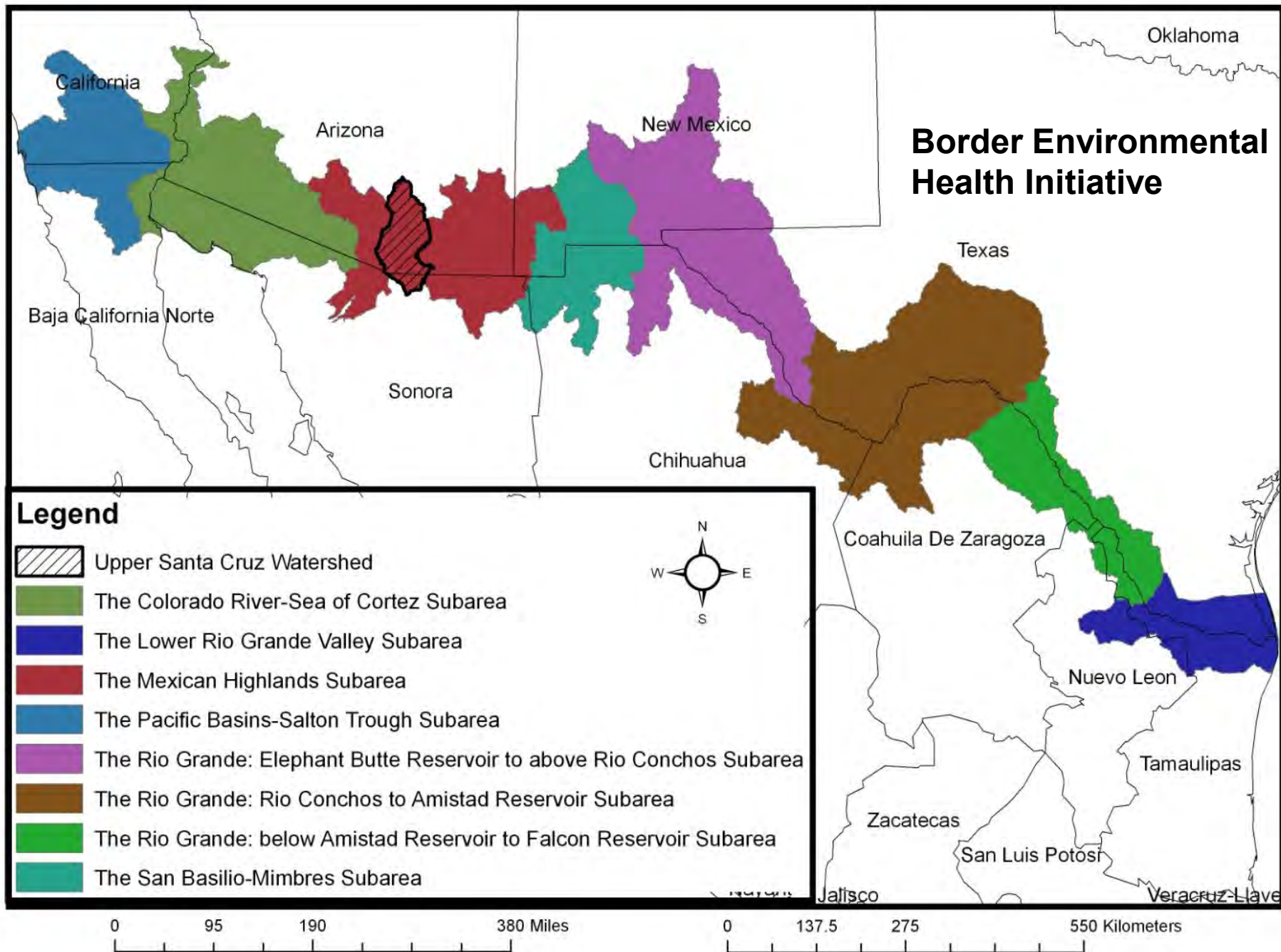


Physical and Biological Science to Study Interactions among Water, and Environmental and Human Health in the Transboundary Upper Santa Cruz Basin

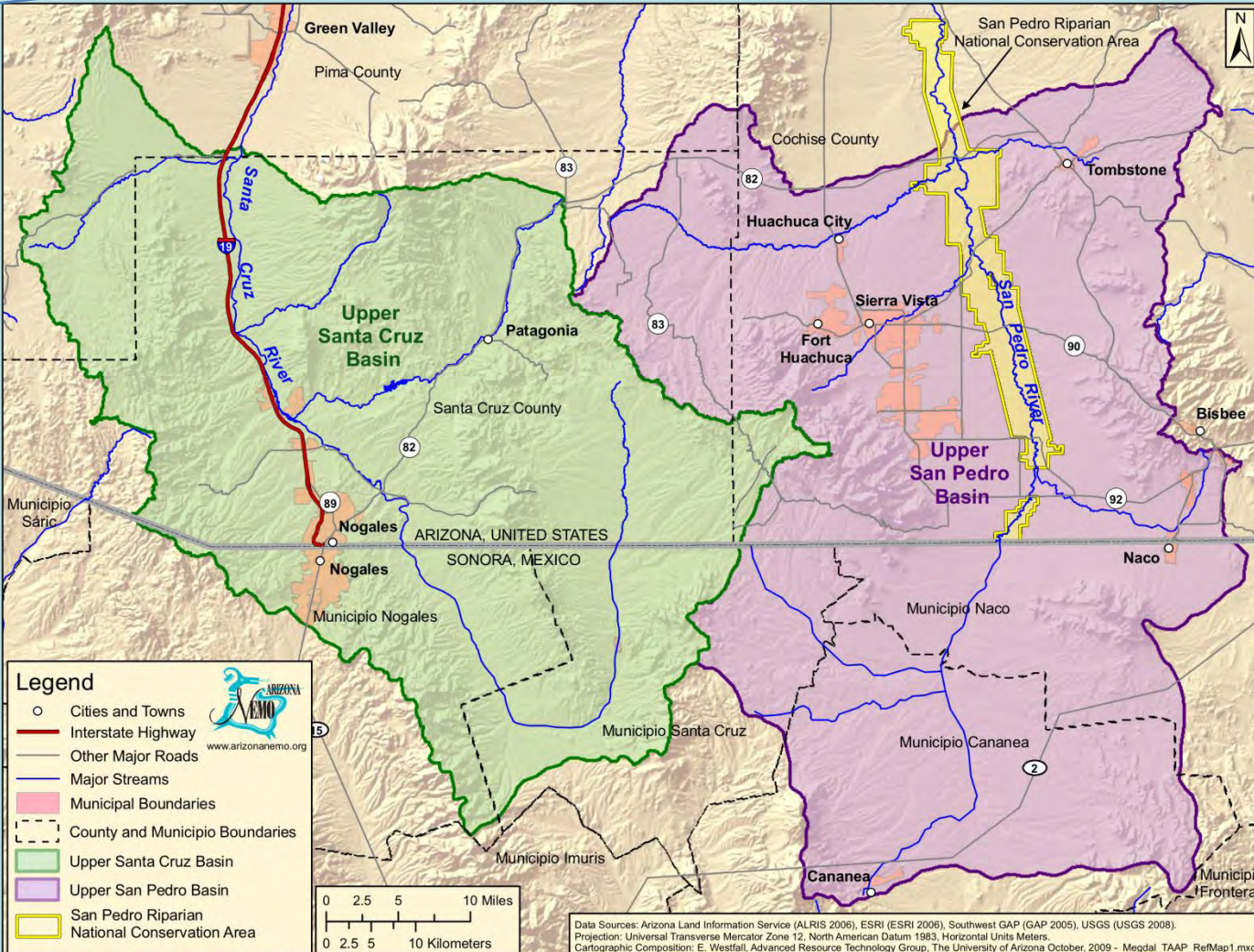
James Callegary¹, Floyd Gray¹, Nicholas Paretti¹, Laura Norman¹,
Kyle Withers², Prescott Vandervoet², Rose McAndrew², Christopher
Scott², Charles Van Riper¹, Sharon Megdal², Andrea Prichard²,
Felipe Caldeira² (¹US Geological Survey, ²University of Arizona)

