

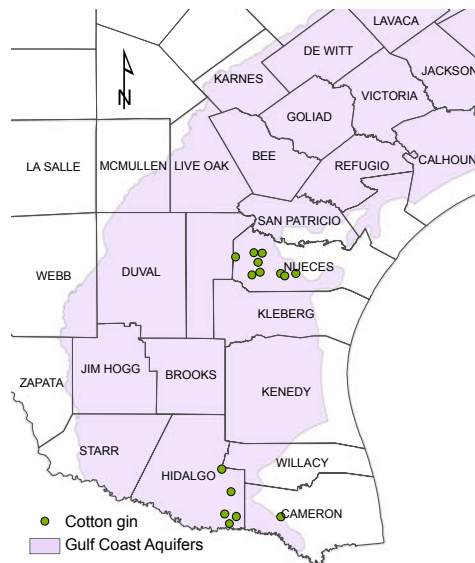


Figure 27. Cotton gin locations in the southwestern Gulf Coast

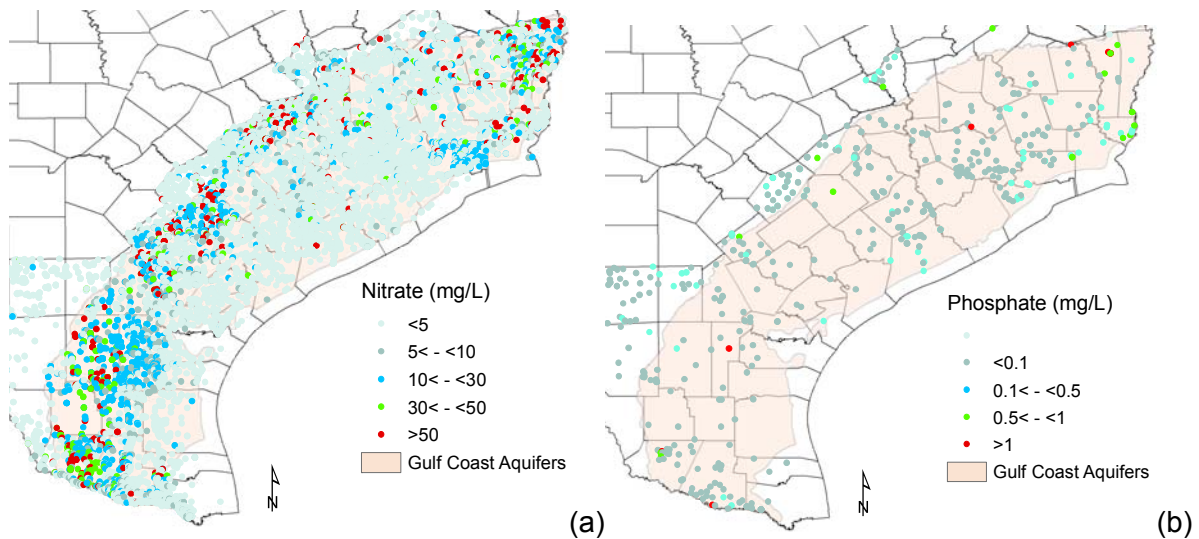
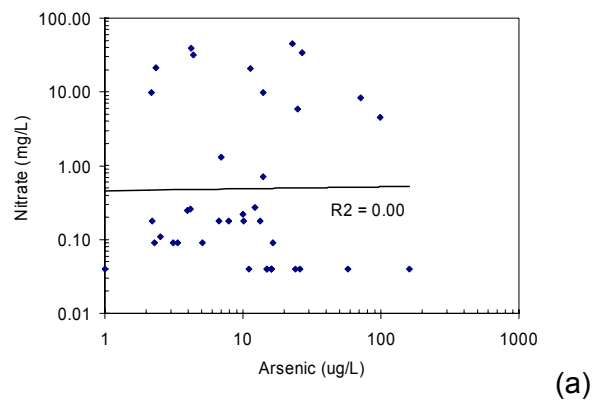


Figure 28. Nitrate (a) and phosphate (b) distribution in the Gulf Coast



NOTE: TWDB data (a)
Figure 29. Crossplot of As vs. Nitrate (southwestern Gulf Coast)

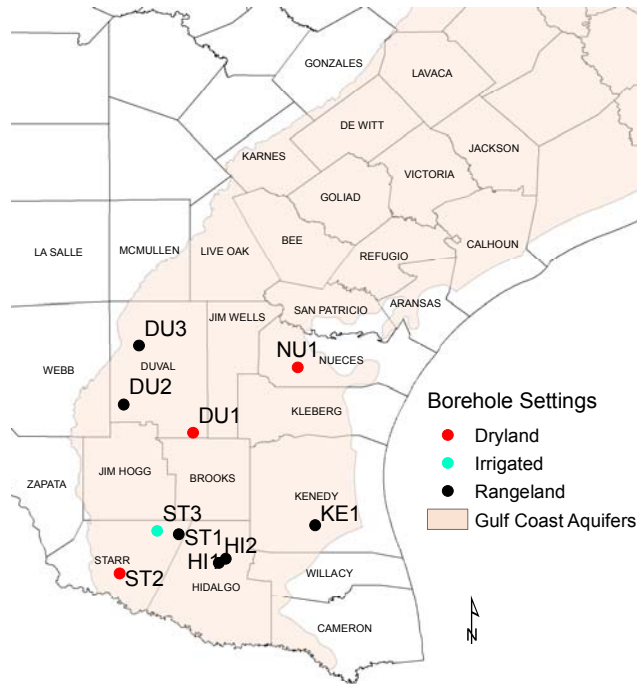
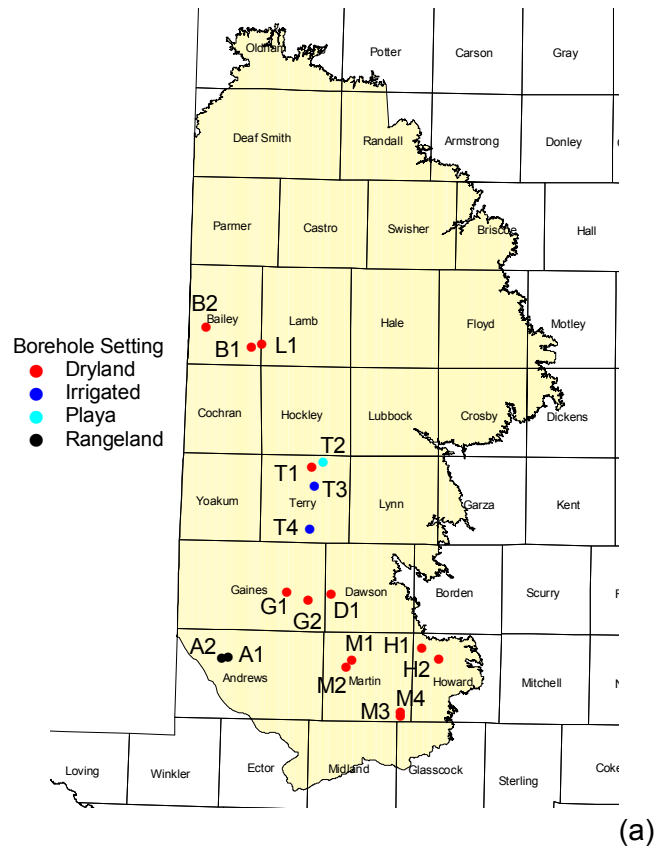


Figure 30. Drilling sites locations: High Plains (a) and southwestern Gulf Coast (b)

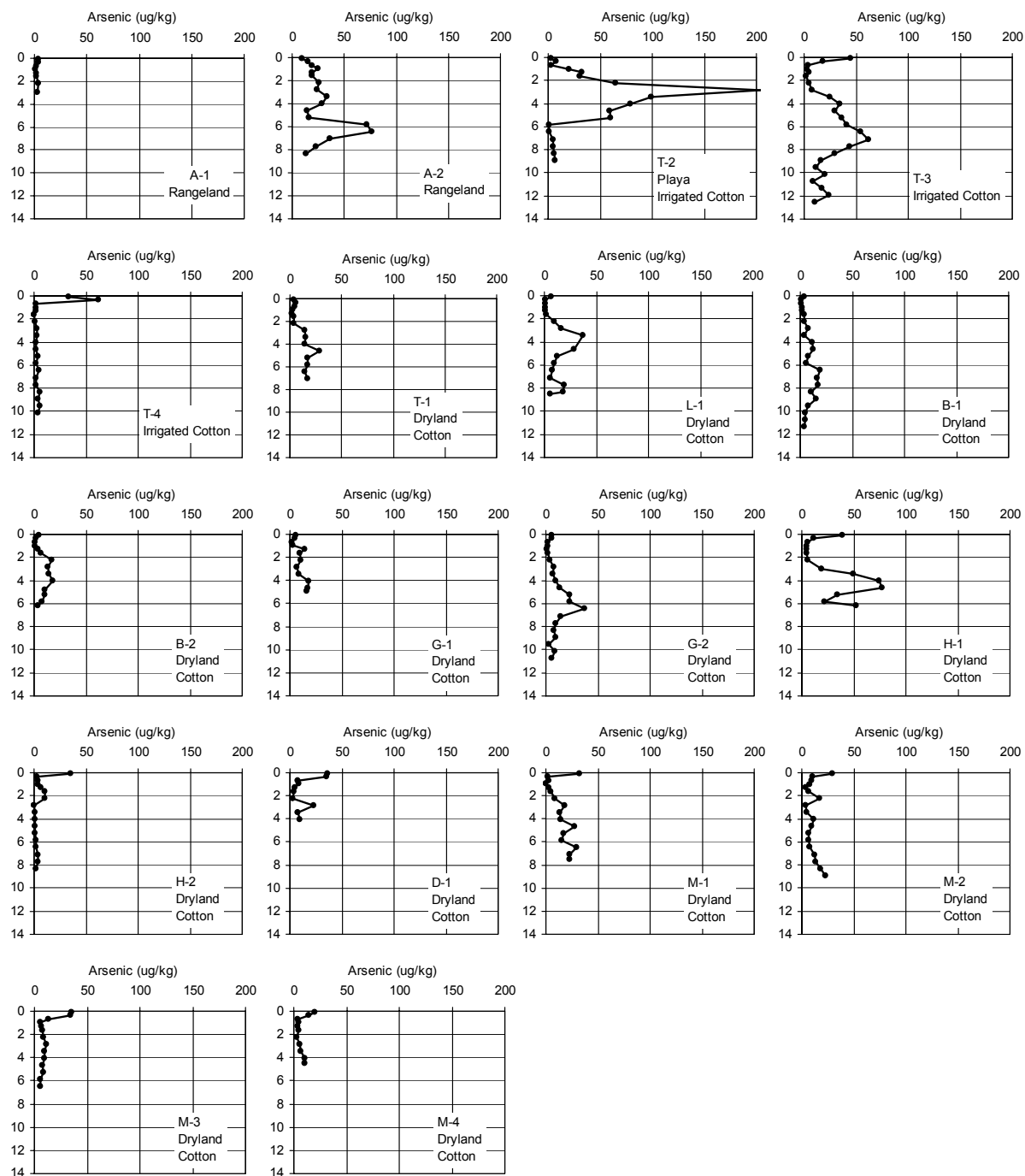


Figure 31. Borehole sample arsenic concentrations in soil in the southern High Plains

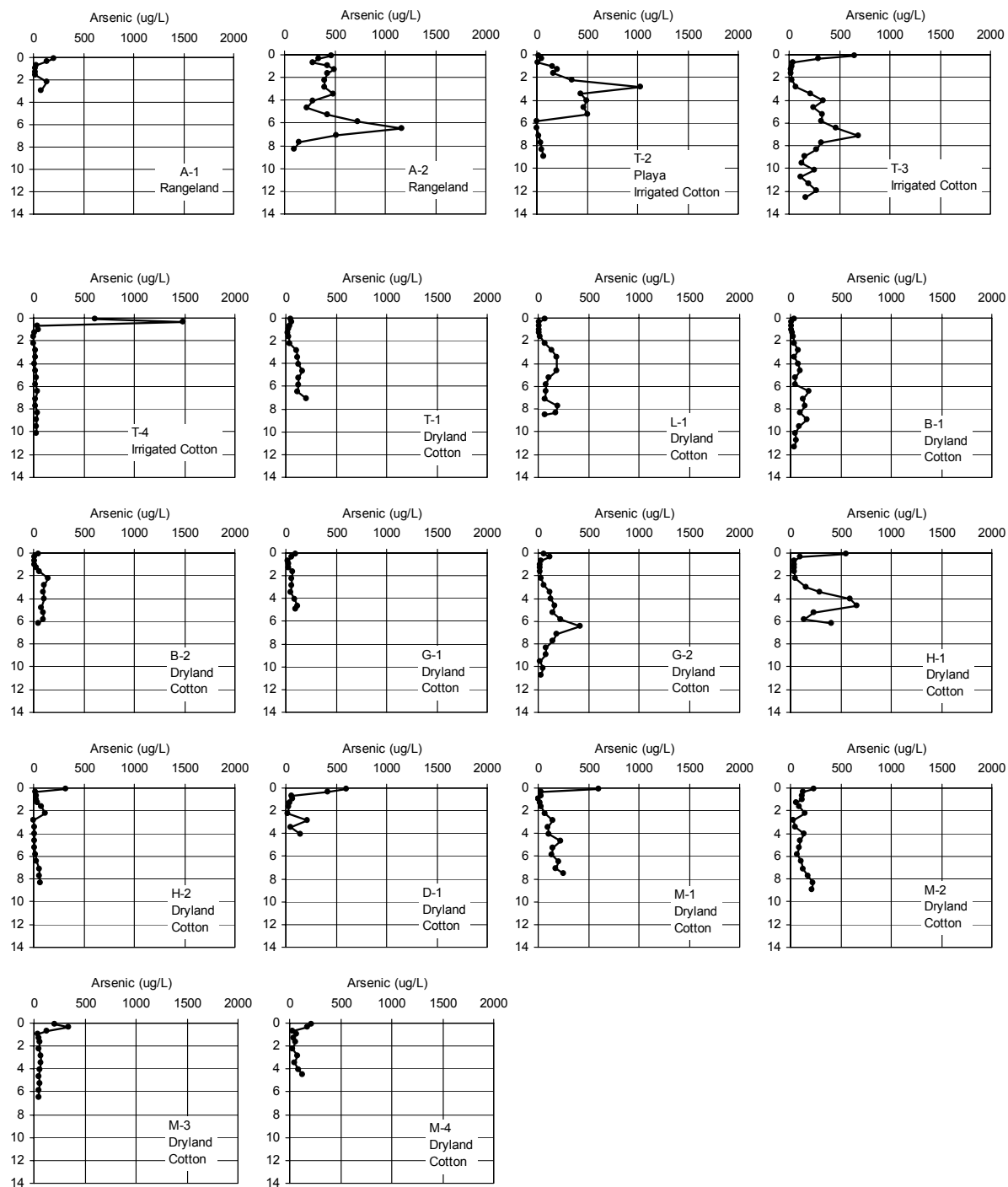


Figure 32. Borehole sample arsenic concentrations in soil water in the southern High Plains

