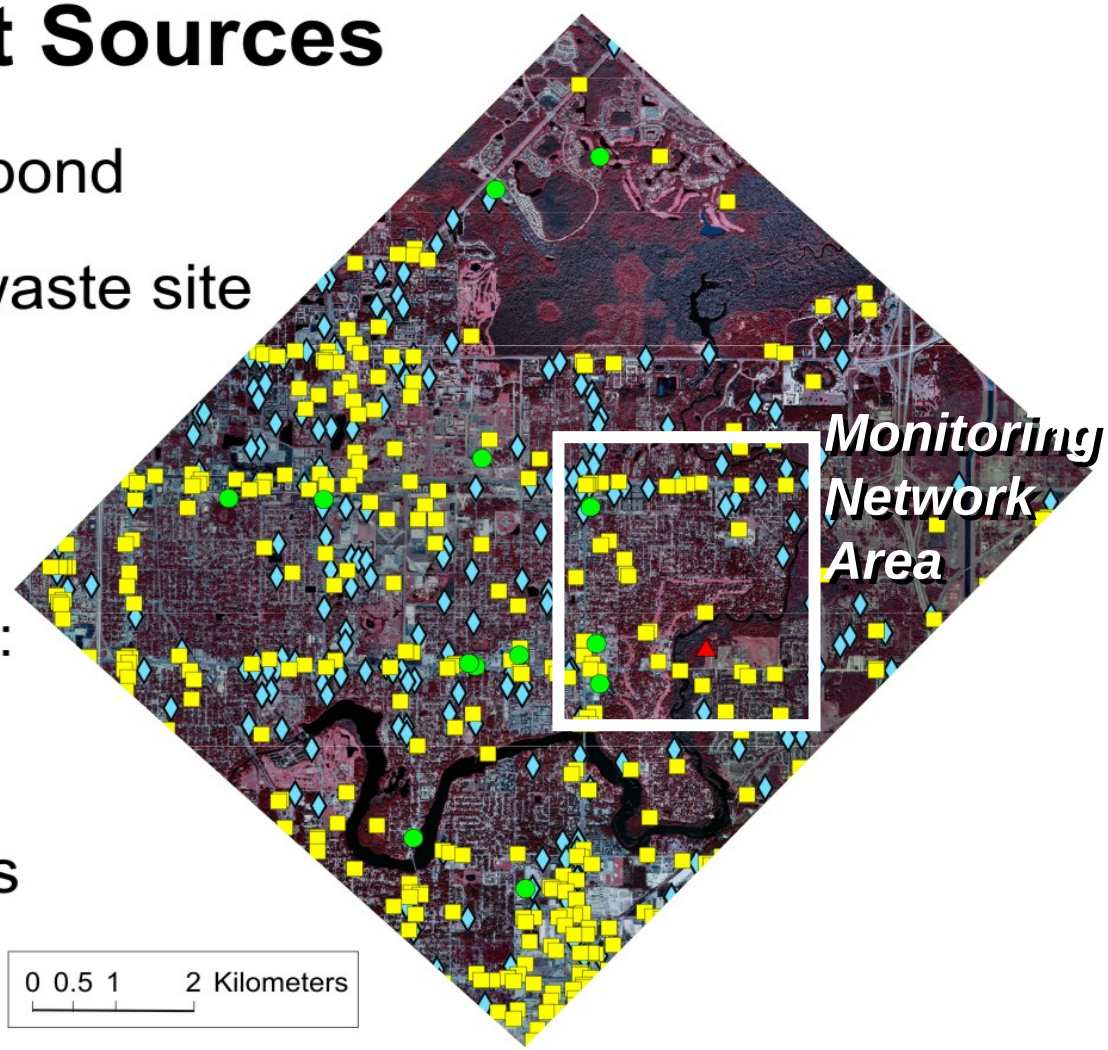
Vulnerability of ground water to contamination

Contaminant Sources

- Stormwater pond
- Hazardous waste site
- (L)UST sites
- Drycleaners

Chemicals applied to:

- Golf Courses
- Residential lawns



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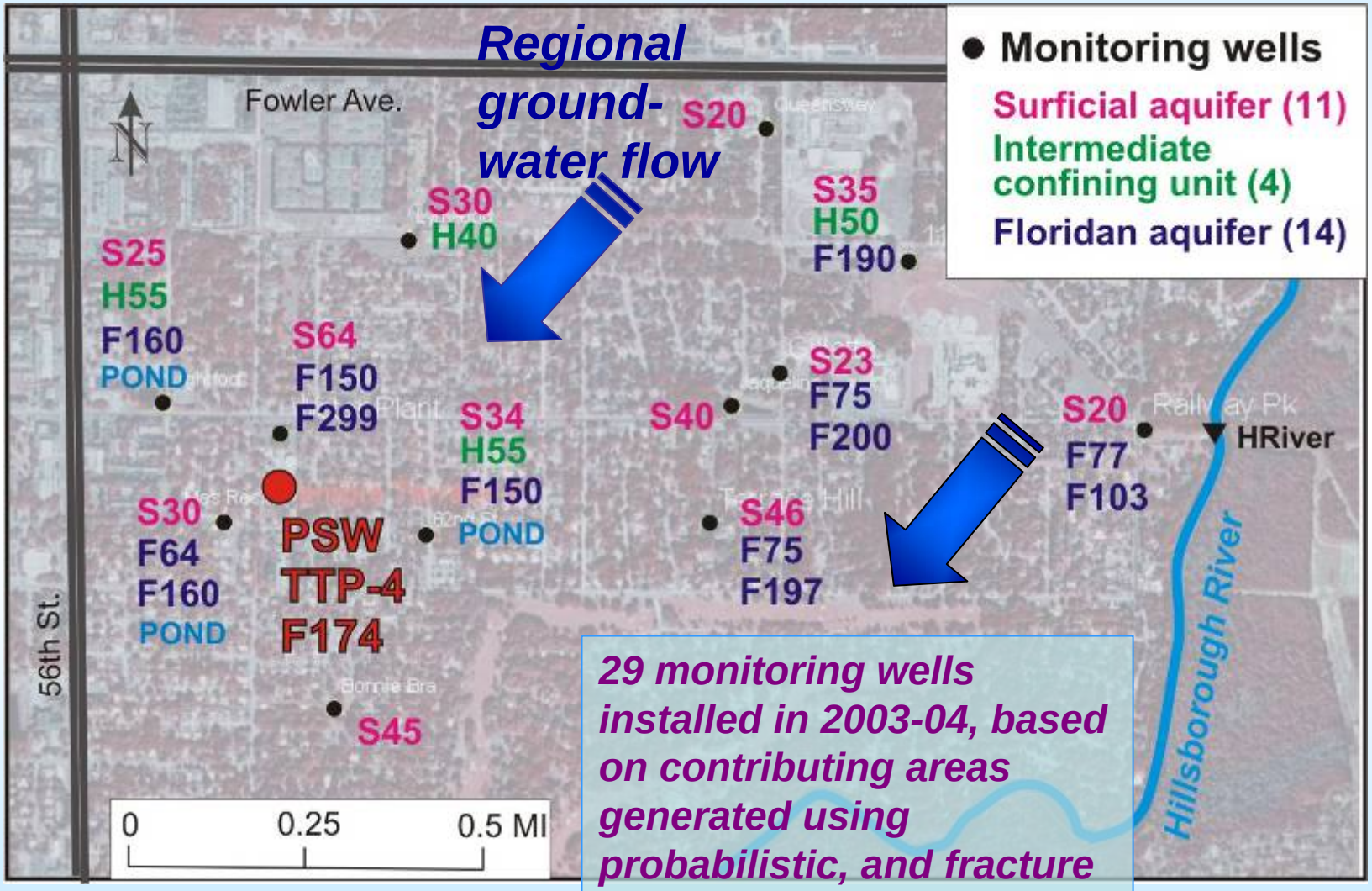
Monitoring Network