Santa Cruz River Researcher's Day

March 19, 2010



US-Mexico Transboundary Aquifer Assessment Program

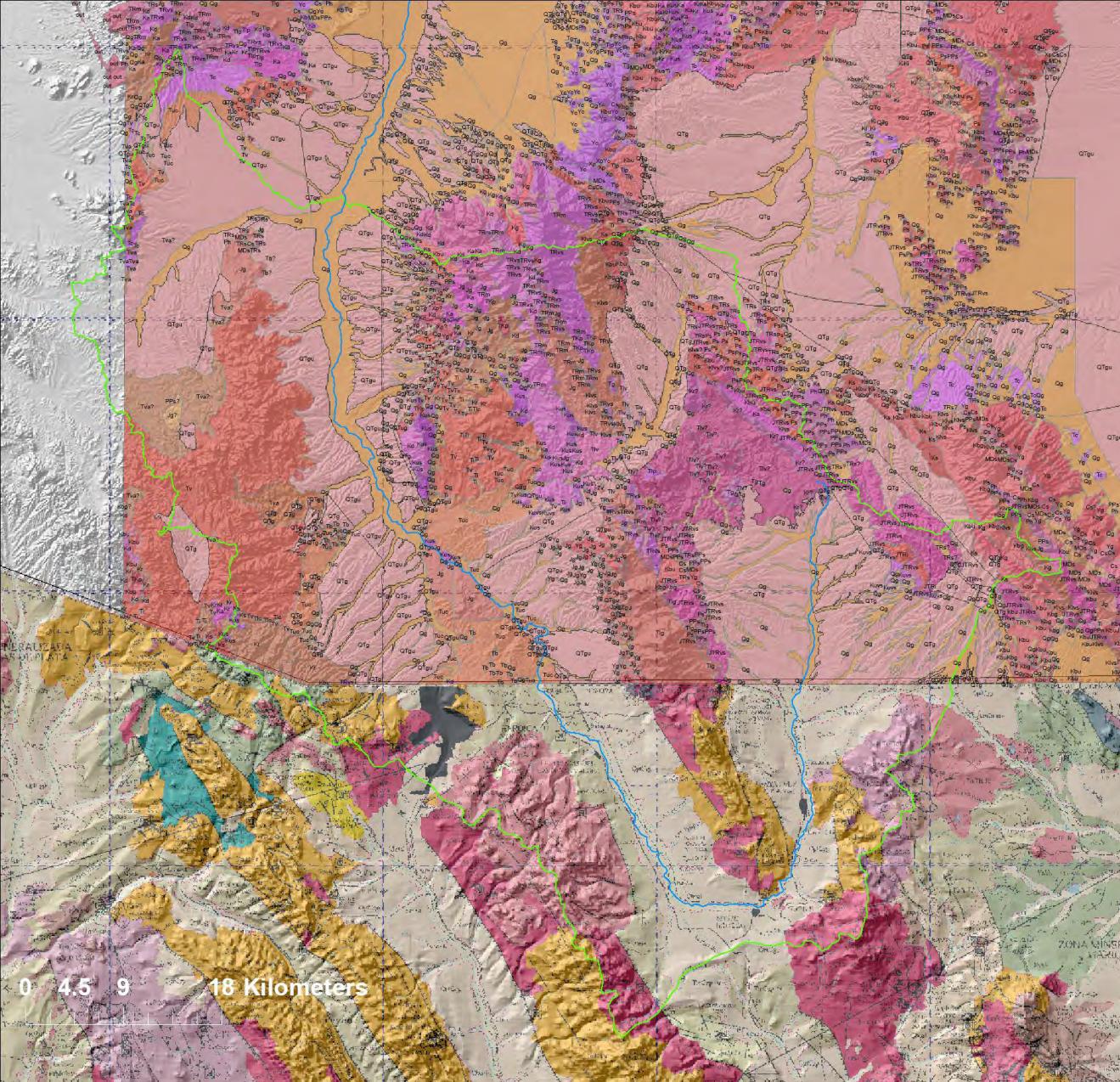


Hydrogeologic Framework