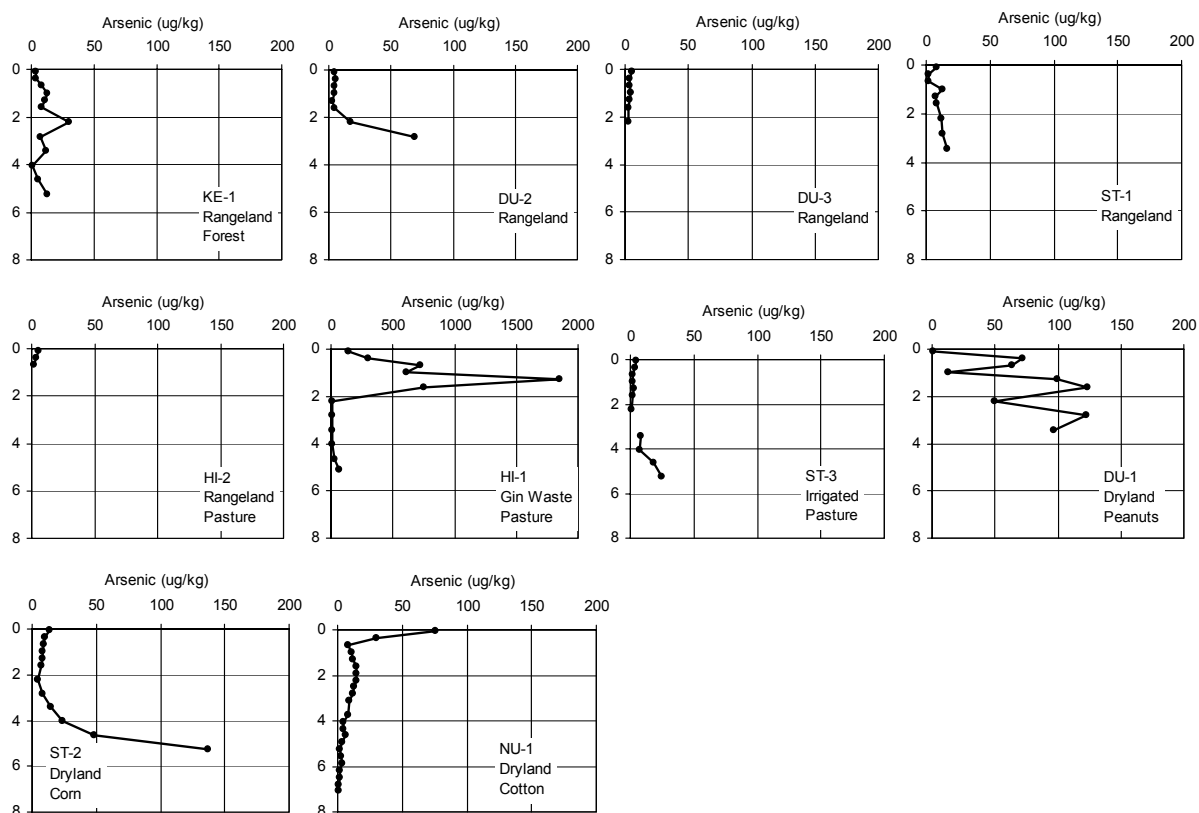


Figure 33. Borehole sample arsenic concentrations in soil in the southwestern Gulf Coast

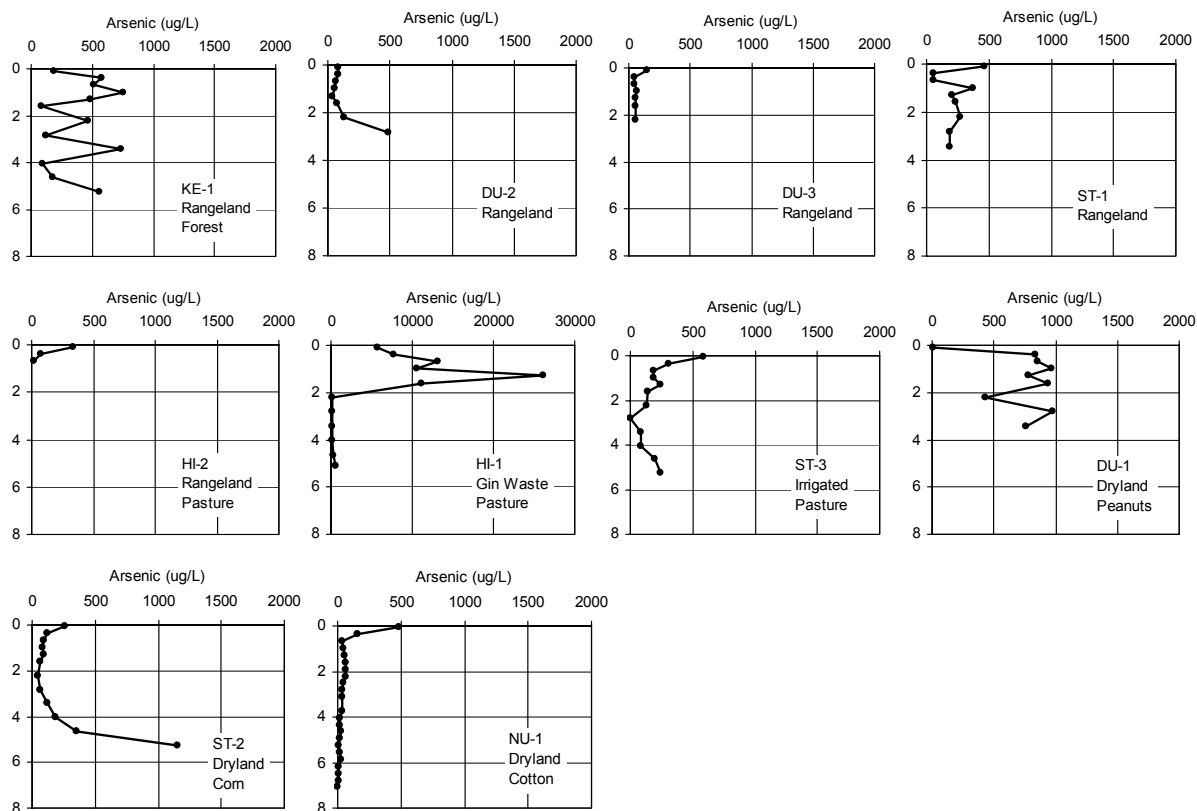
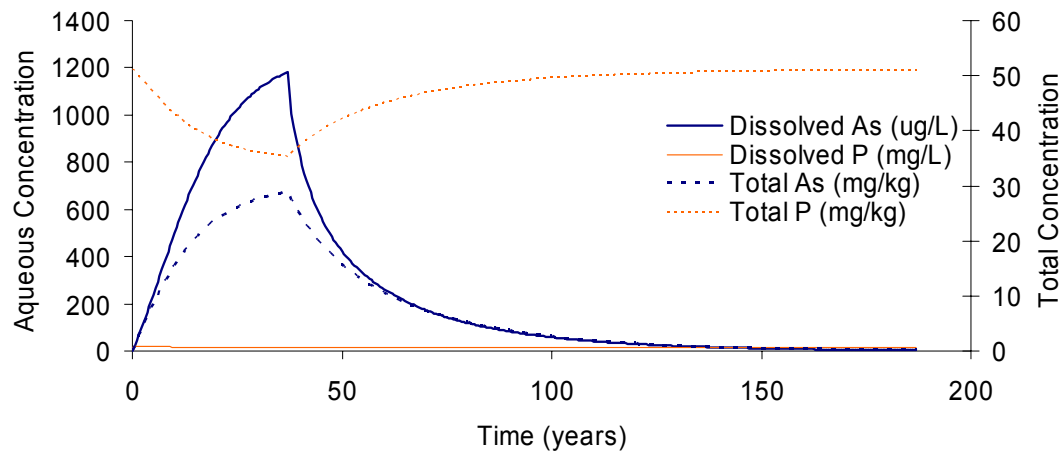


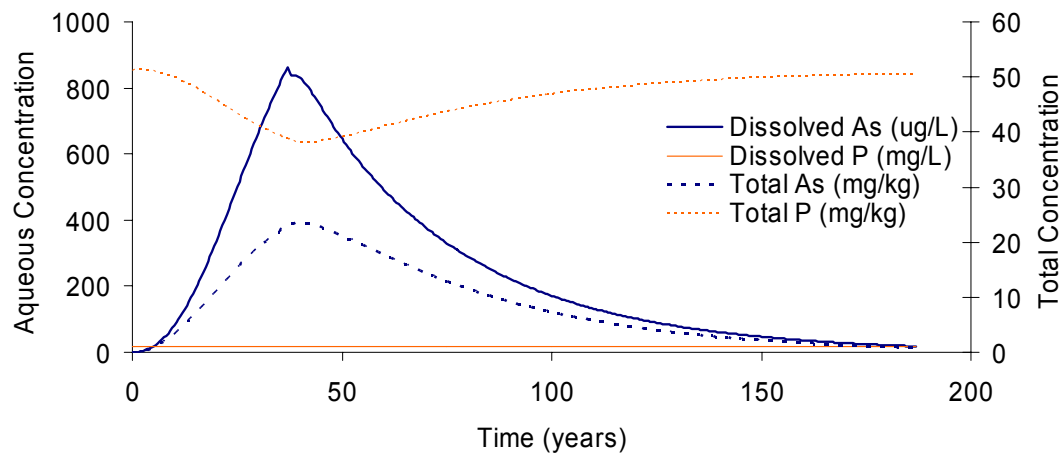
Figure 34. Borehole sample arsenic concentrations in soil water in the southwestern Gulf Coast

Distance = 0.5 m



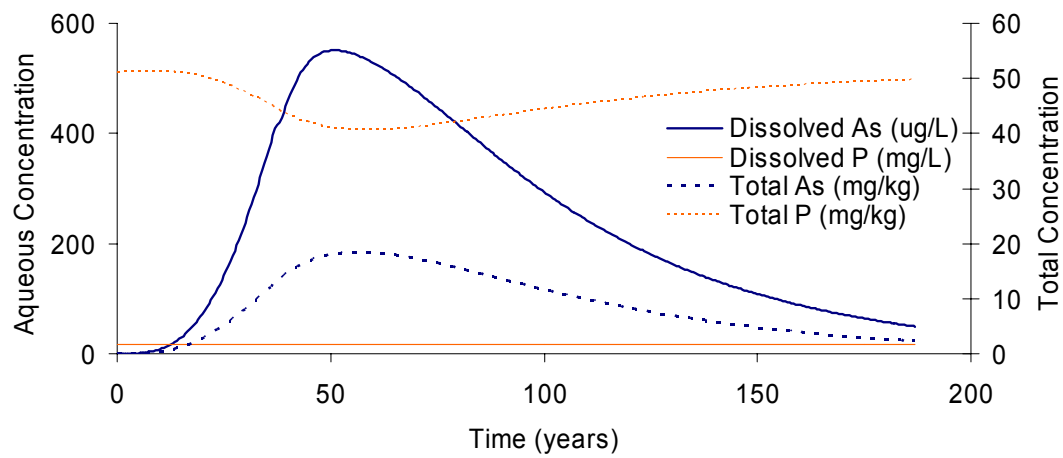
(a)

Distance = 1.5 m



(b)

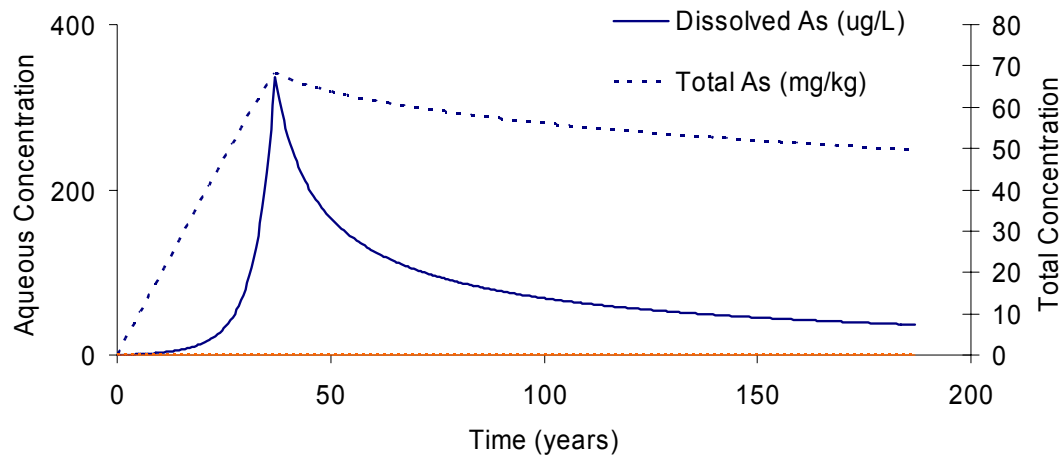
Distance = 2.5 m



(c)

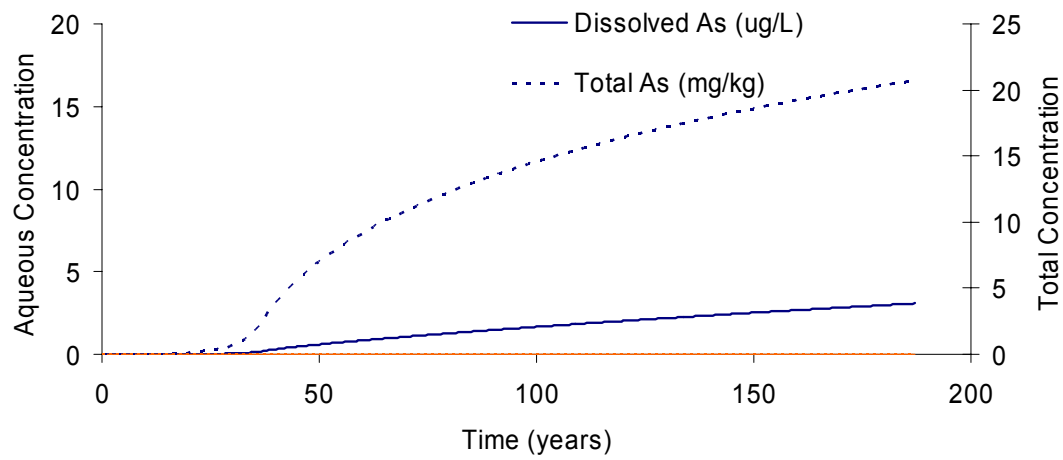
Figure 35. Soil modeling results with phosphates: As and P breakthrough curves at selected distances