29 monitoring wells installed in 2003-04, based on contributing areas generated using probabilistic, and fracture models.

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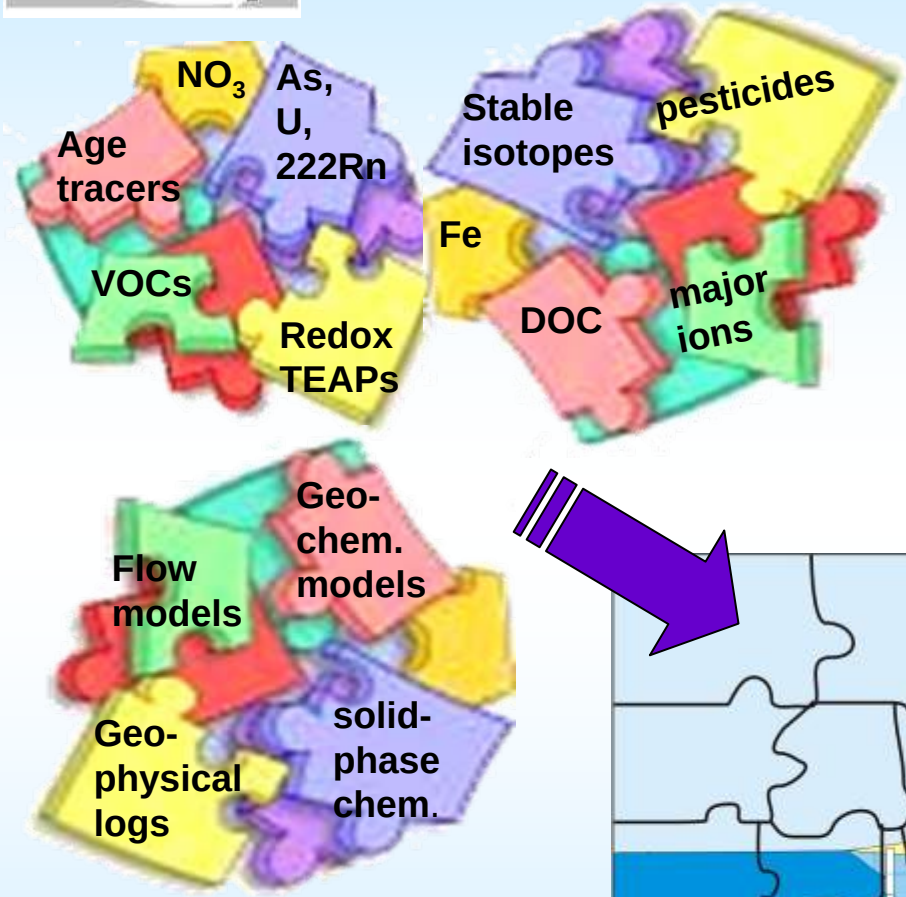
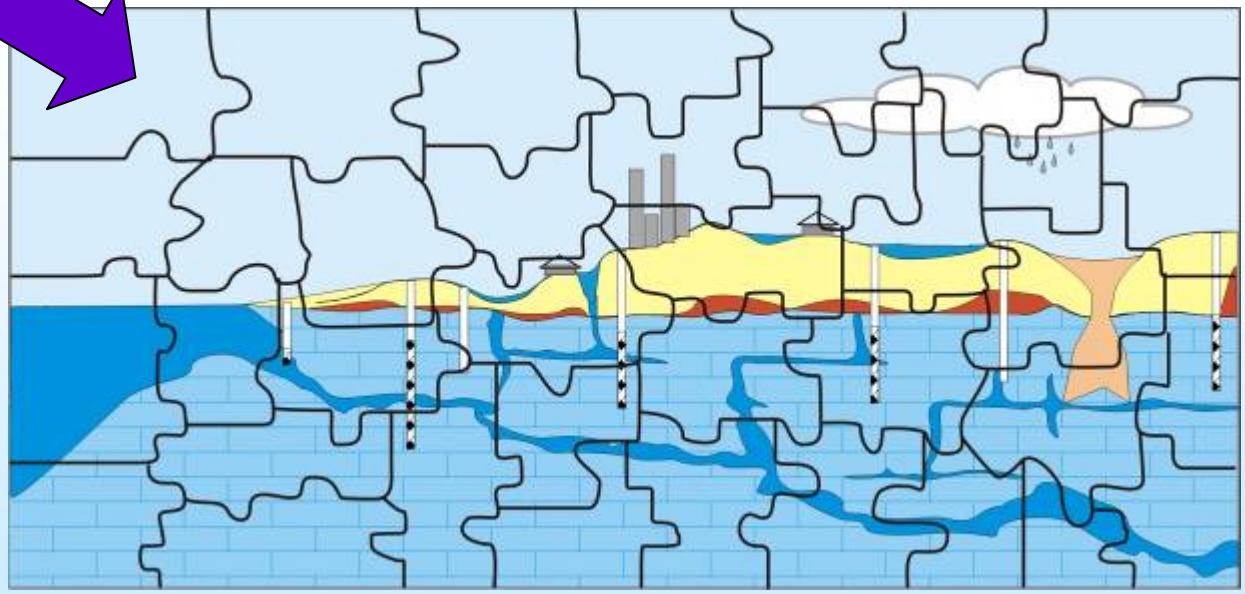
Putting the pieces together