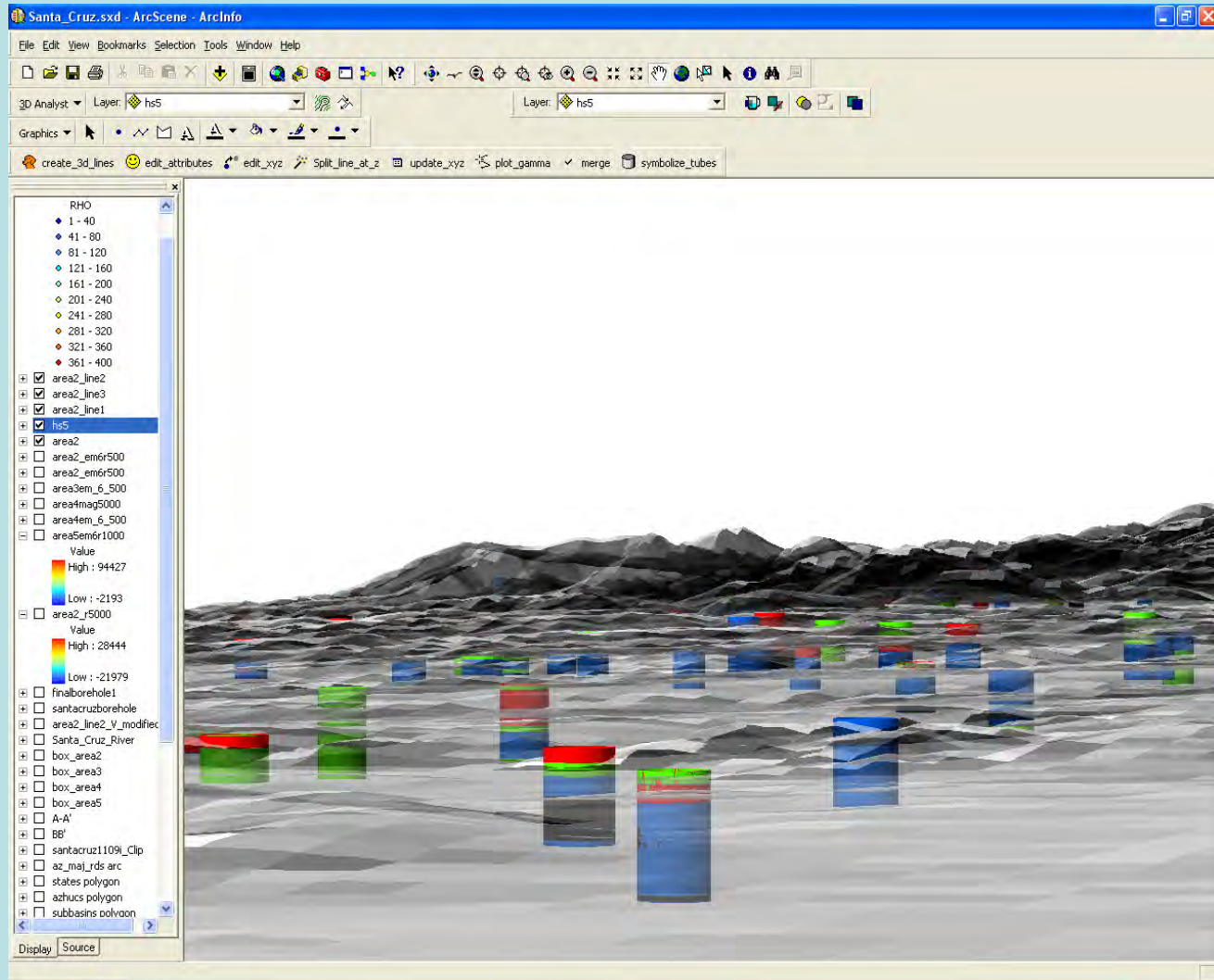
Updating Geologic Maps

US (Drewes et al, 2002, USGS)

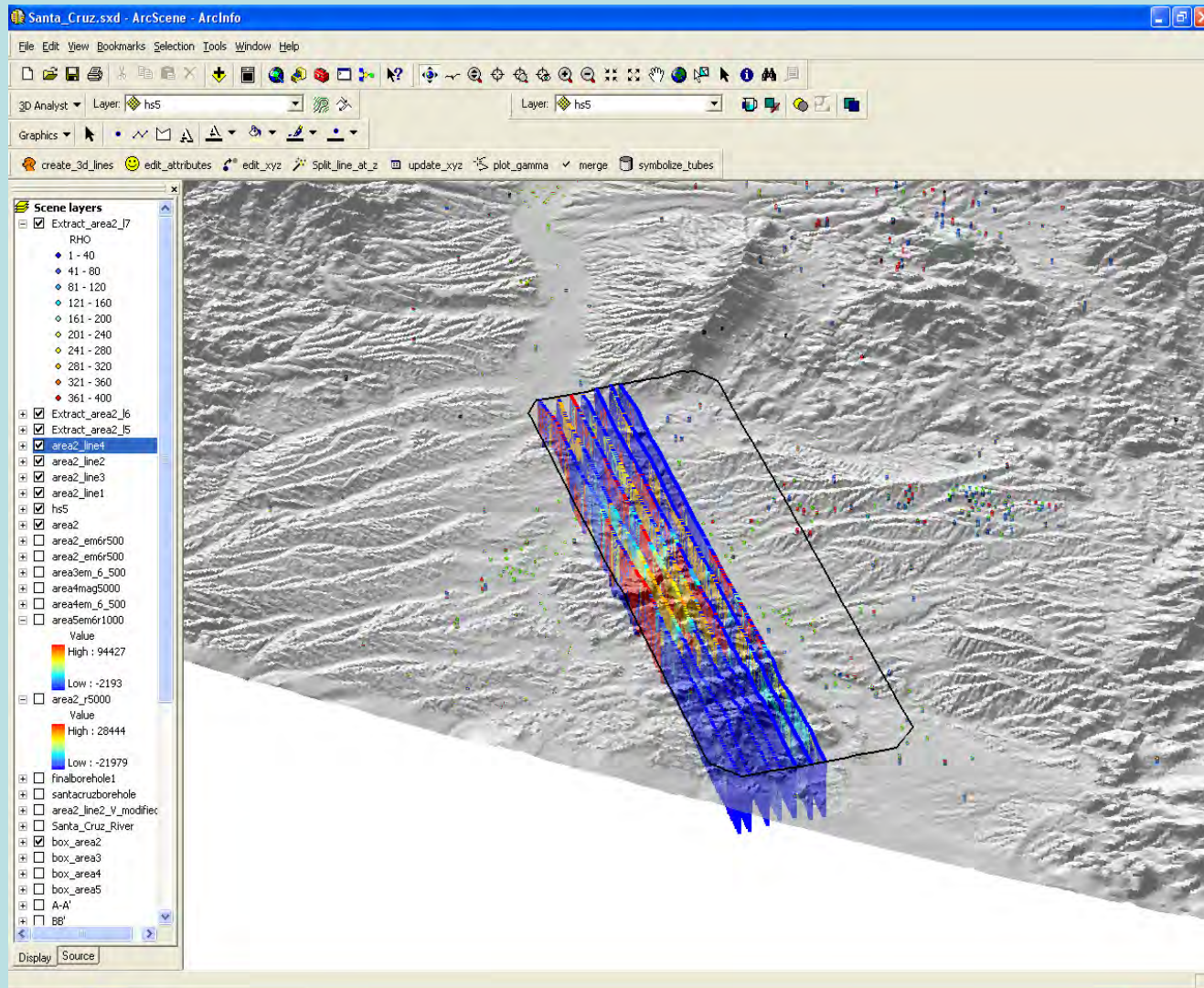
México (Castro-Escárrega et al, 2000, INEGI)