Distance = 0.5 m



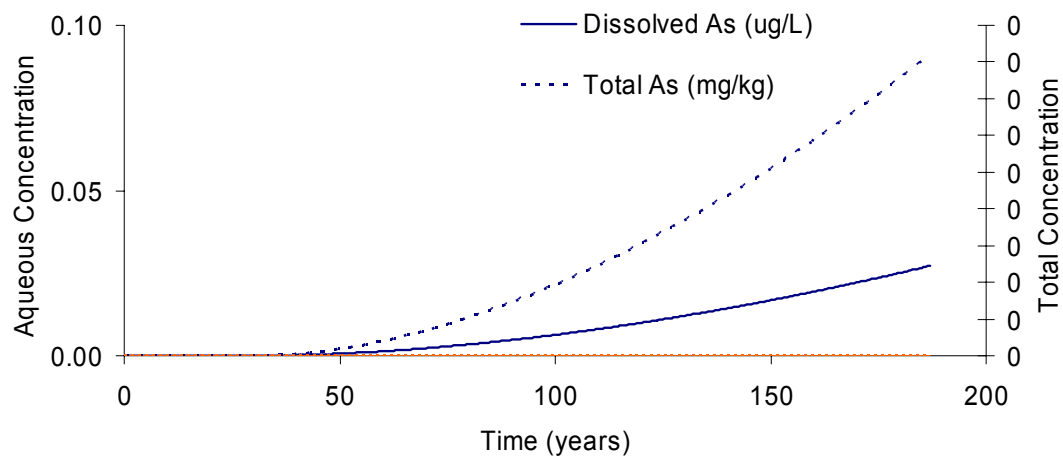
(a)

Distance = 1.5 m



(b)

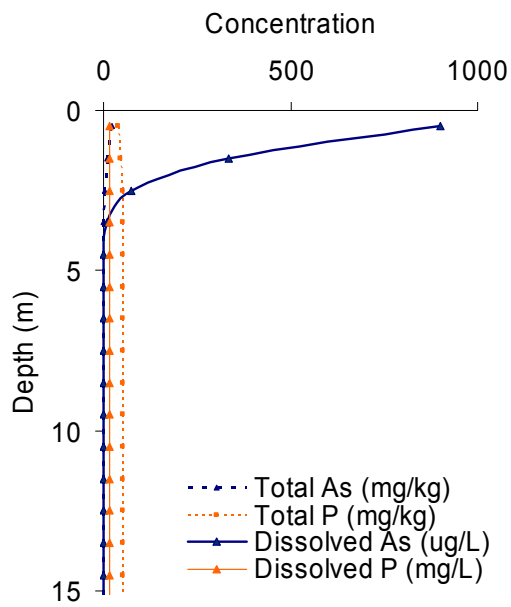
Distance = 2.5 m



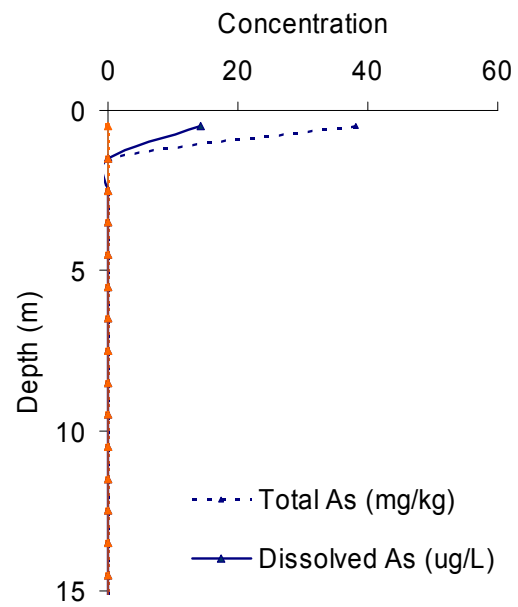
(c)

Figure 36. Soil modeling results without phosphates: As breakthrough curves at selected distances

Time=20 years

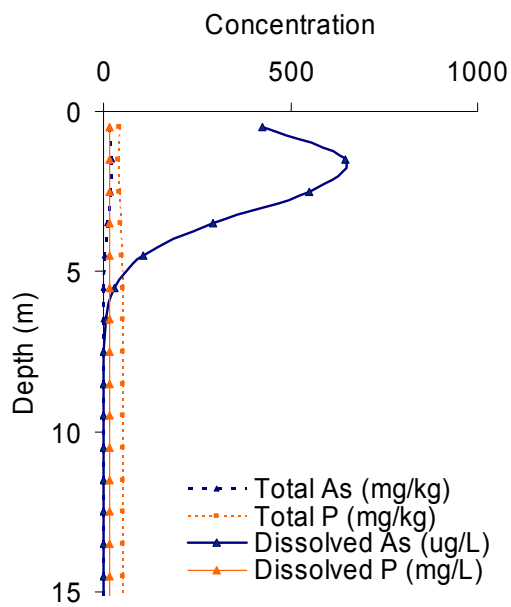


(a)

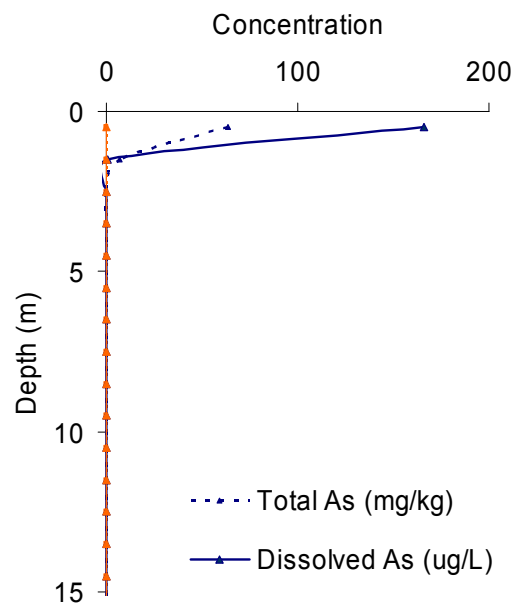


(b)

Time = 50 years



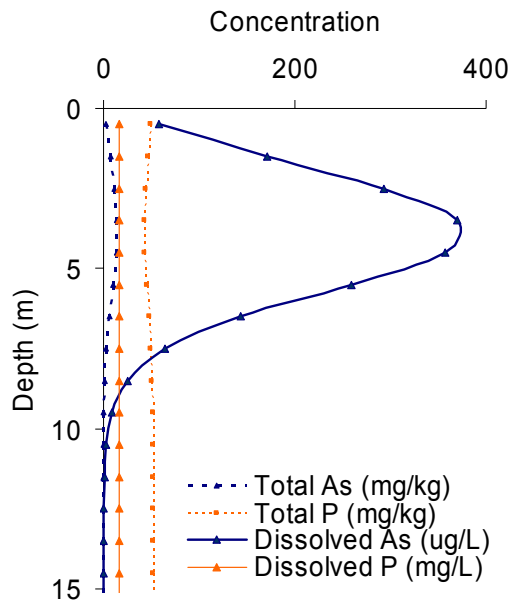
(c)



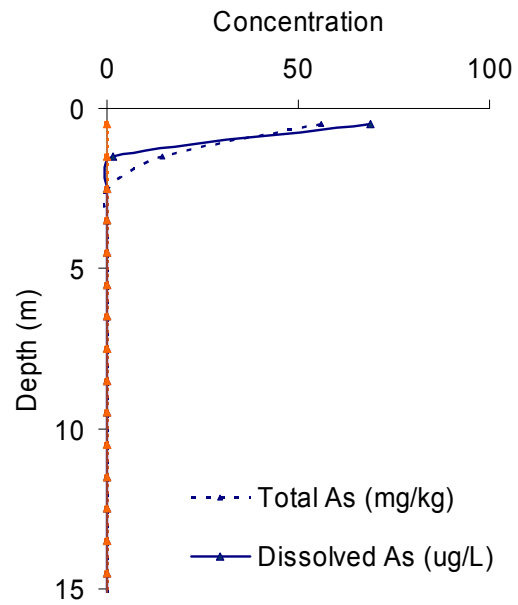
(d)

Figure 37. Soil modeling results with and without phosphates: As and P vertical profiles at selected times

Time = 100 years

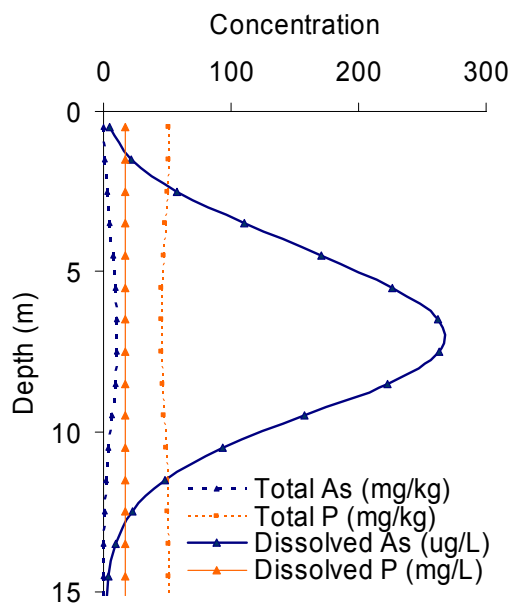


(e)

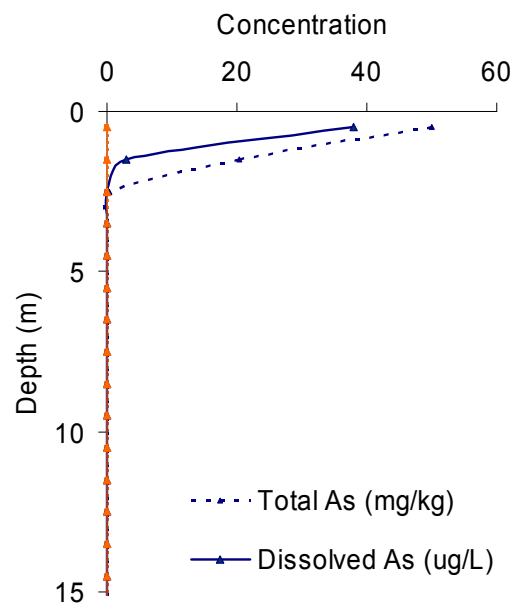


(f)

Time = 180 years

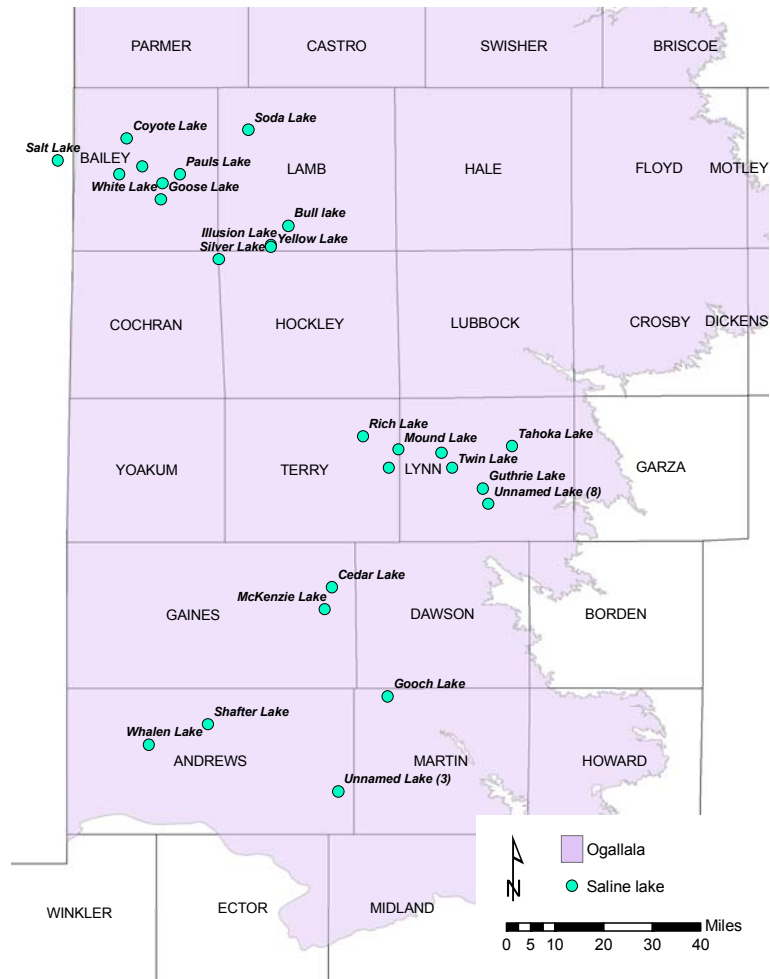


(g)



(h)

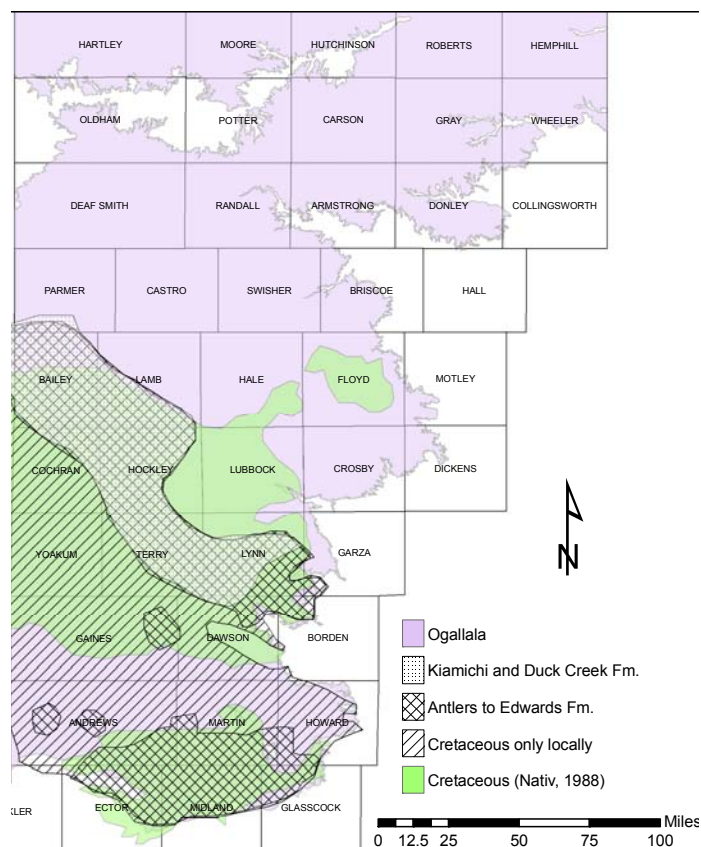
Figure 37. Soil modeling results with and without phosphates: As and P vertical profiles at selected times (continued)