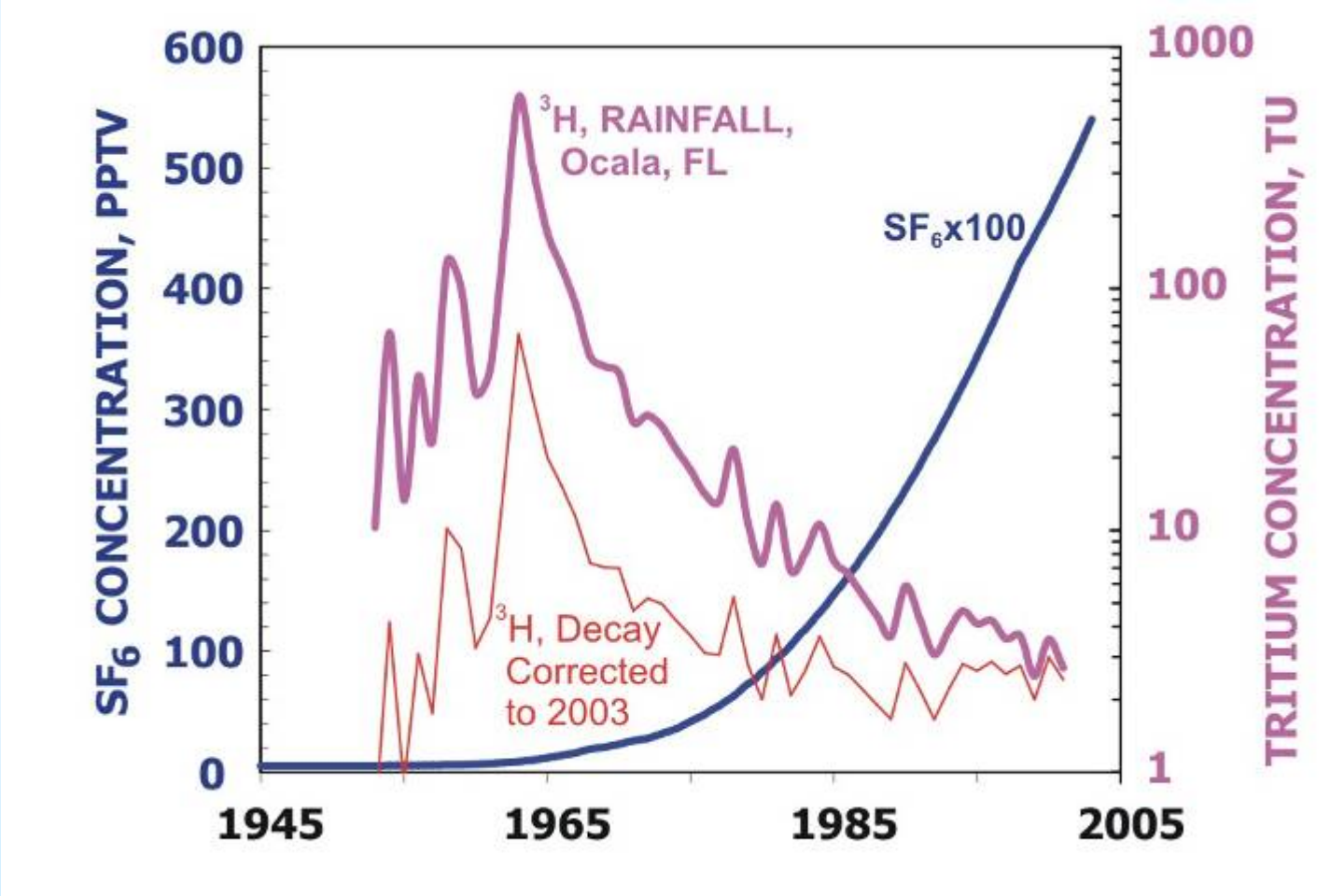


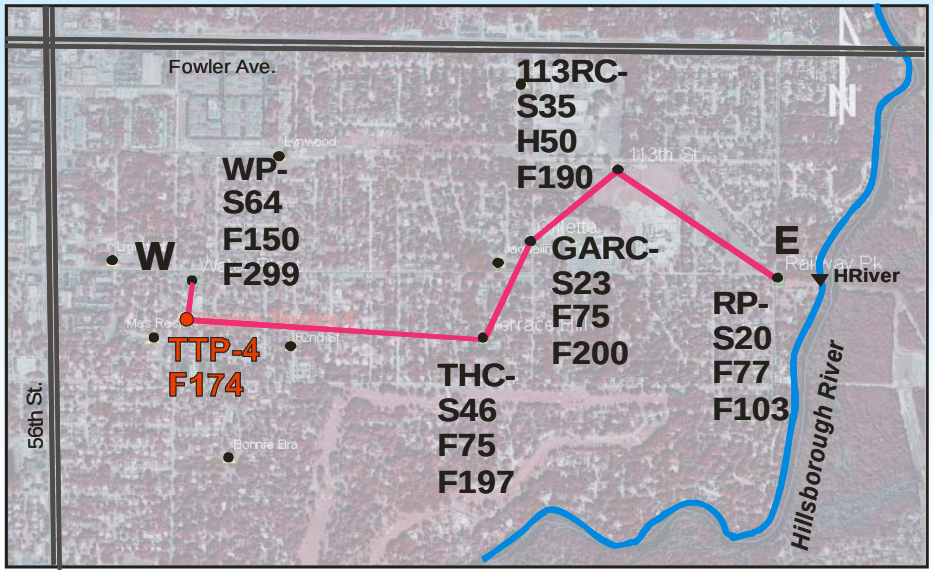
Use of multiple chemical tracers and geochemical modeling to determine:

- ***origin of contaminants in PSW***
- ***movement of contaminants to PSW***
- ***mixtures of water from different hydrogeologic units in PSW***