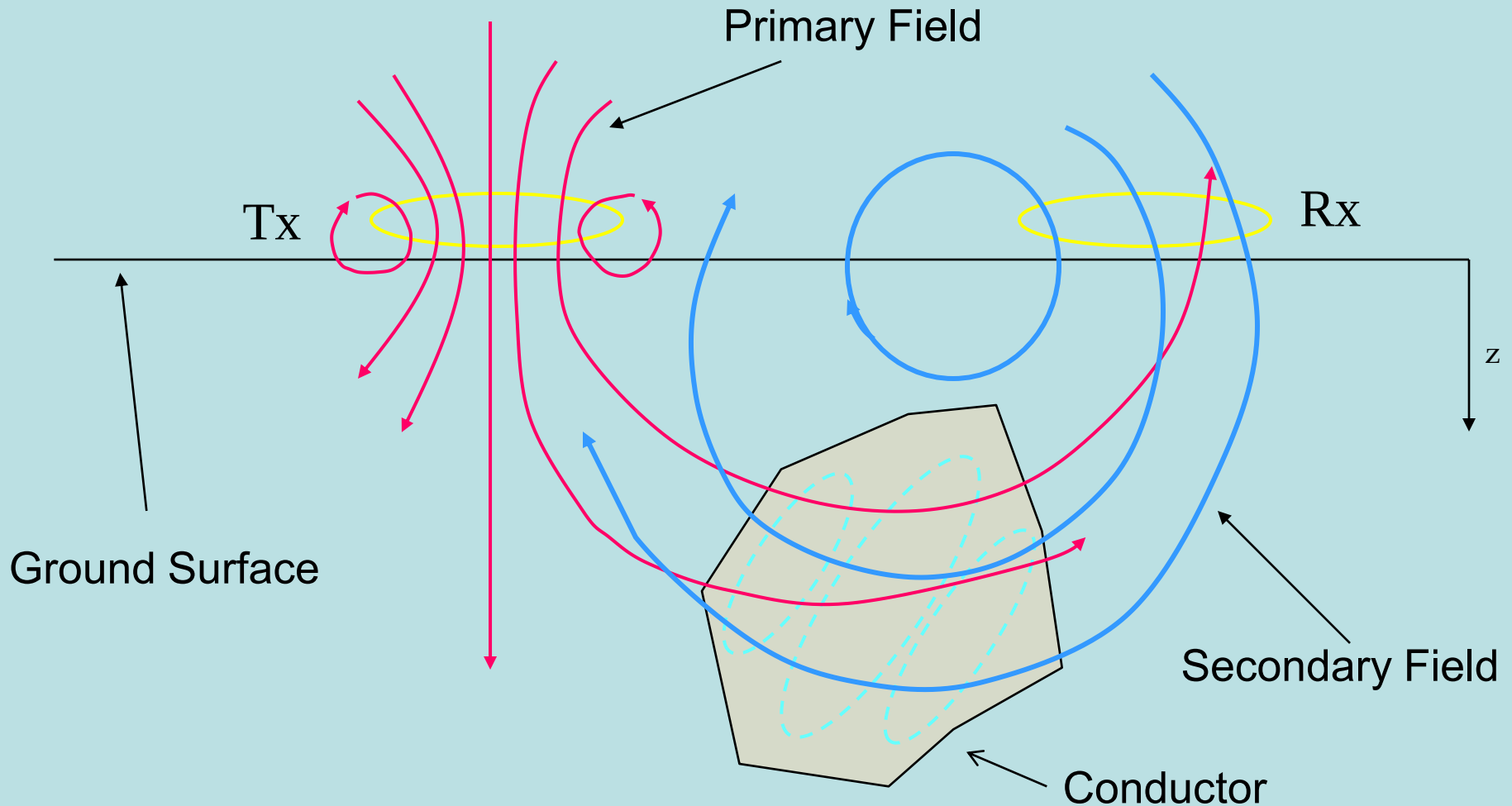
Well Logs Database



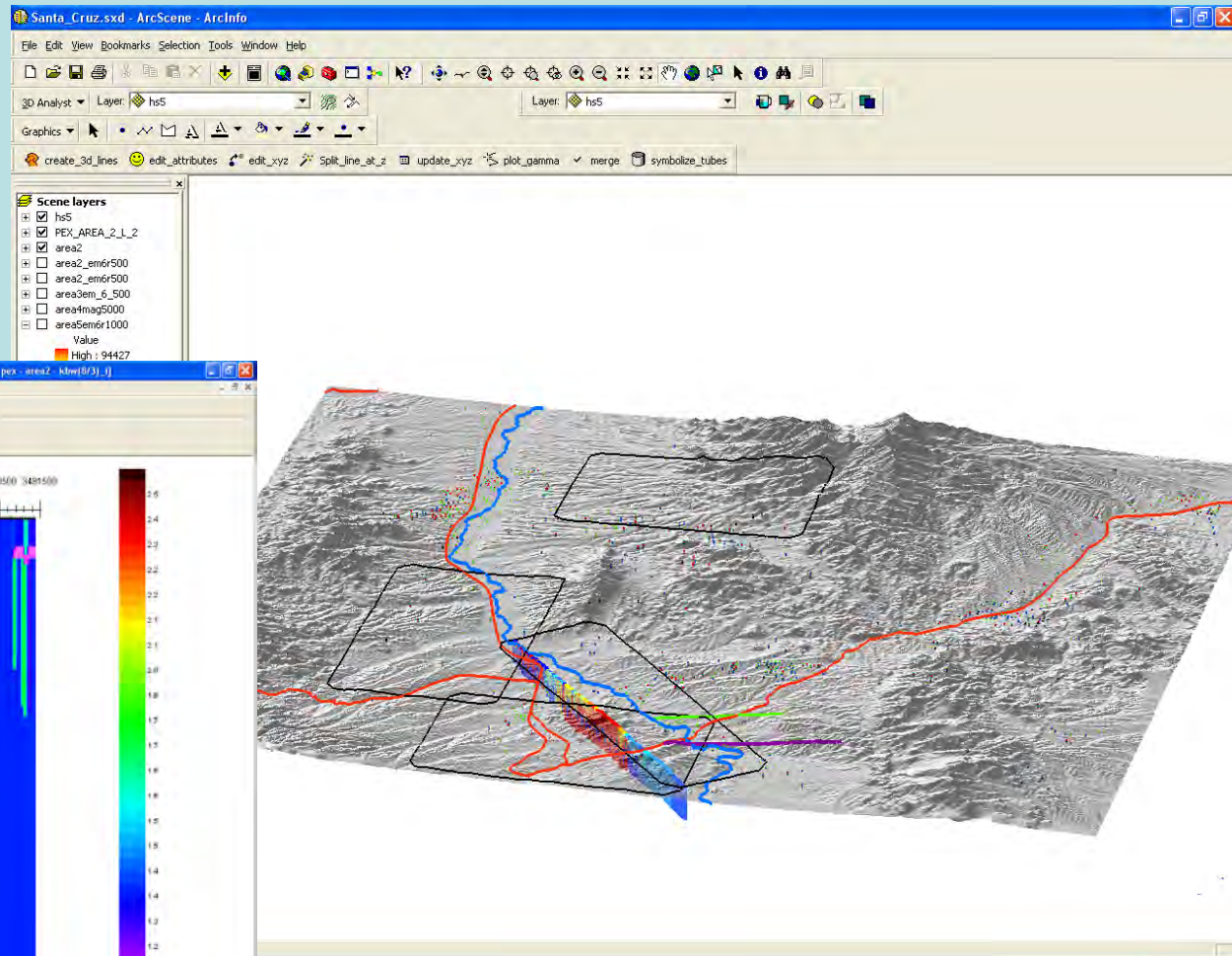