NOTE: Numerals for lakes with unknown lakes are from Wood and Jones (1990)

SOURCE: from Wood and Jones, 1990, and GAT sheets

Figure 38. Location of saline lakes in the Texas High Plains



NOTE: Boundaries close to that of Nativ (1988) were adopted by the TWDB as High Plains Edwards-Trinity minor aquifer

SOURCE: (a) Brand et al. (1953) and (b) Nativ (1988)

Figure 39. Location of Cretaceous subcrops in the southern High Plains

System	Series	Stratigraphic Units		Hydrogeologic Units
				Baker (1979)
Quaternary	Holocene	Alluvium		Chicot aquifer
	Pleistocene	Beaumont Clay		
		Lissie Formation	Montgomery Formation	
			Bentley Formation	
		Willis Sand		
Tertiary	Pliocene	Goliad Sand		Evangeline aquifer
	Miocene	Fleming Formation/ Lagarto Clay		Burkeville Confining System
		Oakville Sandstone		Jasper aquifer
	Oligocene	1 Catahoula tuff or sandstone	2 Upper part of Catahoula tuff	Catahoula Confining System
			2 Anahuac Formation	
			2 Frio Formation	
		1 Frio Clay	2 Vicksburg Group equivalent	

<

SOURCE: Chowdhury and Mace, 2003
Figure 40. Stratigraphy and hydrostratigraphy of the Gulf Coast aquifers

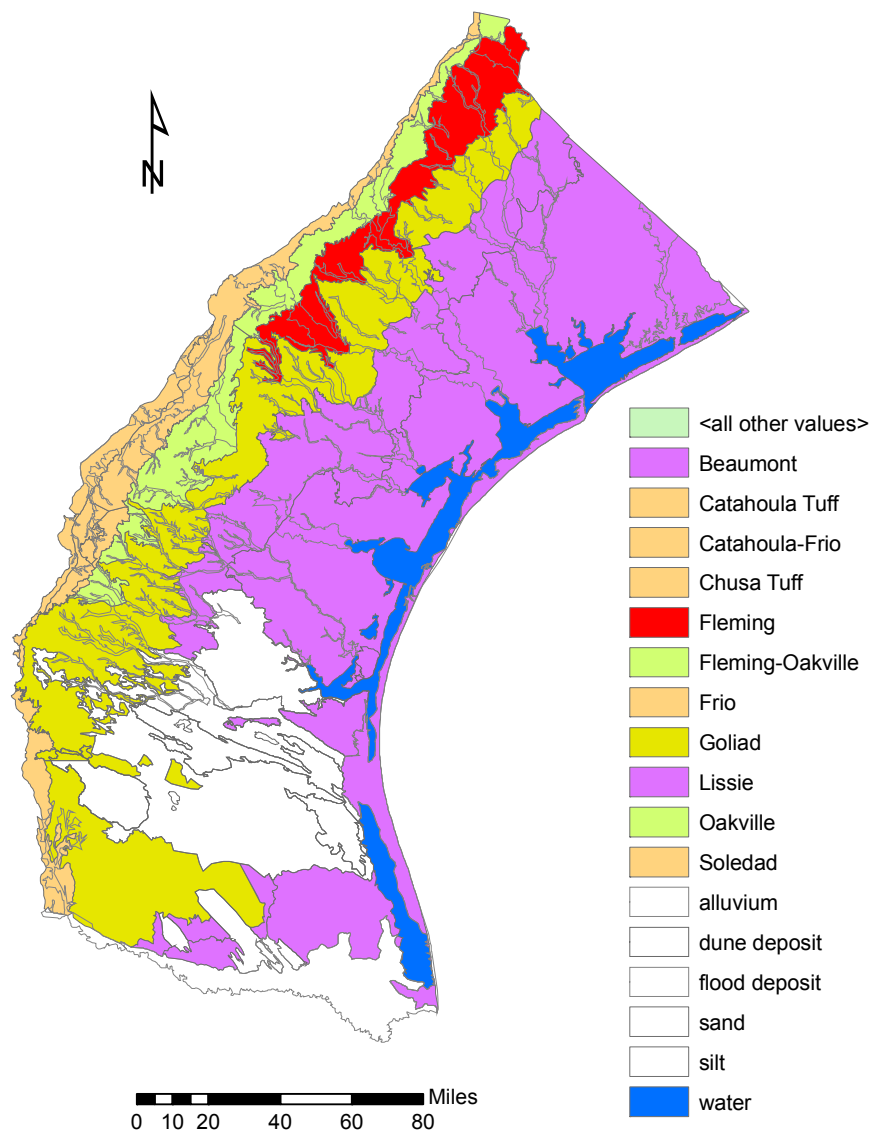


Figure 41. Simplified geologic map of the southwestern Gulf Coast region

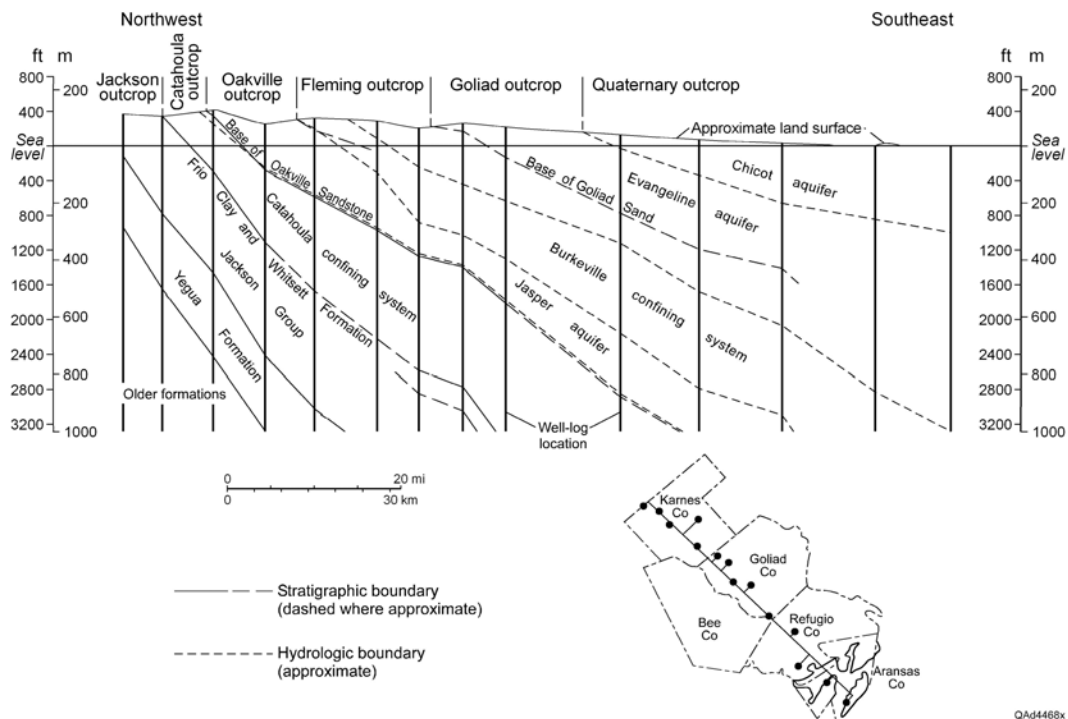


Figure 42. Cross-section along dip in the Gulf Coast aquifer through Karnes, Goliad, and Refugio Counties