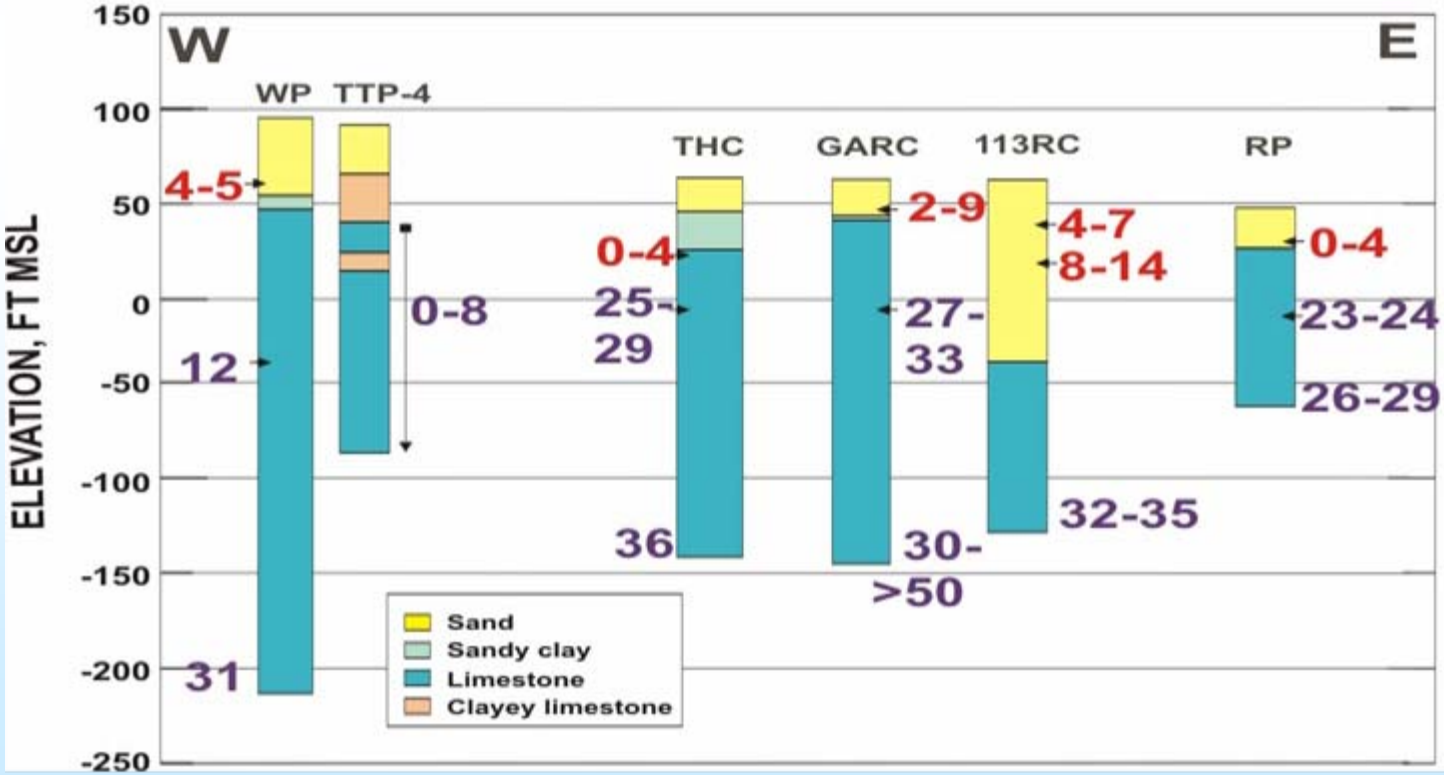


Assessing Ground-Water Age: SF_6 and ^3H atmospheric input





SF_6 and $^3H/^3He$ apparent Ages (yrs) much younger in surficial material than Floridan aquifer



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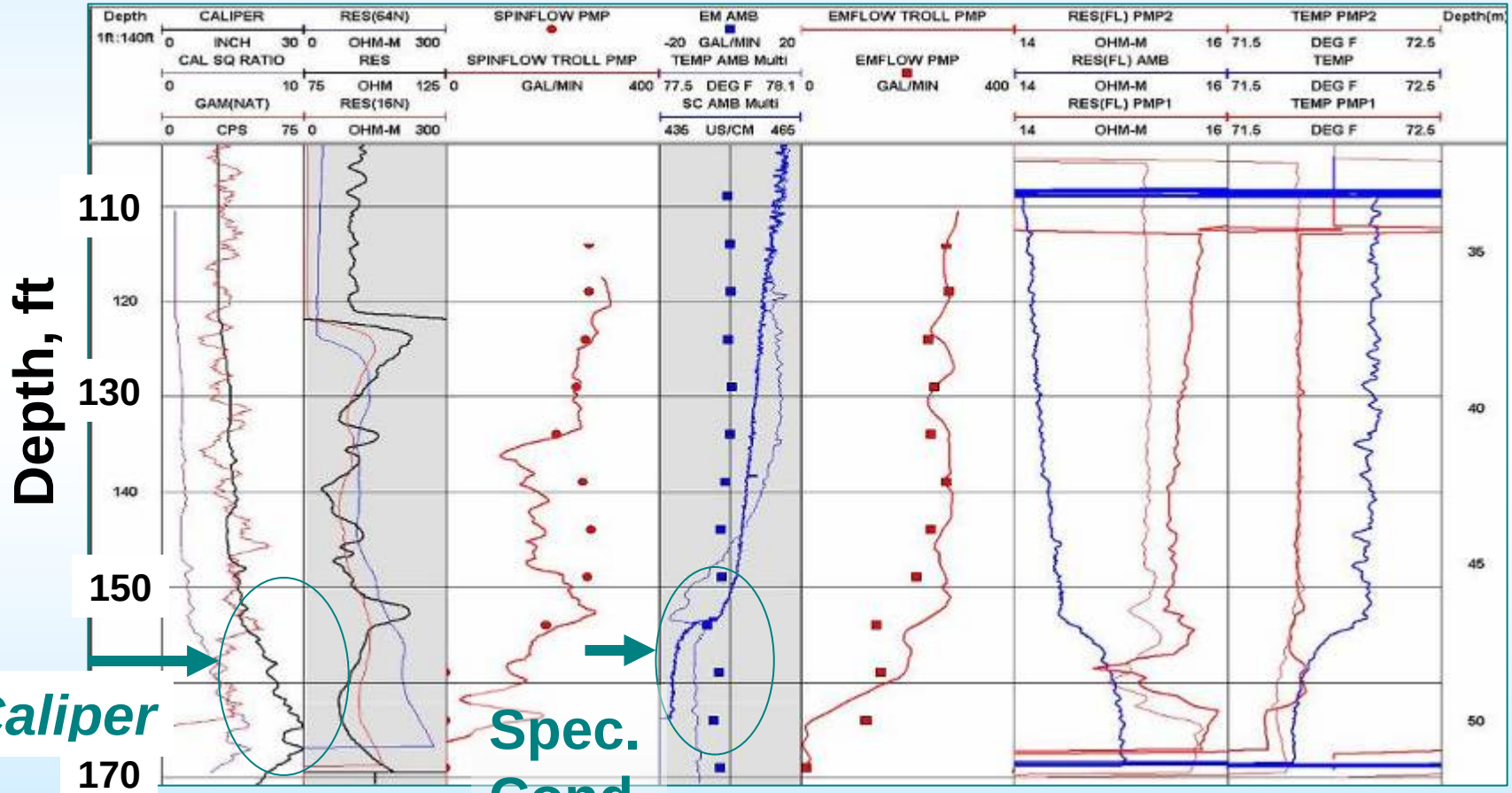
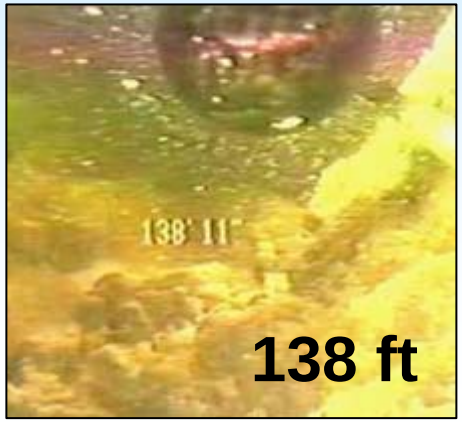
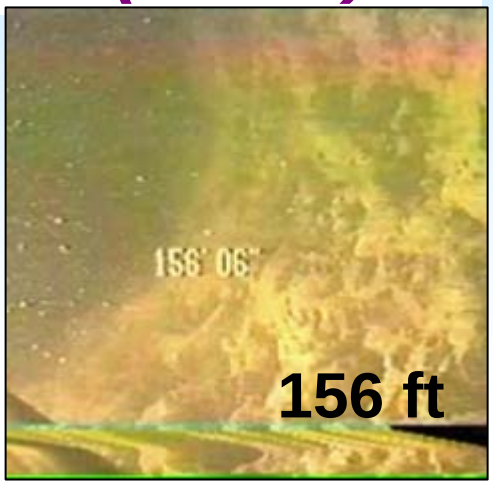
Lower specific conductance and much larger open hole in 150-170 ft zone