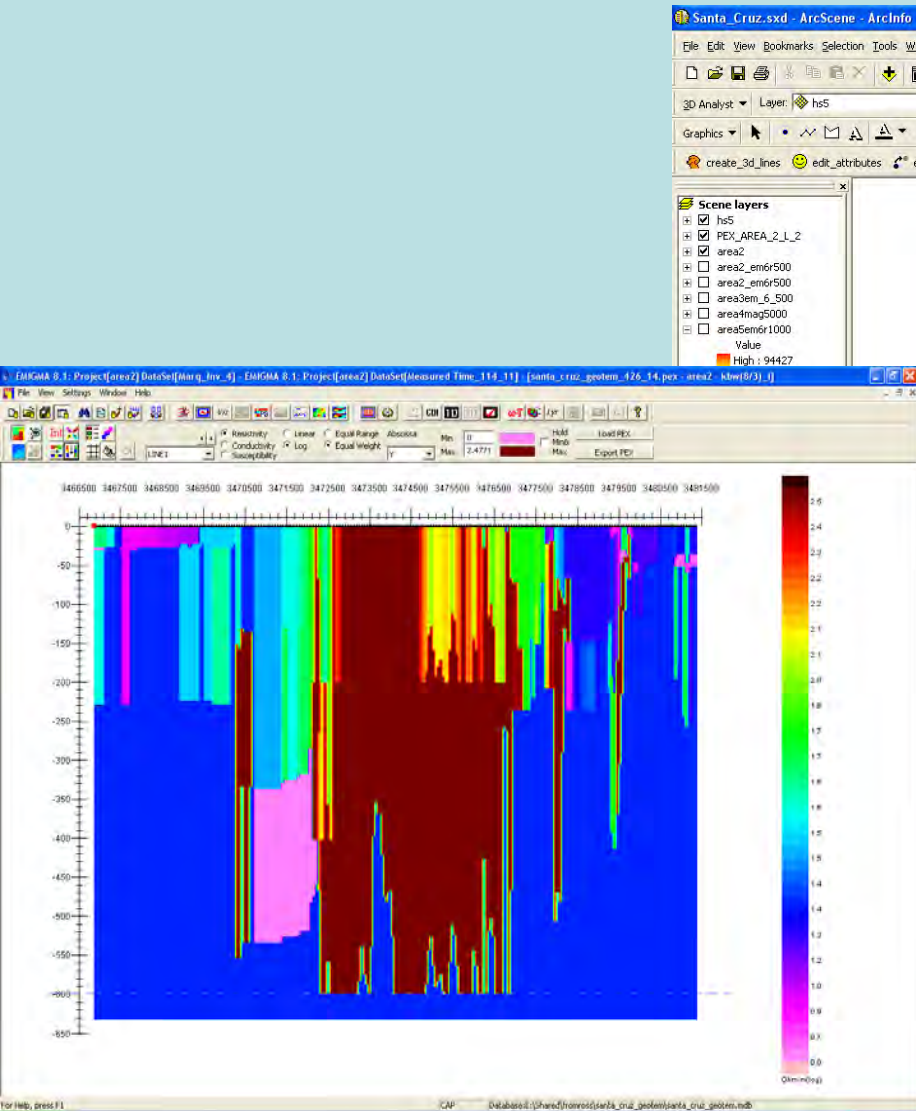
Airborne Electromagnetic Surveys