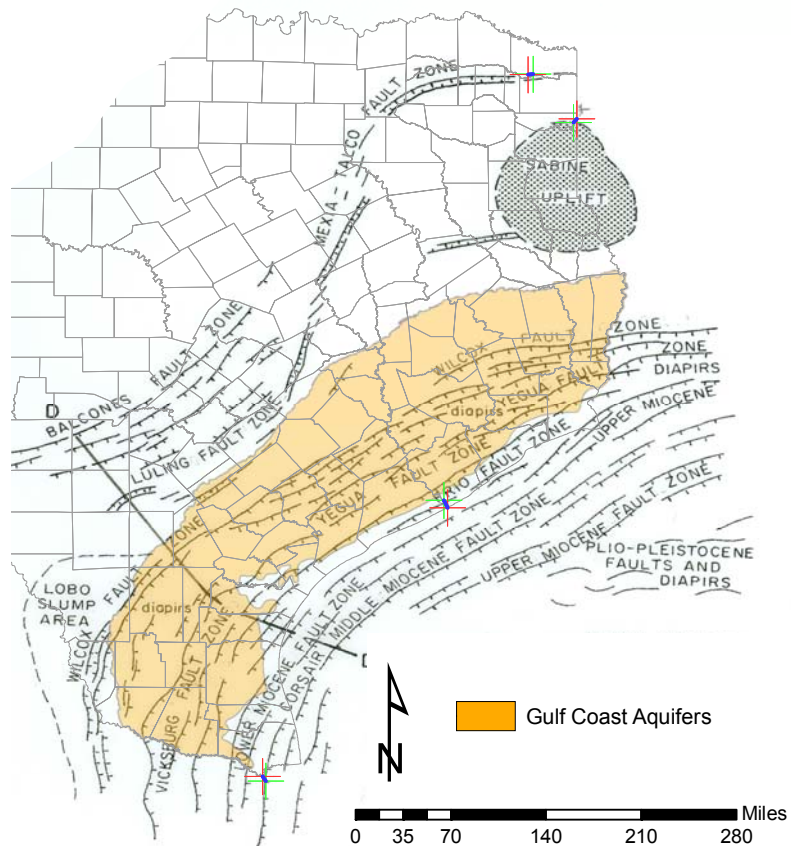


Figure 43. Tectonic map of the Gulf Coast area

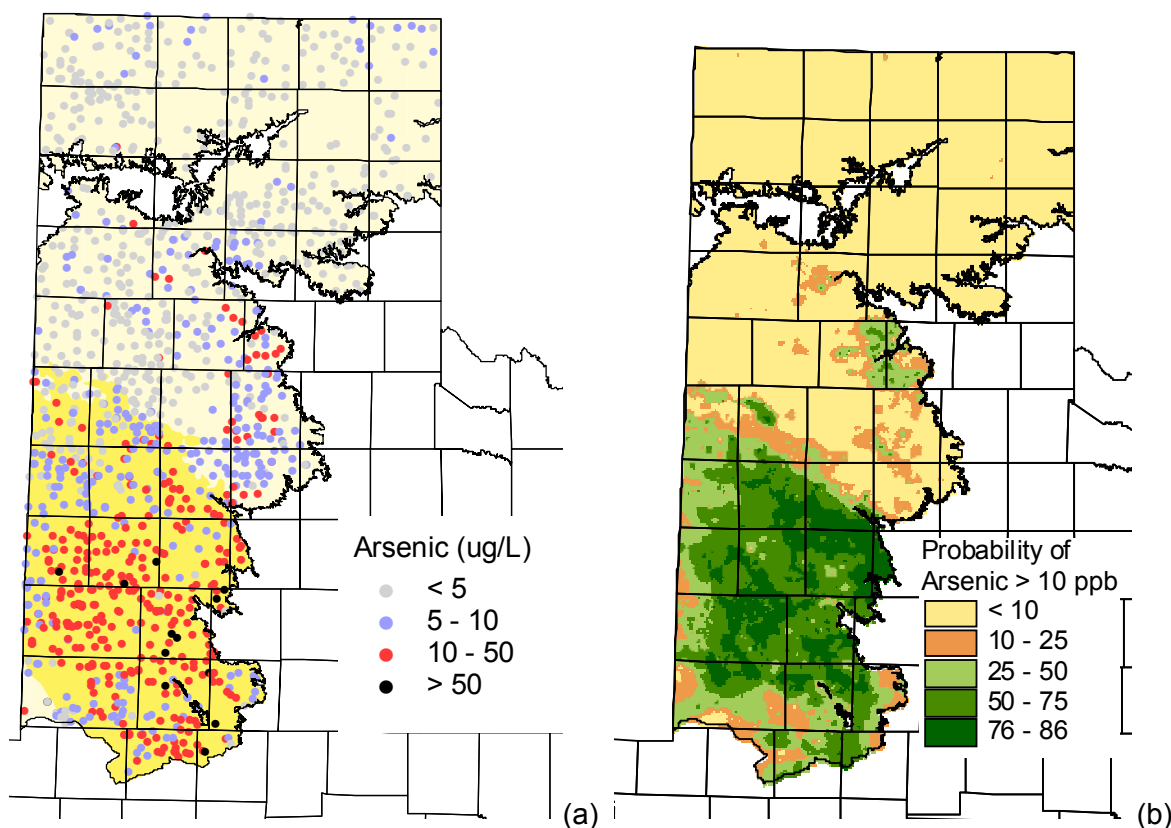
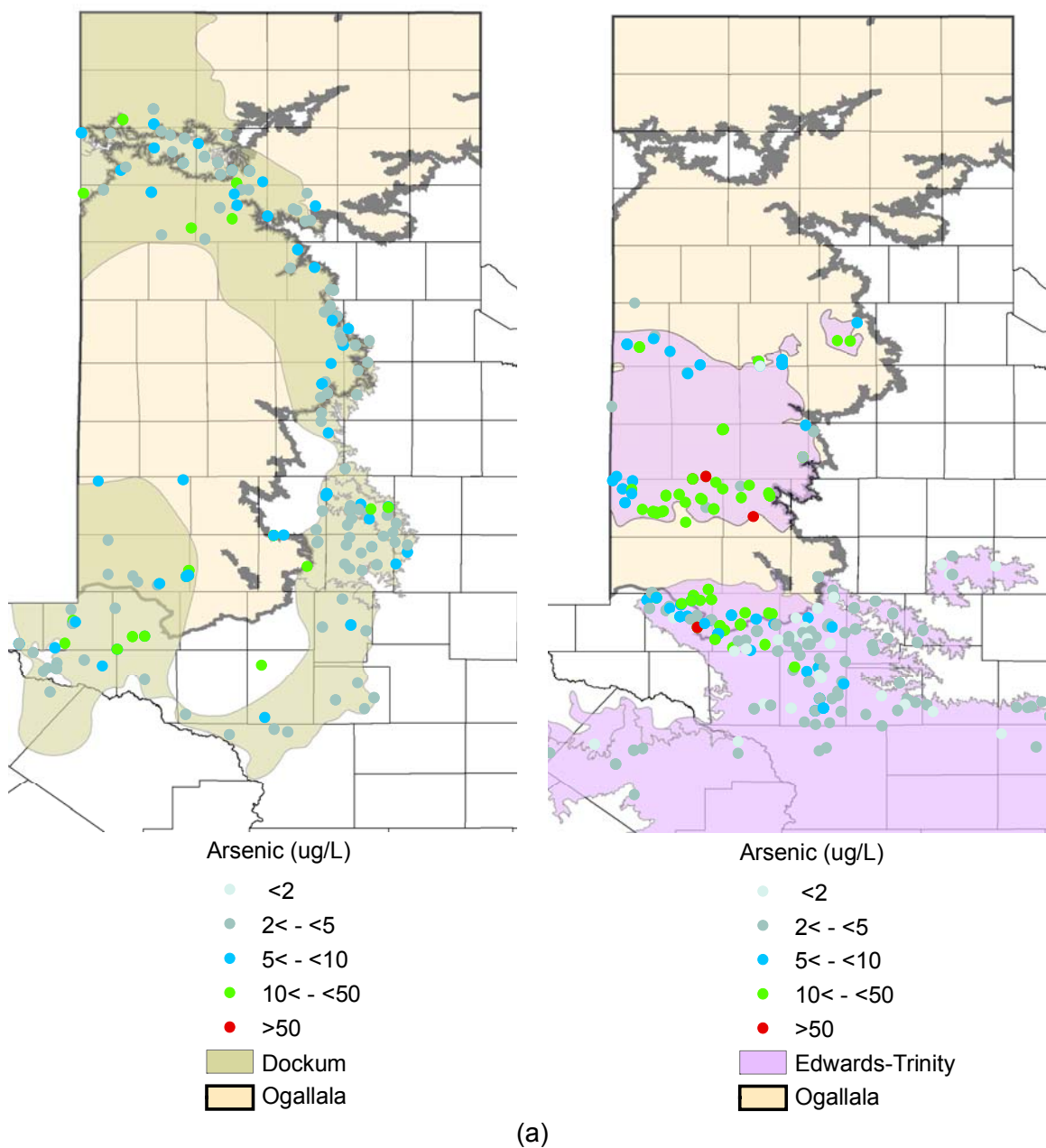
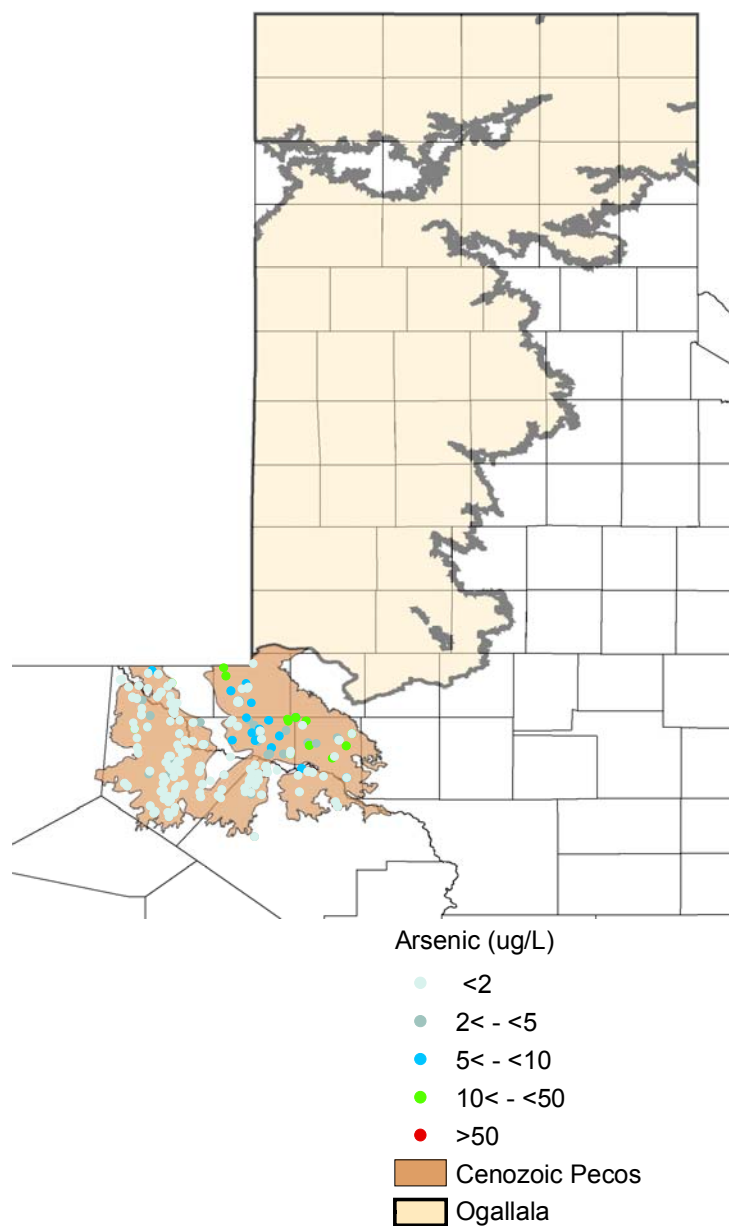


Figure 44. Arsenic distribution in the High Plains aquifer (TWDB database): (a) from arsenic data points; (b) inferred from fluoride data points.



NOTE: data include those High Plains wells screening in multiple formations
 NOTE: only Dockum outcrop and that part of the aquifer with a TDS<5,000 mg/L are shown. Downdip central section is more saline. Dockum Fm. underlies all of the southern High Plains aquifer.
 SOURCE: aquifer outlines from TWDB GIS coverage of major and minor aquifers
 Figure 45. Arsenic distribution in the Dockum (a), Edwards Trinity (b), and Cenozoic Pecos Alluvium aquifers (c).



NOTE: data include those High Plains wells screening in multiple formations

SOURCE: aquifer outlines from TWDB GIS coverage of major aquifers

Figure 45. Arsenic distribution in the Dockum (a), Edwards Trinity (b), and Cenozoic Pecos Alluvium aquifers (c). (continued)

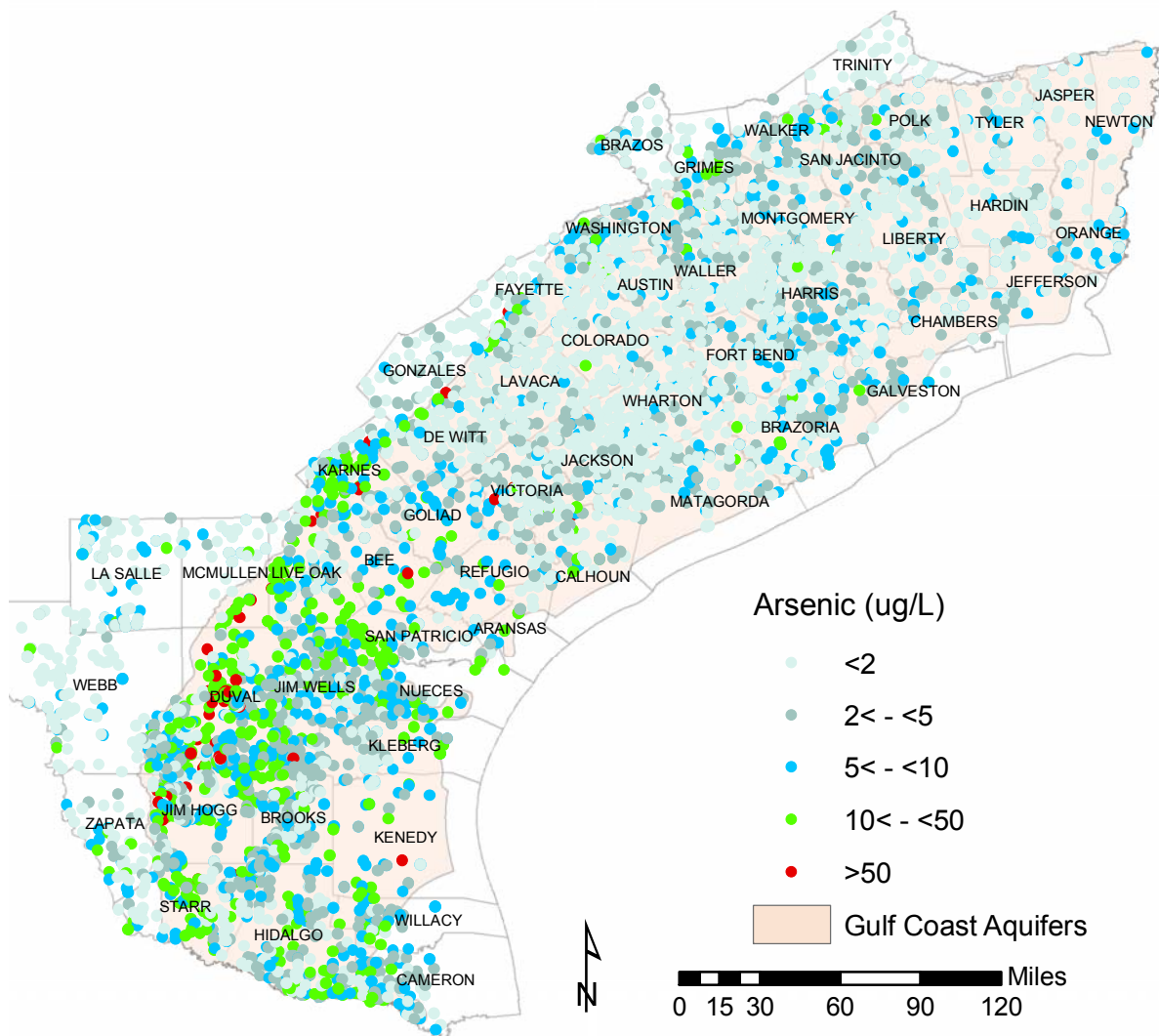


Figure 46. Arsenic distribution in the Gulf Coast aquifers (TWDB and NURE databases)

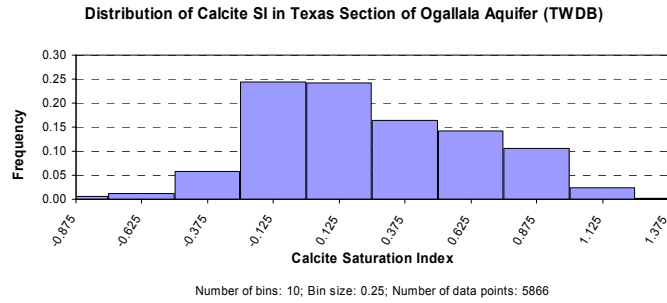
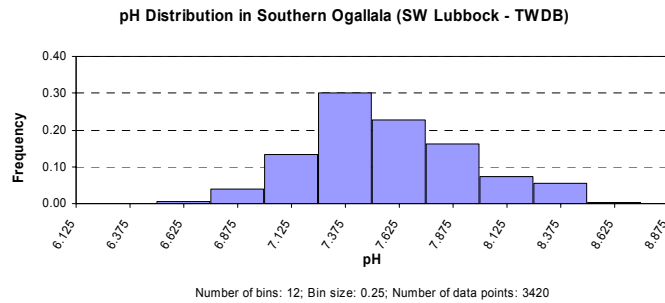
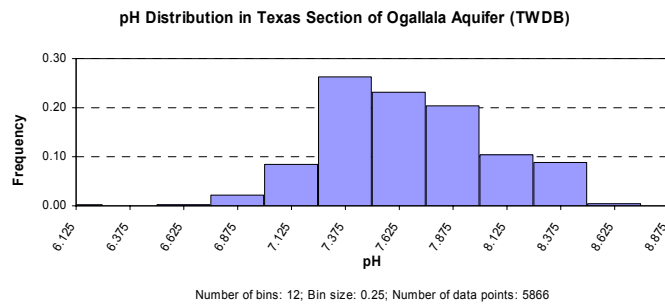


Figure 47. Distribution of calcite saturation index in the southern High Plains aquifer (TWDB data set)



(a)



(b)

Figure 48. pH distribution in the High Plains Aquifer: all Texas data points (a); southwestern region of southern High Plains (b). all data points (TWDB database).

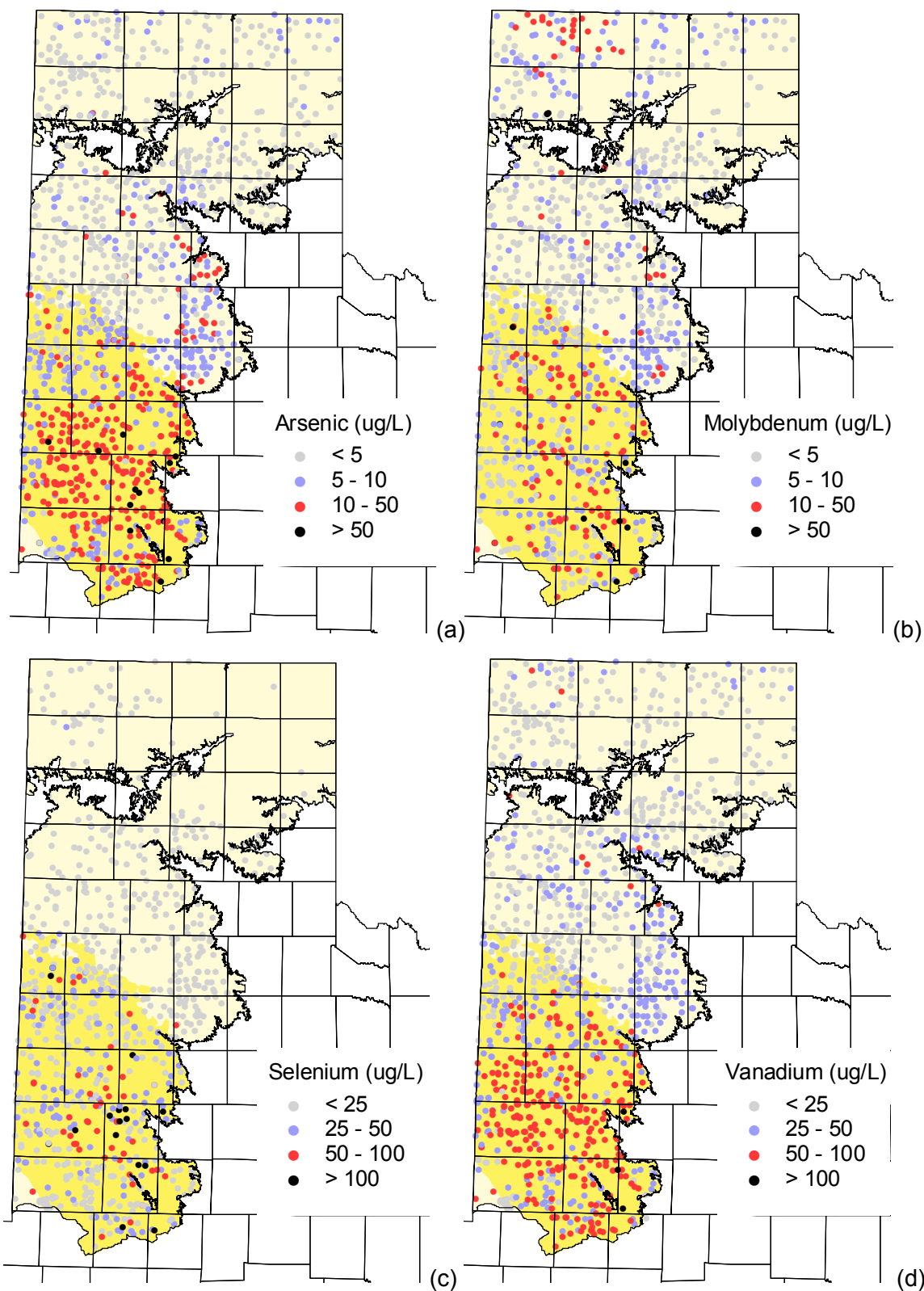


Figure 49. Spatial distribution of As (a), Mo (b), Se (c), V (d), B (e), F (f), U (g), silica (h), Fe (i), chloride (j), sulfate (k), TDS (l), and pH (m) in High Plains aquifers. All plots use only TWDB data except U where NURE data are used.