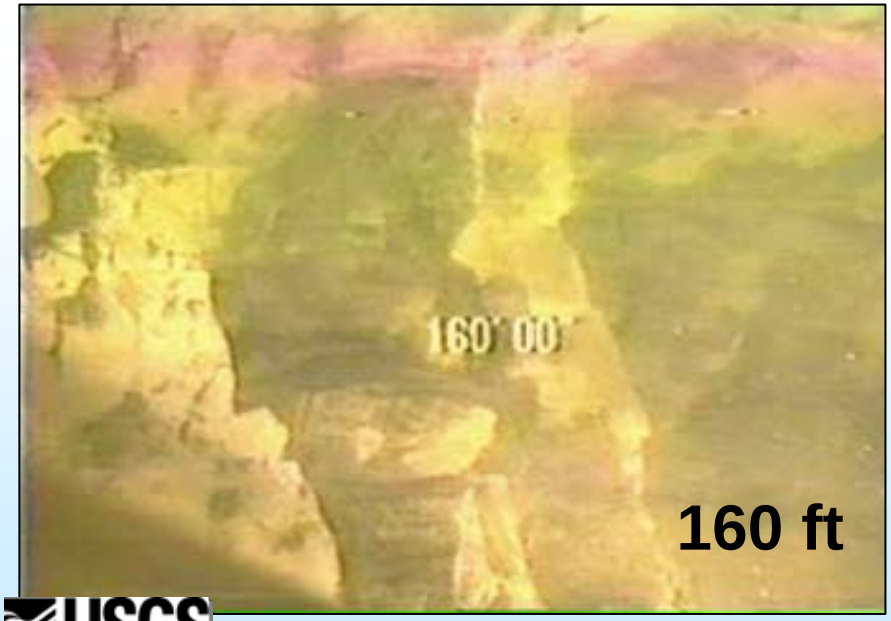


Geophysical logs of public supply well bore (TTP-4)

Optical Televiewer shots show large openings in limestone in Public supply well bore (TTP-4)







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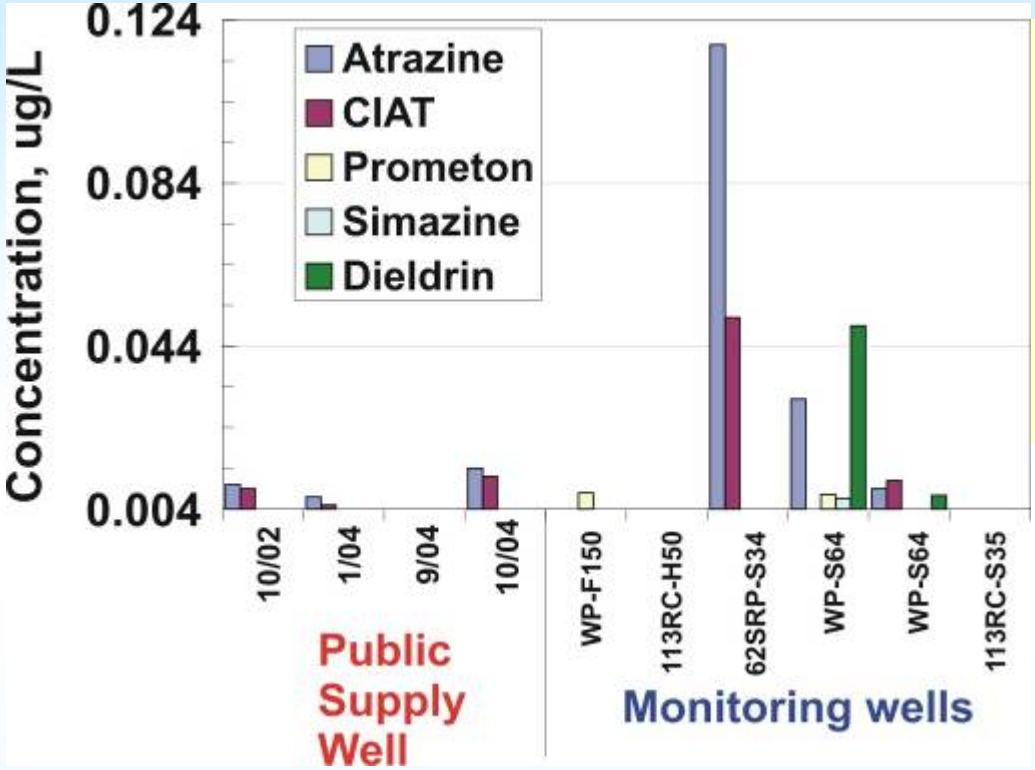
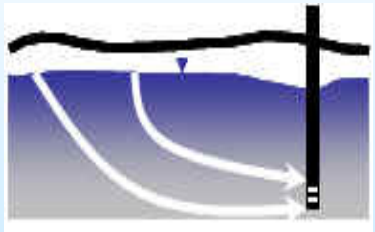
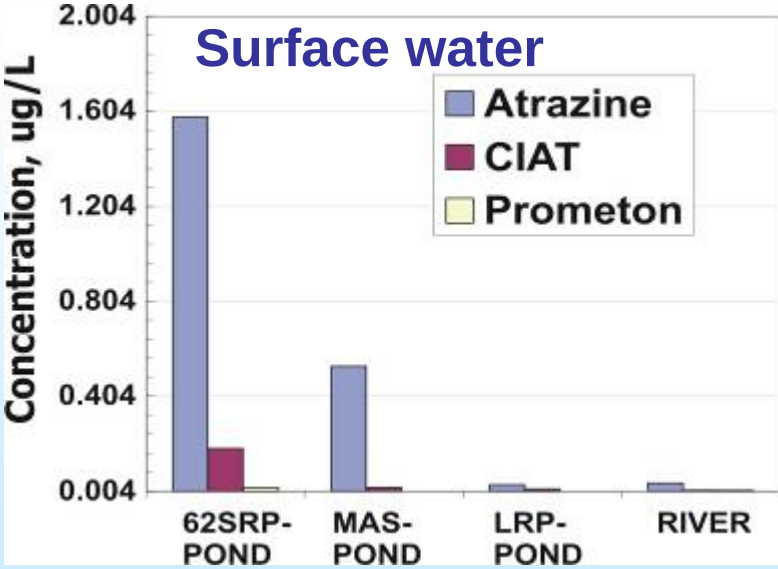
Pesticides detected in public supply well