Electromagnetic Induction Process



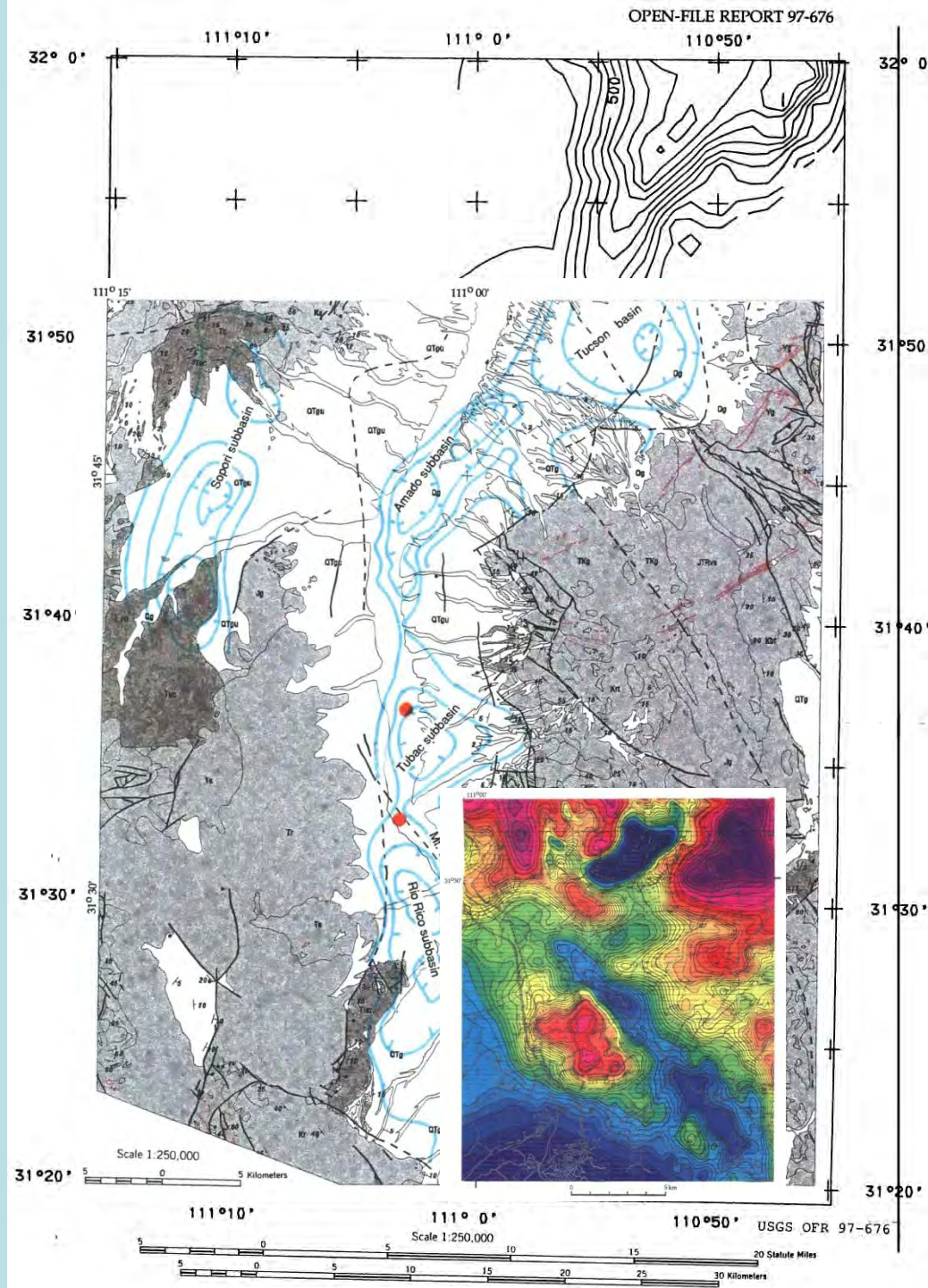
Airborne Electromagnetics: Modeling



Potential Fields: Gravity and Magnetics

(Gettings y Houser,
1997, USGS)