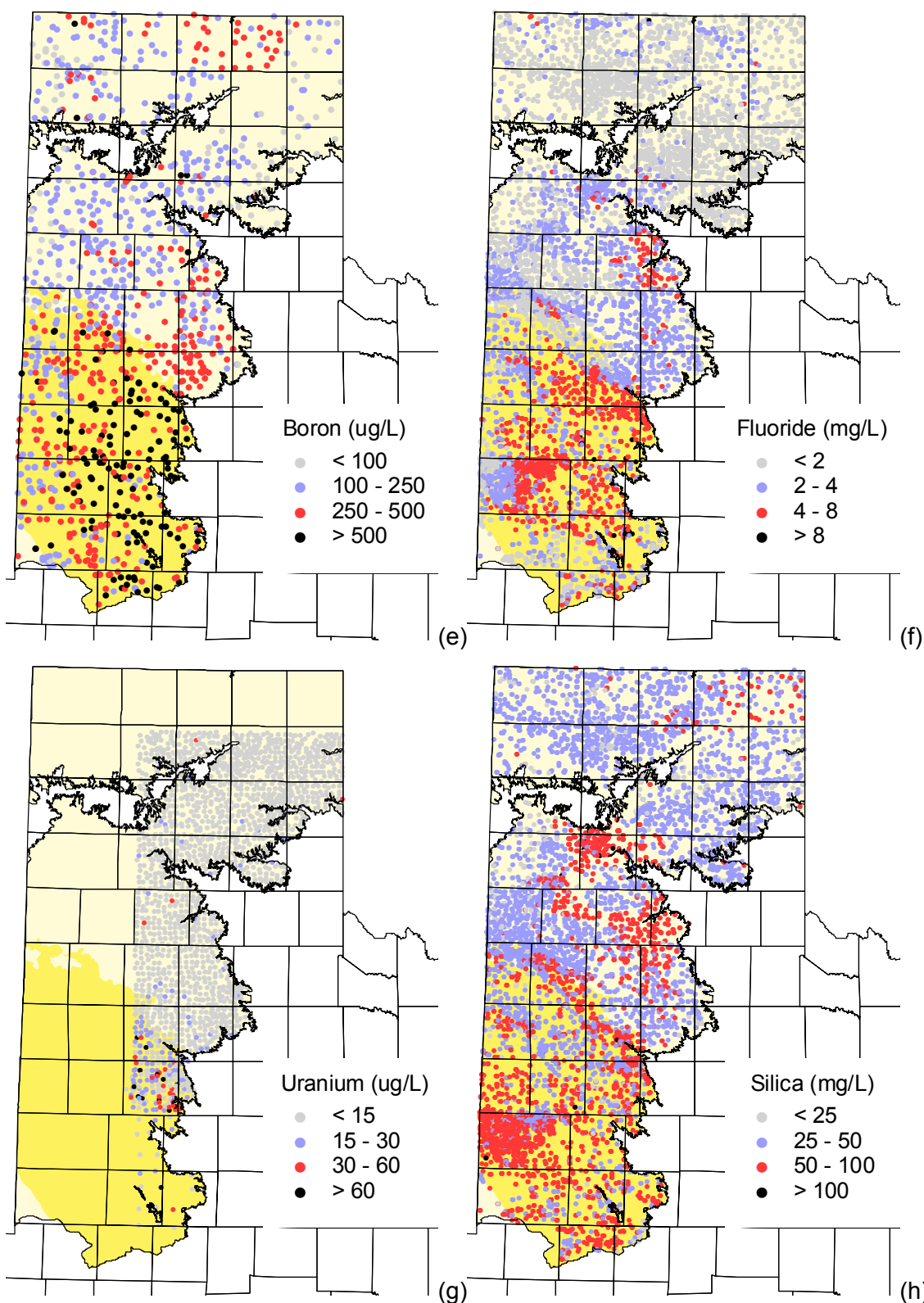


Figure 49. Spatial distribution of As (a), Mo (b), Se (c), V (d), B (e), F (f), U (g), silica (h), Fe (i), chloride (j), sulfate (k), TDS (l), and pH (m) in High Plains aquifers. All plots use only TWDB data except U where NURE data are used. (continued)

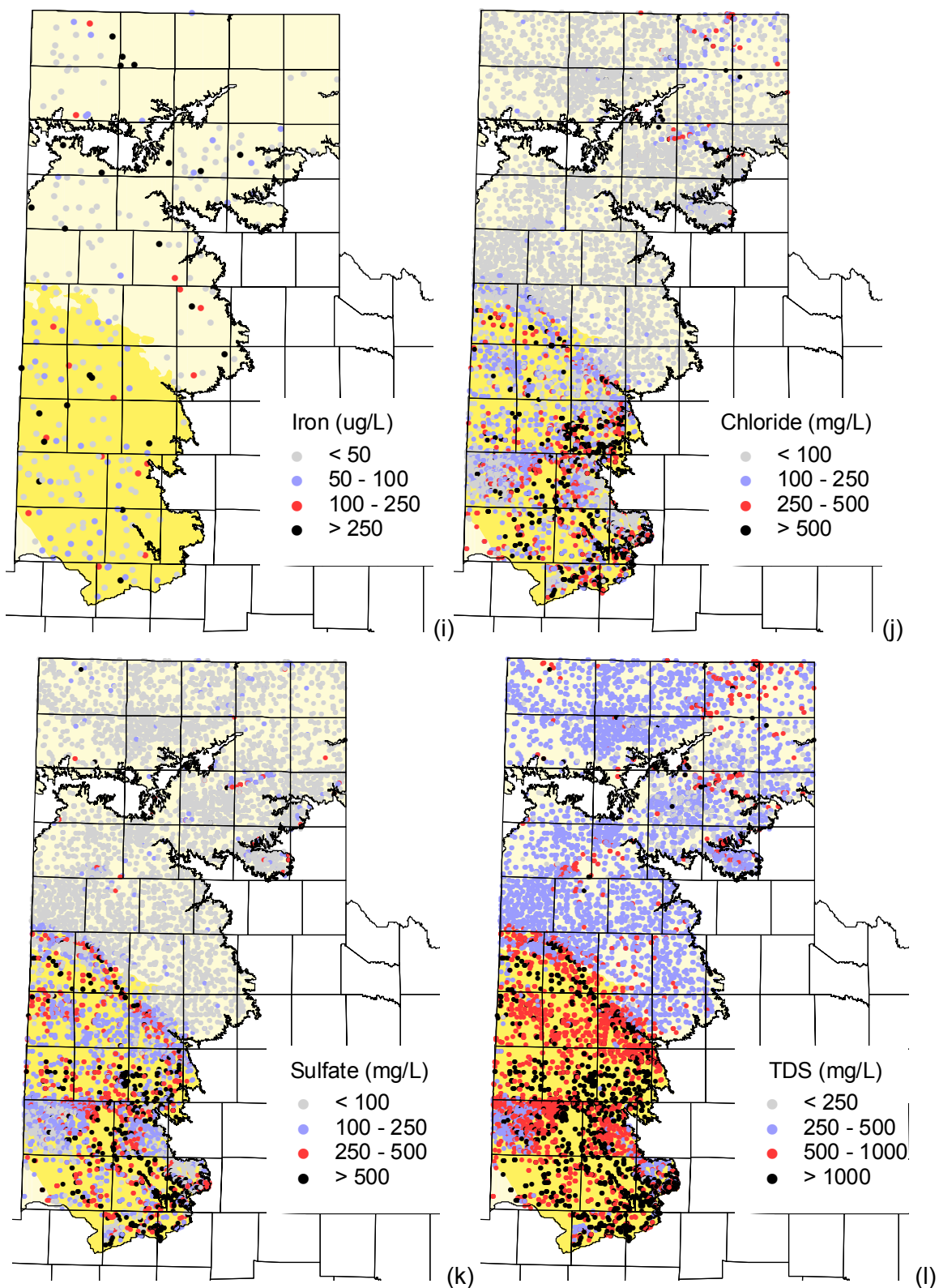


Figure 49. Spatial distribution of As (a), Mo (b), Se (c), V (d), B (e), F (f), U (g), silica (h), Fe (i), chloride (j), sulfate (k), TDS (l), and pH (m) in High Plains aquifers. All plots use only TWDB data except U where NURE data are used. (continued)

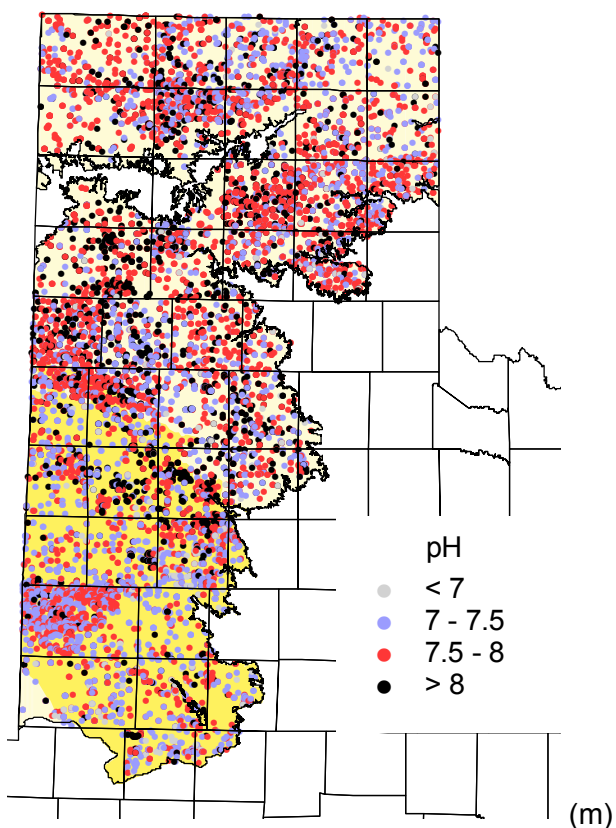
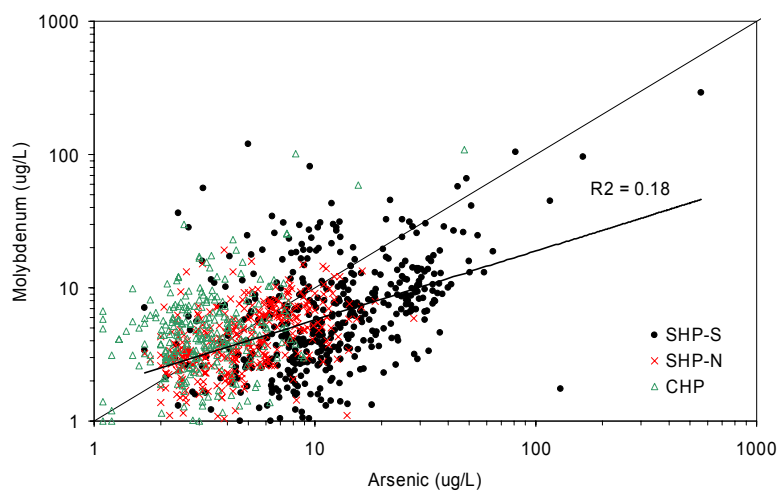
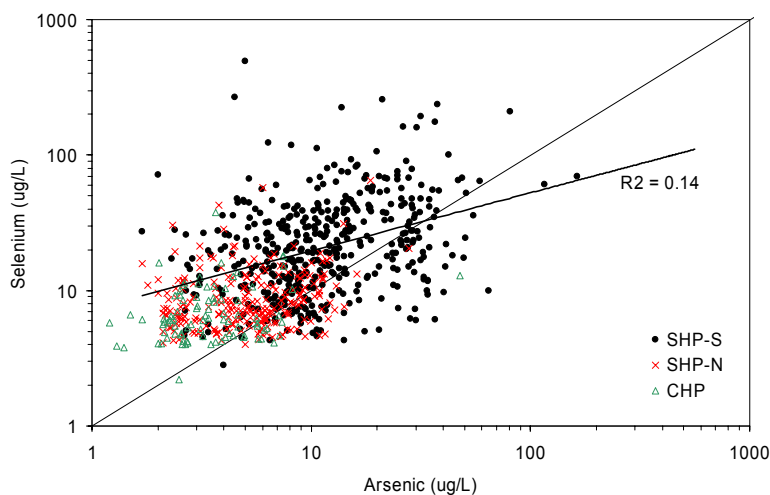


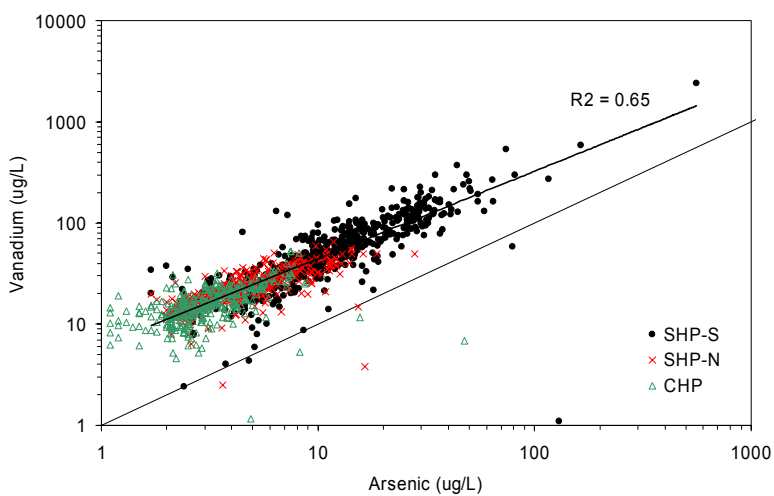
Figure 49. Spatial distribution of As (a), Mo (b), Se (c), V (d), B (e), F (f), U (g), silica (h), Fe (i), chloride (j), sulfate (k), TDS (l), and pH (m) in High Plains aquifers. All plots use only TWDB data except U where NURE data are used. (continued)