- *Atrazine and Deethylatrazine (CIAT) were detected four times in water from PSW (TTP-4)*
- *Concentrations were highest in 62SRP POND and surficial well at this site.*





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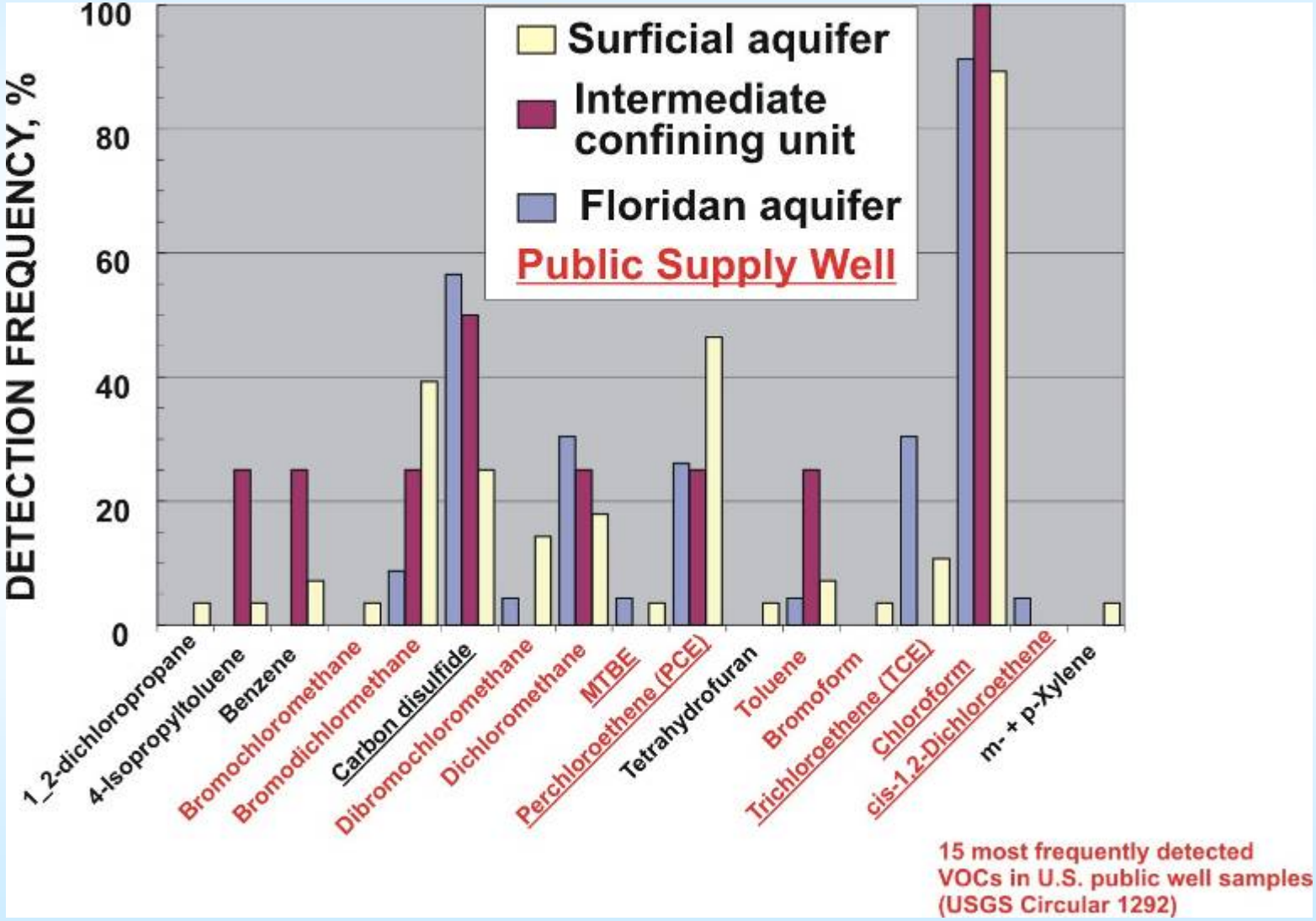
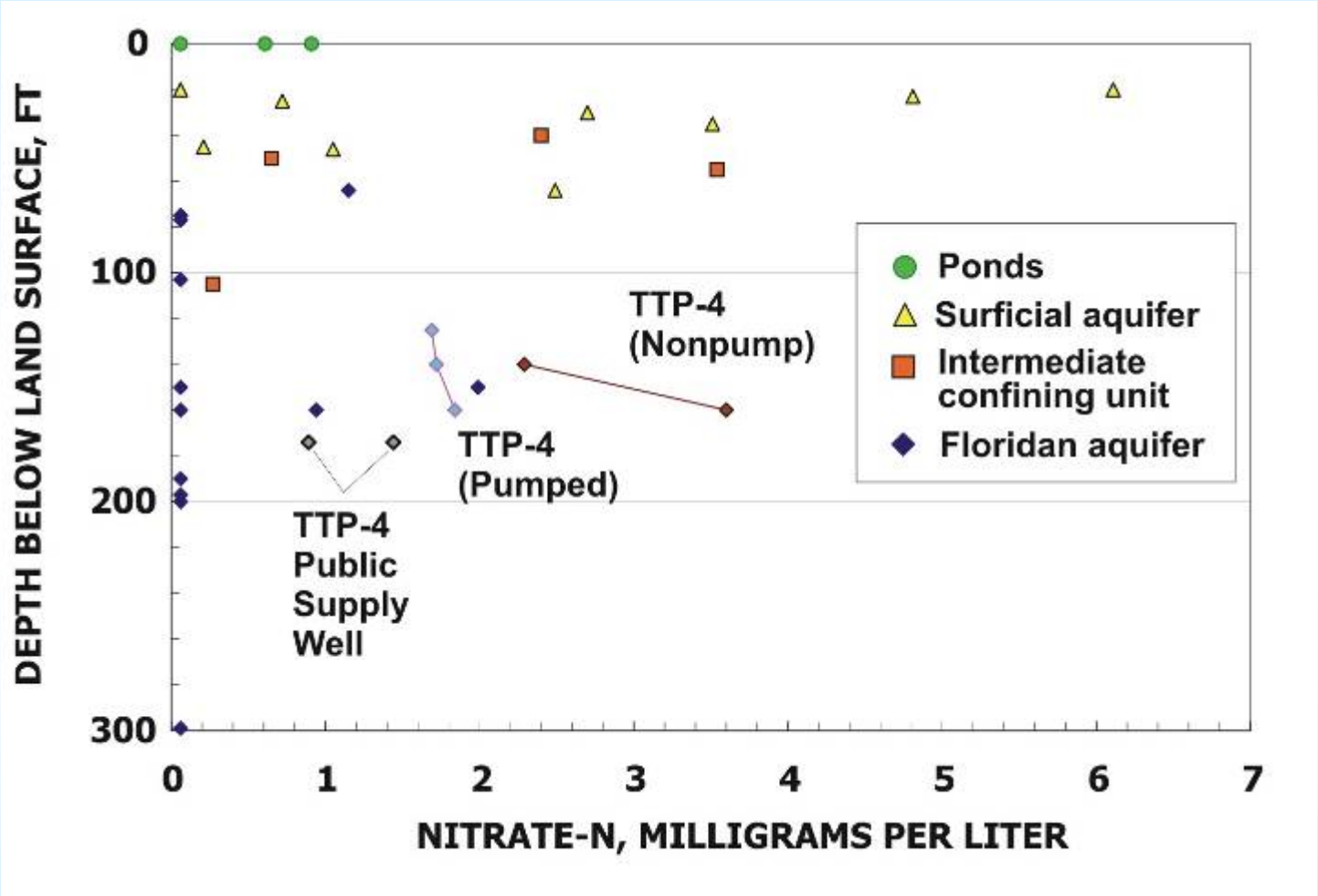
6 VOCs detected in samples from public supply well