- Future work: 3D gravity and magnetic modeling

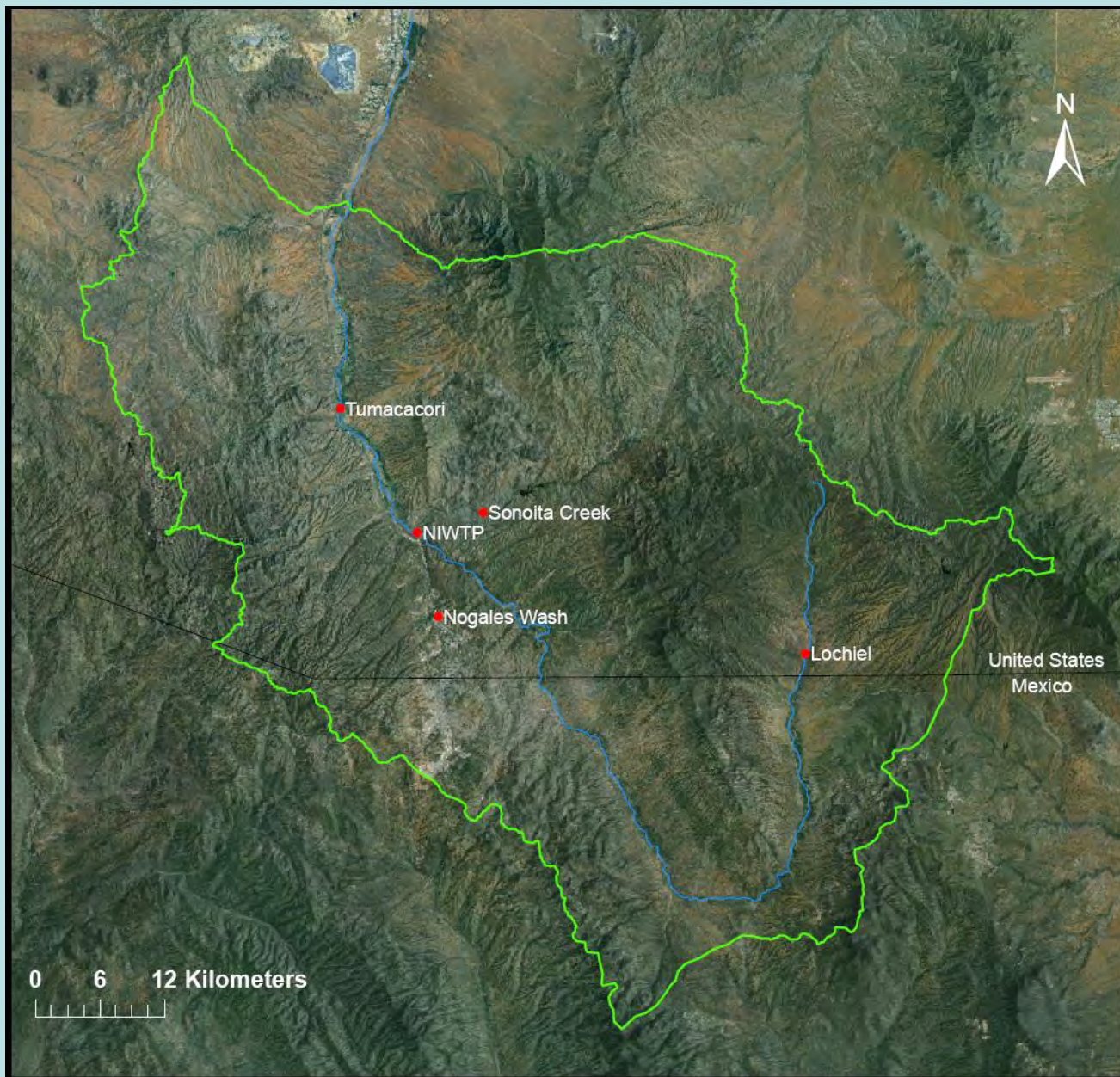




Geophysics: Ground-based TEM



Emerging Contaminants: Sampling Locations



Emerging Contaminants

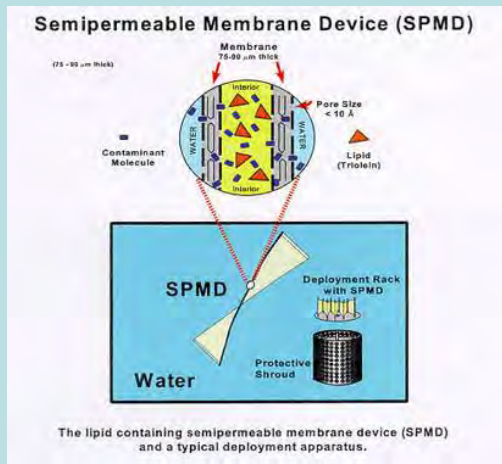
- Analytes
 - Halo-organics
 - Pharmaceuticals
 - Wastewater compounds
 - Metals
- Media
 - Water
 - Sediment
 - Tissue: plant, fish, macroinvertebrates, birds

The Virtual Fish: SPMD Basics

(Adapted from Duane Chapman (USGS CERC))

What's the Problem?

- Oil and water don't mix: Many harmful pollutants are oils or oil-like and *do* dissolve in water at low concentrations.
- These chemicals dissolve in other oils much more easily than in water. They are "lipophilic" (fat loving) and "hydrophobic" (water fearing) contaminants.
- Because these contaminants are usually present in low concentrations in water, they rarely cause quick death in fish or other aquatic animals.
- But here's the catch: Animals have fats (lipids) in their bodies. Hydrophobic contaminants tend to move from water to the fats in animals where harmful concentration can build up. This is called "bioconcentration." In a sense, animals inadvertently gather the contaminants from the water.
- CERC developed a ***semipermeable membrane device*** (SPMD) to mimic the parts of animals that cause bioconcentration.
 - Membrane of the SPMD allows contaminants to pass through, like membranes of animal cells. The oil inside is similar to a highly purified fish fat.
- When the SPMDs are put in the water and left for a month, they gather hydrophobic contaminants just as a fish would. We then collect the SPMDs and chemically analyze them for the contaminants.



Emerging Contaminants Results

Compound	General Use	Santa Cruz R @ Santa Gertrudis Lane	Santa Cruz R nr Nogales WWTP	Nogales Wash @ Ruby Rd	Santa Cruz R nr Lochiel, AZ	Sonita Creek blw Patagonia Dam	Percent Decrease From WWTP to Santa Gertrudis
POCIS							
phenol	Disinfectant, leechate	x	x		ND	ND	5
para-cresol	Wood preservative	x	x	x	x	x	4
skatol	Fecal sterol	ND	x	ND	ND	ND	
N,N-diethyltoluamide (DEET)	Insecticide, mosquito repellent	x	x	ND	ND	x	25
ethyl citrate	Fragrance, tobacco additive, cosmetics	x	x	ND	ND	ND	74
Tri (2-chloroethyl) phosphate (TCEP)	Fire retardant (CI)	x	x	x	ND	x	12
4-n-octylphenol	Nonionic detergent metabolite	ND	ND	ND	ND	ND	
galaxolide (HHCB)	Fragrance, tobacco additive, cosmetics	x	x	x	ND	x	64
triclosan	Disinfectant, antimicrobial	x	x	ND	ND	ND	45
OPEO2	Nonionic detergent metabolite	x	x		ND	ND	72
bisphenol A	Plasticizer			x	ND	ND	
propofol	Anesthetic	ND	x	ND	ND	ND	
chloroxylenol	Antibacterial	ND	x	ND	ND	ND	
diphenhydramine	Antihistamine		x	ND	ND	ND	
lidocaine	Anesthetic	x	x	ND	ND	ND	7
tramadol	Analgesic	x	x	ND	ND	ND	13
phenobarbital	Barbiturate	x		ND	ND	ND	
iminostilbene	Antiepileptic	x	x	ND	ND	ND	13
fluconazole	Antifungal	x	x	ND	ND	ND	2
venlafaxine	Serotonin-norepinephrine reuptake inhibitor	x	x	ND	ND	ND	40
primidone	Anticonvulsant	x		ND	ND	ND	
carbamazepine	Antiepileptic	x	x	x	ND	ND	9
codiene	Analgesic	x	x	ND	ND	ND	28