(a)

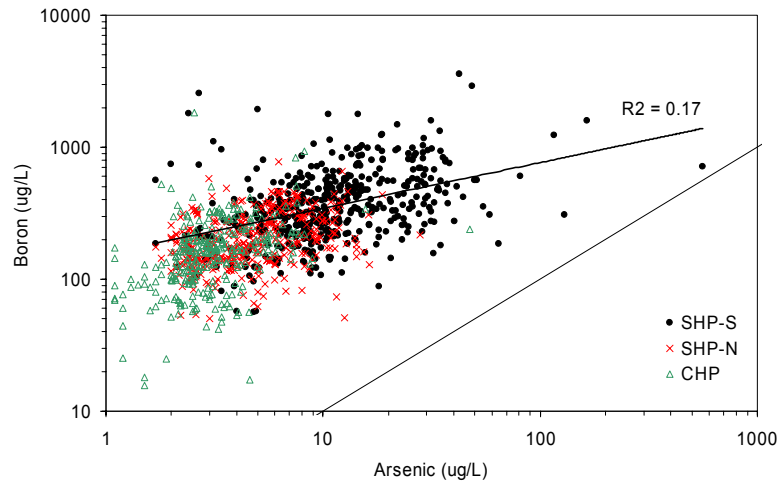


(b)

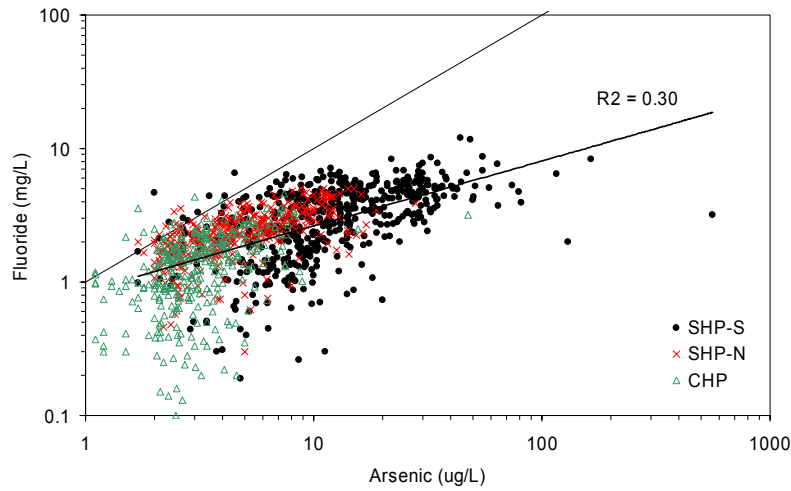


(c)

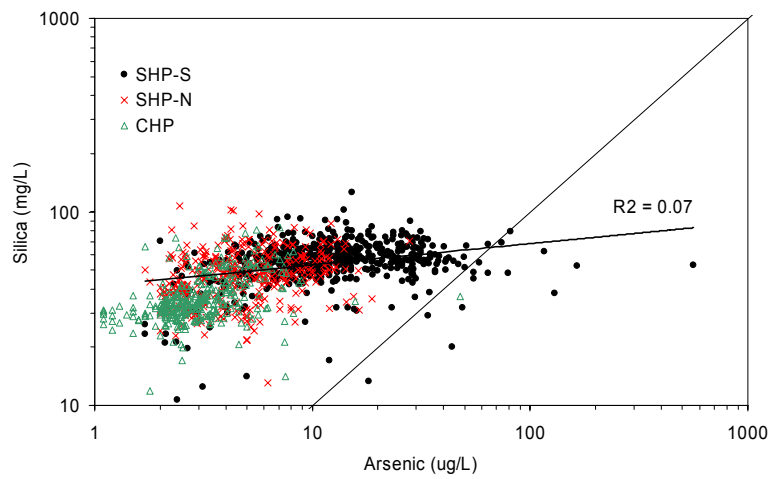
Figure 50. Cross-plots of (a) As vs. Mo, (b) vs. Se, (c) vs. V, (d) vs. B, (e) vs. F, (f) vs. silica, (g) vs. Fe, (h) vs. bicarbonate, (i) vs. sulfate, (j) vs. chloride, (l) vs. TDS and (m) vs. pH (NURE data set), High Plains aquifers.



(d)



(e)



(f)

Figure 50. Cross-plots of (a) As vs. Mo, (b) vs. Se, (c) vs. V, (d) vs. B, (e) vs. F, (f) vs. silica, (g) vs. Fe, (h) vs. bicarbonate, (i) vs. sulfate, (j) vs. chloride, (l) vs. TDS and (m) vs. pH (NURE data set), High Plains aquifers. (continued)

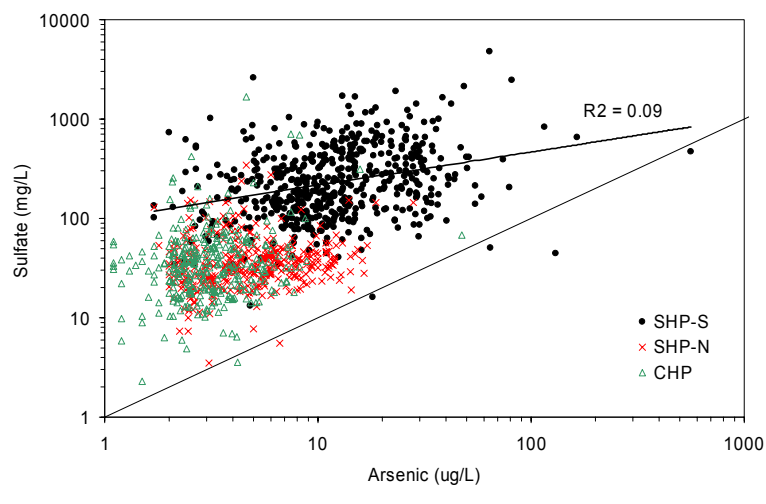
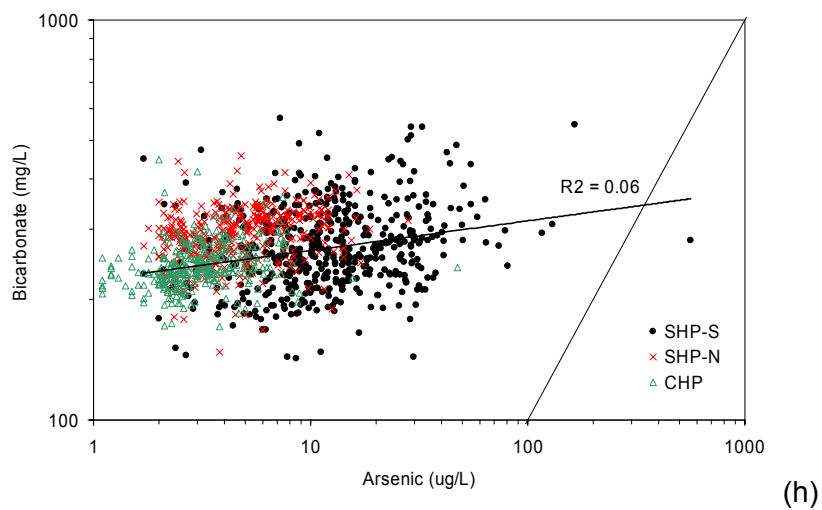
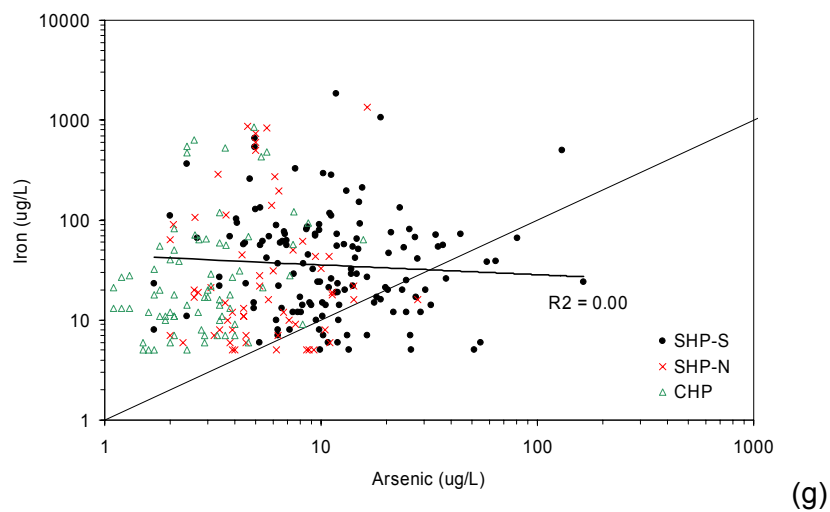
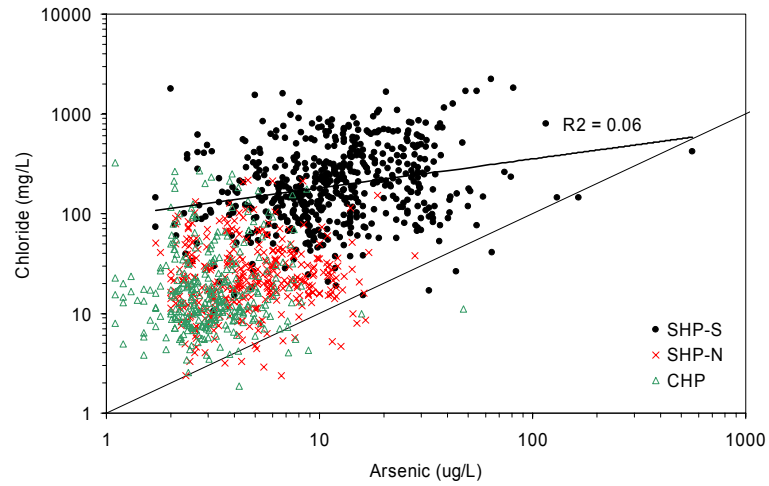
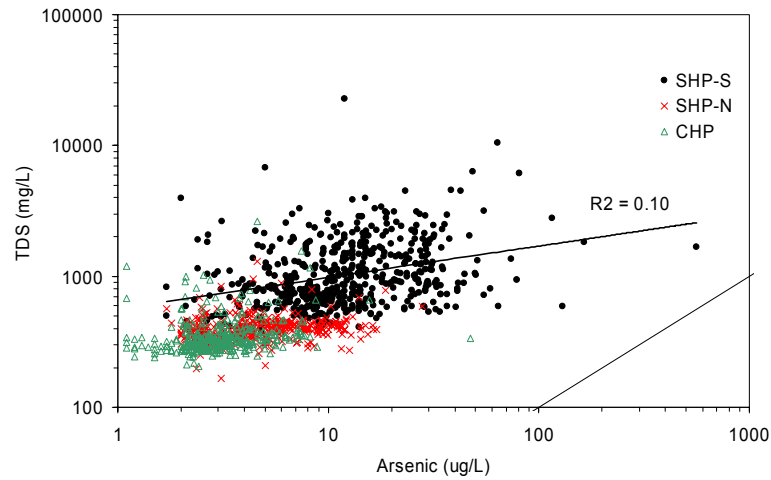


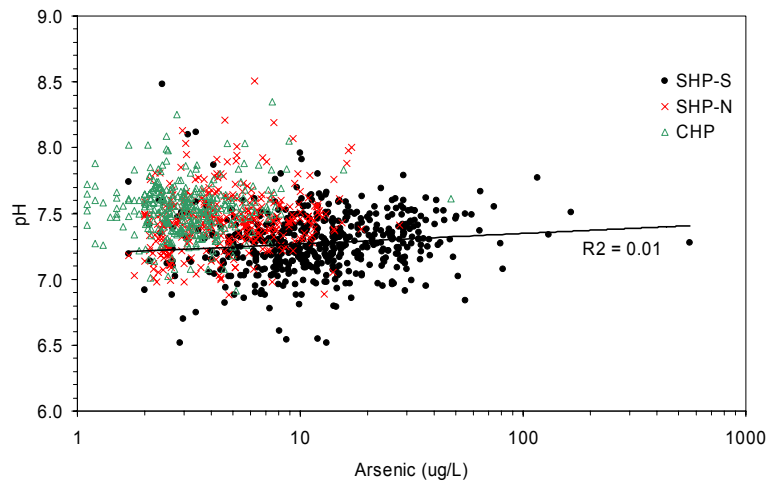
Figure 50. Cross-plots of (a) As vs. Mo, (b) vs. Se, (c) vs. V, (d) vs. B, (e) vs. F, (f) vs. silica, (g) vs. Fe, (h) vs. bicarbonate, (i) vs. sulfate, (j) vs. chloride, (l) vs. TDS and (m) vs. pH (NURE data set), High Plains aquifers. (continued)



(j)

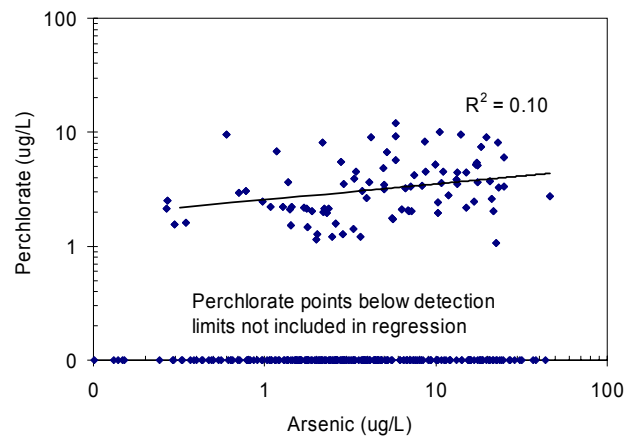


(l)



(m)

Figure 50. Cross-plots of (a) As vs. Mo, (b) vs. Se, (c) vs. V, (d) vs. B, (e) vs. F, (f) vs. silica, (g) vs. Fe, (h) vs. bicarbonate, (i) vs. sulfate, (j) vs. chloride, (l) vs. TDS and (m) vs. pH (NURE data set), High Plains aquifers. (continued)



NOTE: Data set from Public Water Supply well sampling (Jackson et al., 2004)
 Figure 51. Cross-plot of As vs. perchlorate, southern High Plain aquifers.