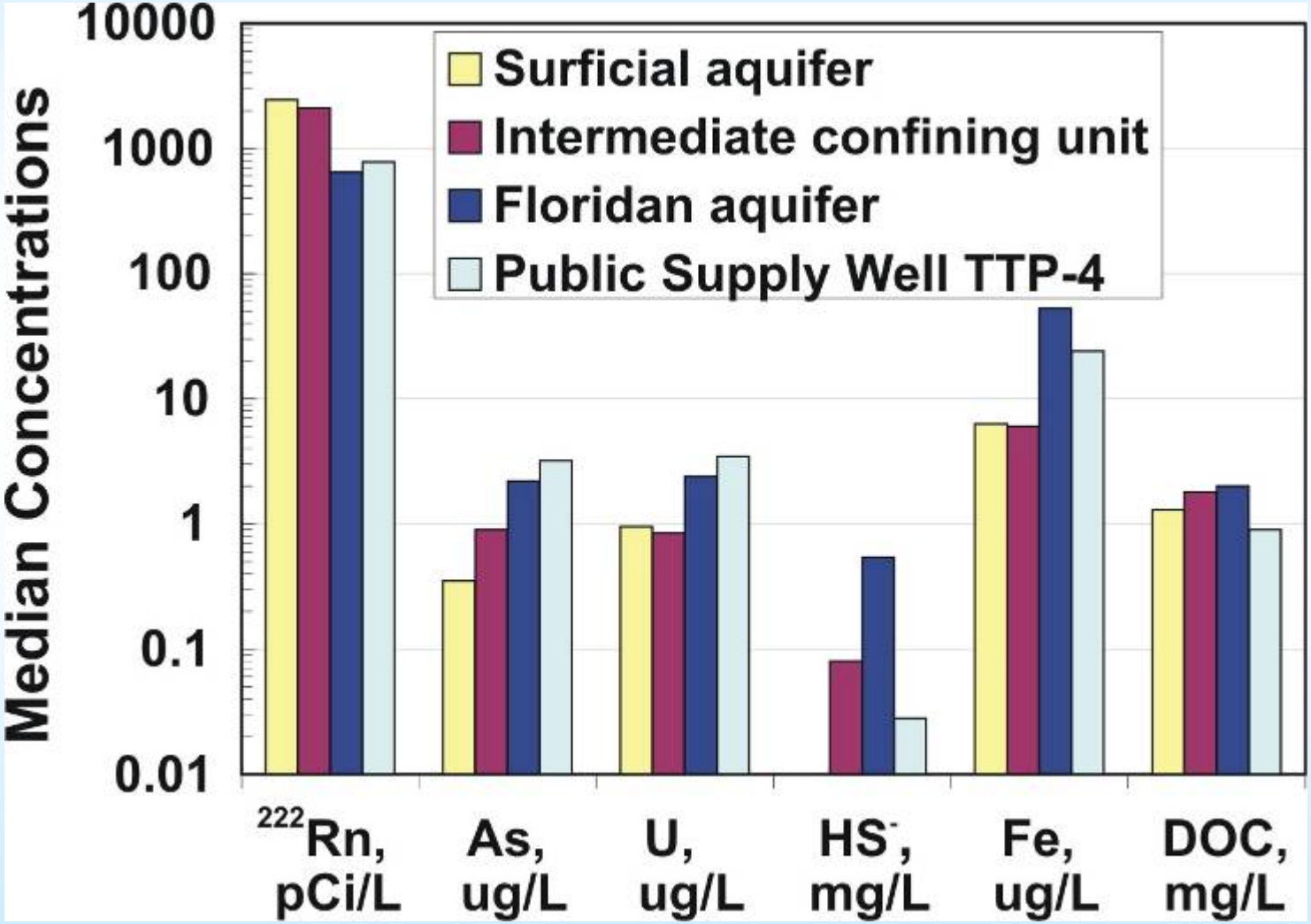


Nitrate-N concentrations decrease with depth except for public supply well



NO_3-N concentrations higher in oxic surficial aquifer system than anoxic Floridan aquifer with exception of TTP-4 and other wells in 150-160 ft depth zone.