x

Detection

ND

Non-Detection

Matrix interference

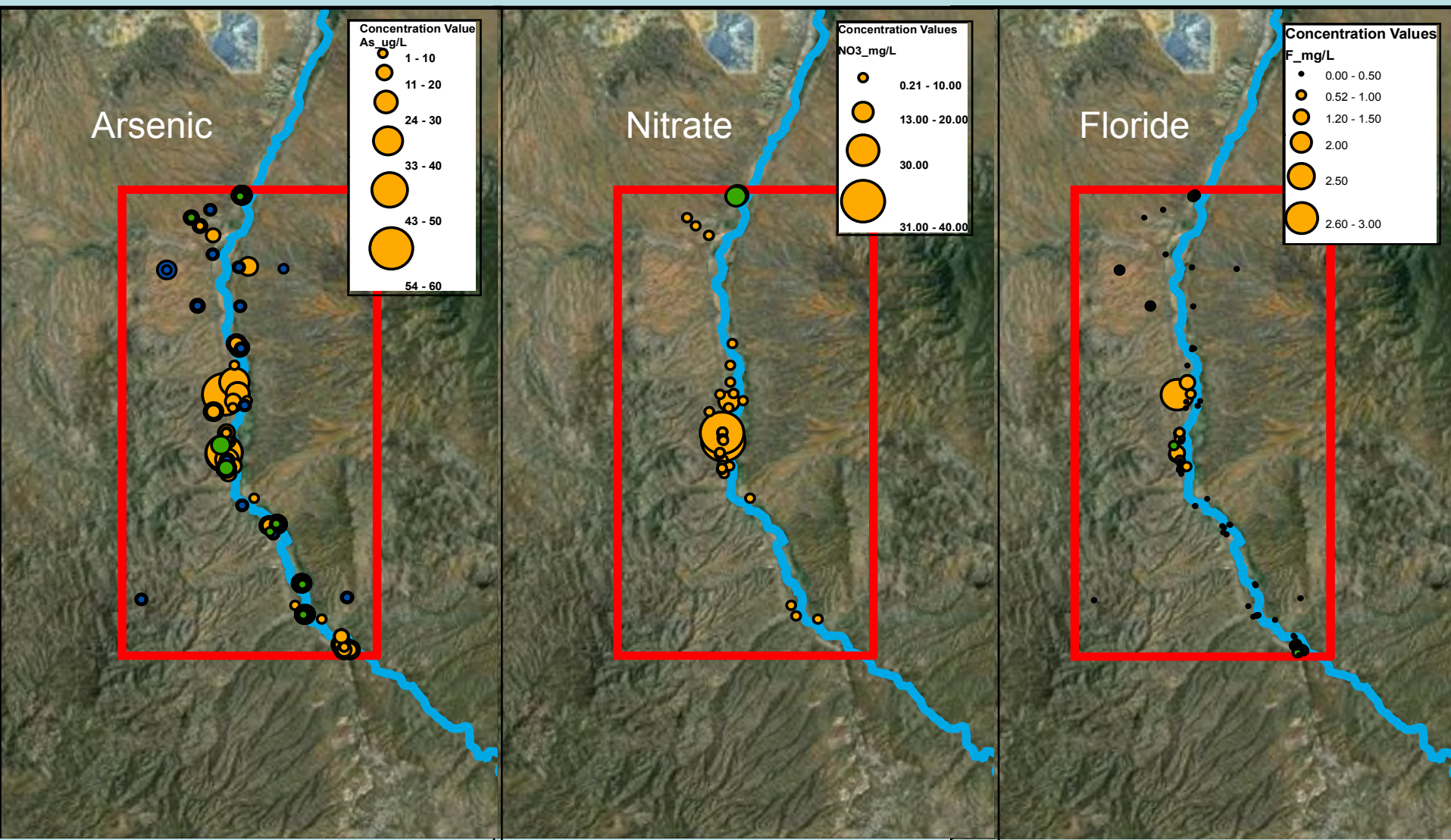
Emerging Contaminants Results

Compound	General Use	Santa Cruz R @ Santa Gertrudis Lane	Santa Cruz R nr Nogales WWTP	Nogales Wash @ Ruby Rd	Santa Cruz R nr Lochiel, AZ	Sonita Creek blw Patagonia Dam	Percent Decrease From WWTP to Santa Gertrudis
<u>SPMD</u>							
1,4-dichlorobenzene	Disinfectant, deodorant, pesticide	ND	x	ND	ND	ND	
4-tert-octylphenol	Nonionic detergent metabolite	ND	x	ND	ND	ND	
tonalide (AHTN)	Fragrance, musk		x	x			
Tri (dichlorisopropyl) phosphate (TCPP)	Fire retardant (CI)	x	x	ND	ND	ND	36
cholesterol	Plant/animal sterol	x	x	x	x	x	15
beta-sitosterol	Plant sterol	x	x	x	x	x	-19
iminostilbene	Antiepileptic	ND	x	ND	ND	ND	
<u>Water</u>							
fipronil sulfide	Insecticide	x	x	x	ND	ND	
desulfinyl fipronil	Insecticide	x	x	x	ND	ND	
chlorpyrifos	Insecticide	x	x	x	ND	ND	
fipronil	Insecticide	x	x	ND	ND	ND	
ddt, p,p'	Pesticide	x	x	ND	ND	ND	
polybrominated diphenyl ether (99)	Fire retardant (Br)	x	x	ND	ND	ND	
dechlorane plus	Flame retardan (Cl)	ND	x	ND	ND	ND	
pentachloroanisole (pca)	Pesticide	ND	x	ND	ND	ND	
x	Detection						
ND	Non-Detection						
	Matrix interference						

Isotopes Results

Sample	$\delta^{18}\text{O}$ ‰	δD ‰	$\delta^{34}\text{S}$ ‰	Tritium TU	Error TU
Sonoita Ck blw. Patagonia Dam	-4.2	-40	10.3	3.6	0.25
Santa Cruz R. @ Santa Gertrudis Lane	-6.8	-50	5.1	2.7	0.31
Santa Cruz R. nr. Lochiel	-7.3	-53	-1.9	2.5	0.32
Santa Cruz R. nr. Nogales WWTP	-7.3	-52	5.5	1.3	0.25
Nogales Wash @ Ruby Rd.	-6.5	-48	6.0	2.4	0.37

Geochemistry: Database



Additional Work

- Working with College of Public Health to sample water in 40 households in two different types of Colonia in Nogales, Sonora for E. coli, As, Pb, Hg during summer and winter of 2010
- New gage in Nogales Wash to be installed within next two months with funding from ADWR (funding source EPA Border 2012)
- Laura Norman: IBWC-funded rainfall-runoff modeling for Ambos Nogales and EPA-funded Santa Cruz Ecosystems Portfolio Model
- Floyd Gray: Flood forecasting system for Nogales, Sonora; National Geologic Mapping Program



Gracias por su Atención

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Web site in development:

www.cals.arizona.edu/azwater/taap