Naturally occurring contaminants in public supply well reflect mixing of water



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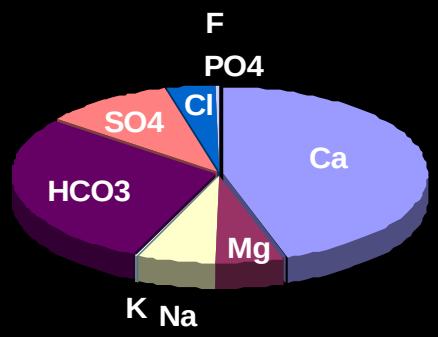
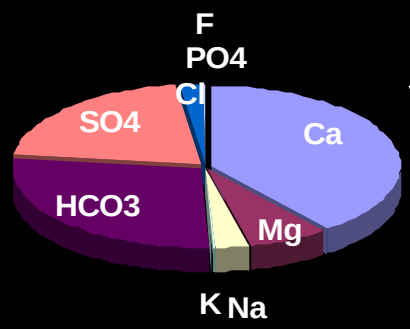
Geochemical Mass-balance mixing models for public supply well (NETPATH)



Surficial aquifer water

+

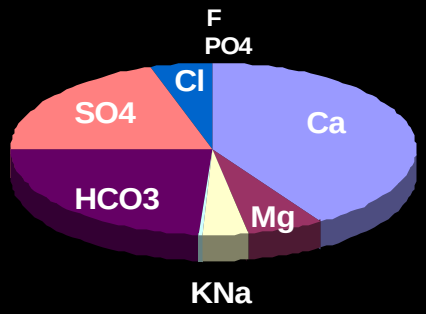


Floridan aquifer water

Reactions:

Mineral dissolution/precipitation

Oxidation/reduction of C, S, N, Fe species



Public Supply Well water TTP-4

Model constraints:

C, S, Ca, Mg, Fe, redox

Model phases:

Calcite, dolomite, gypsum, pyrite, FeOOH, CH2O, CO2

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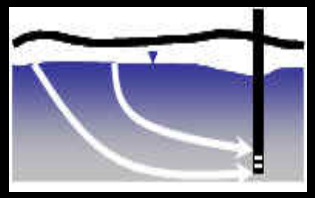
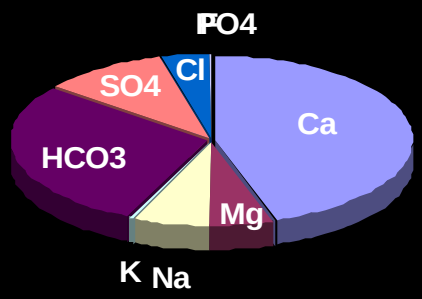


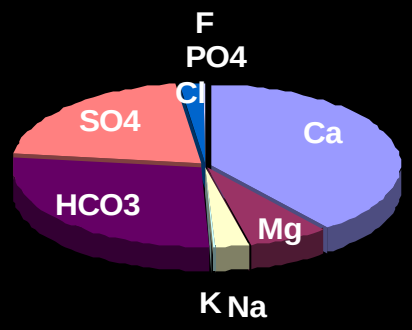
Public Supply well water contains 30-60% water from surficial aquifer



Surficial aquifer water

30-60%

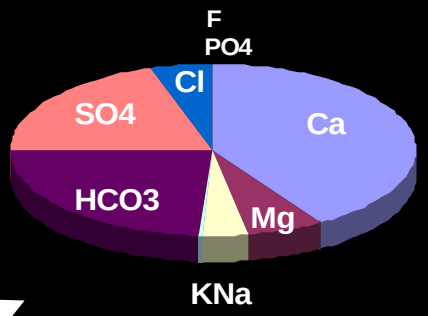
+



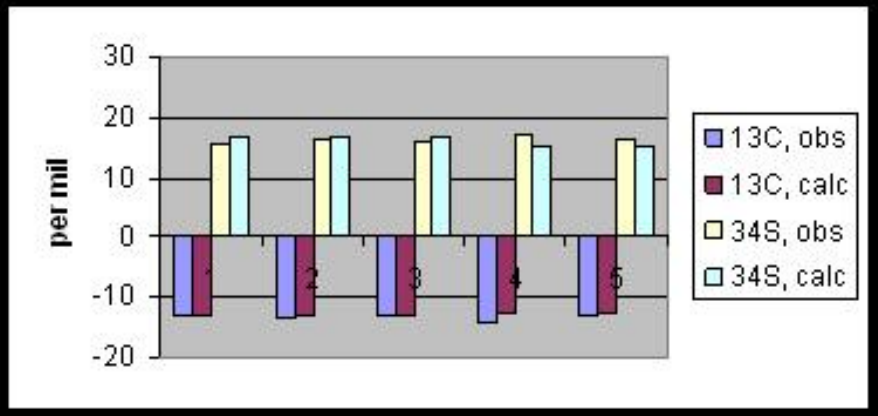
Floridan aquifer water

40-70%

Sensitivity of models evaluated by comparing calculated isotopic compositions to observed compositions



Public Supply Well water TTP-4



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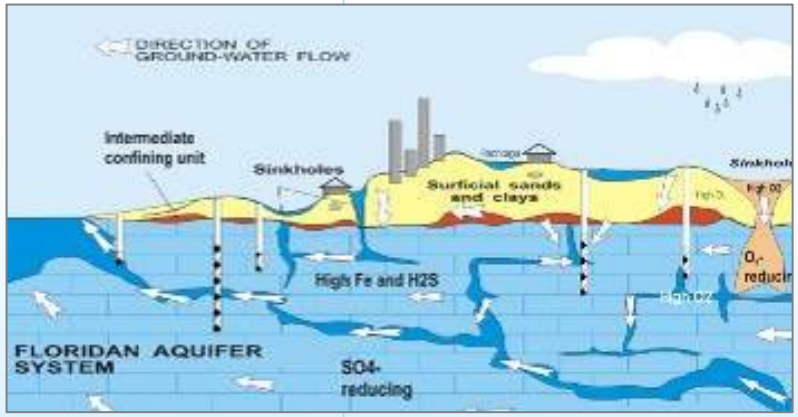
Conclusions:
Public Supply Well Vulnerability Issues

Combined chemical, geophysical, and modeling data indicate mixing of water in PSW from surficial aquifer and Floridan aquifer due to short circuiting of water through a highly transmissive zone.

- ***Elevated NO_3-N conc. (FAS waters typically have much lower NO_3 due to denitrification),***
- ***Numerous detections of VOCs, pesticides at low conc.***
- ***Elevated As, U, ^{222}Rn conc. compared to water from monitoring wells in the FAS***



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Acknowledgments:

USGS National Water Quality Assessment Program

Bruce Bernard
Darlene Blum
Sandy Eberts
Patty Metz
Terry Petrosky
John Pittman
Ann Tihansky

City of Temple Terrace

Transport of Anthropogenic And Natural Contaminants To Public Supply Wells (TANC)

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