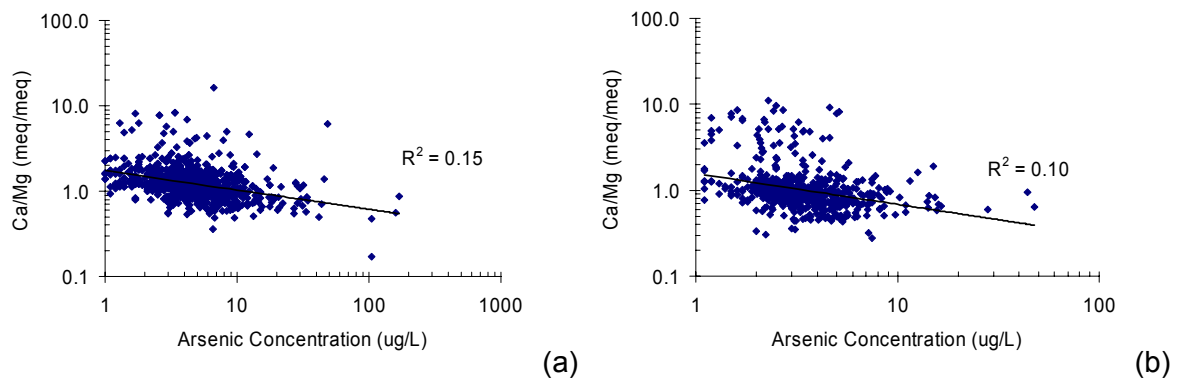


Figure 52. Cross-plot of As vs. Ca/Mg ratio, southern High Plains; NURE (a) and TWDB (b) databases

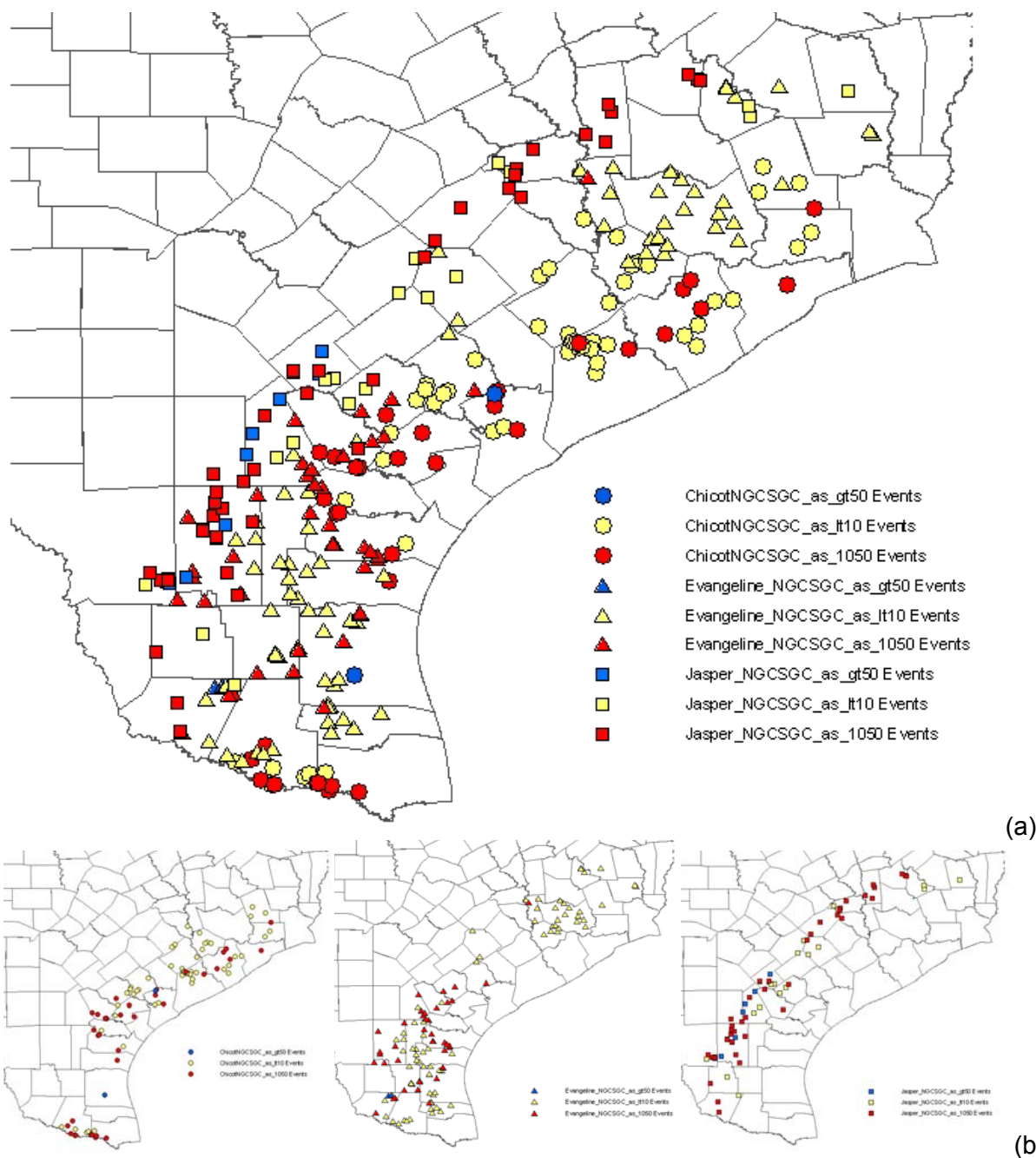


Figure 53. Arsenic spatial distribution by aquifer: all together (a) and, individually, in Chicot, Evangeline, and Jasper aquifers (b).

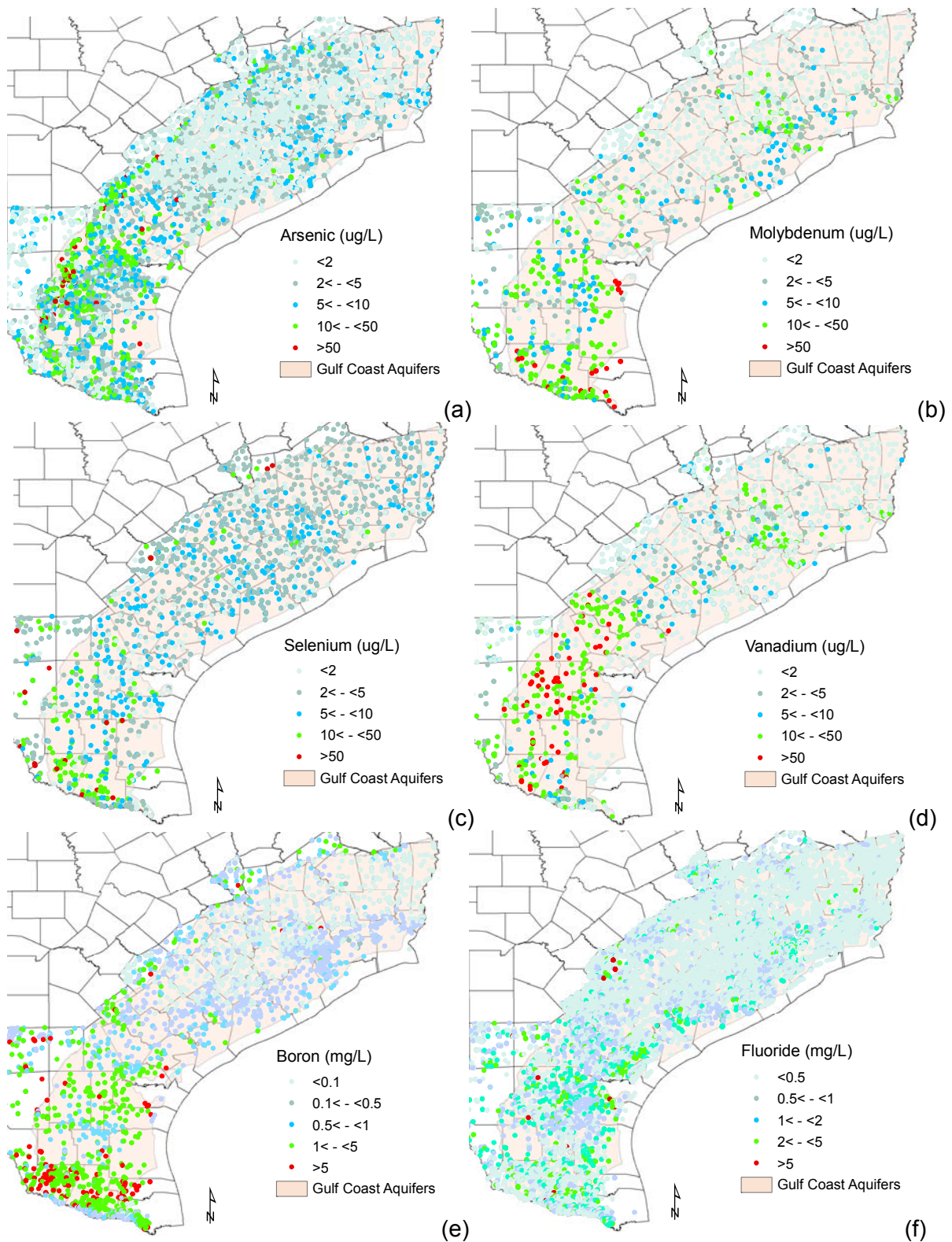


Figure 54. Spatial distribution of As (a), Mo (b), Se (c), V (d), B (e), F (f), U (g), silica (h), Fe (i), chloride (j), sulfate (k), TDS (l), and pH (m) in Gulf Coast aquifers. All plots use only TWDB data except As and U where NURE data are also included.

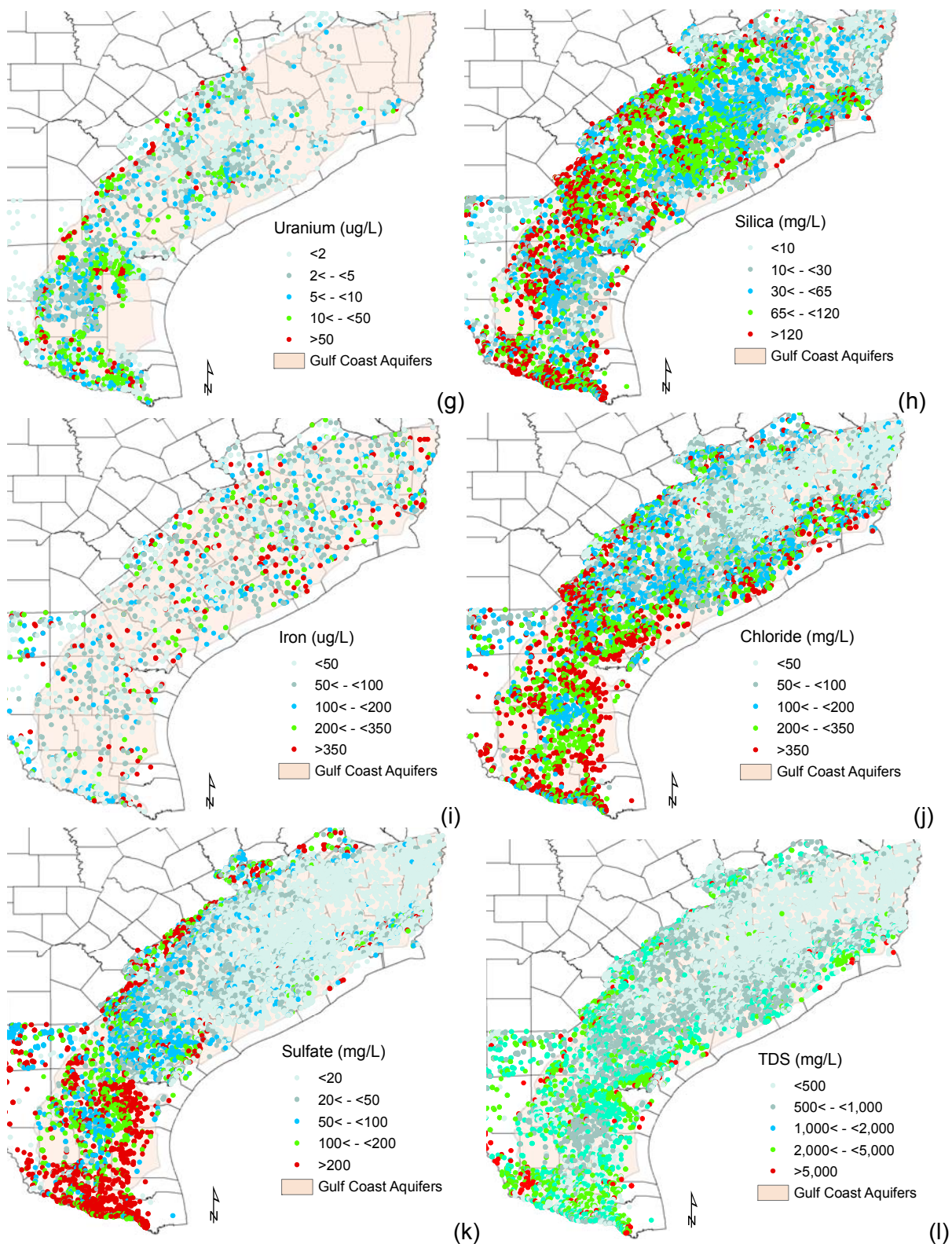


Figure 54. Spatial distribution of As (a), Mo (b), Se (c), V (d), B (e), F (f), U (g), silica (h), Fe (i), chloride (j), sulfate (k), TDS (l), and pH (m) in Gulf Coast aquifers. All plots use only TWDB data except As and U where NURE data are also included. (continued)

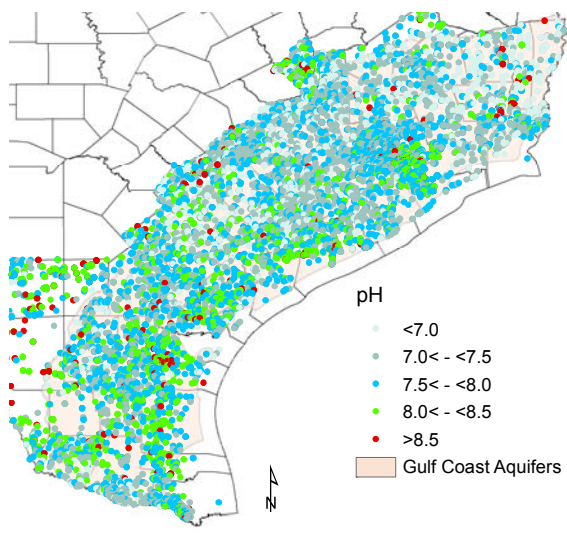
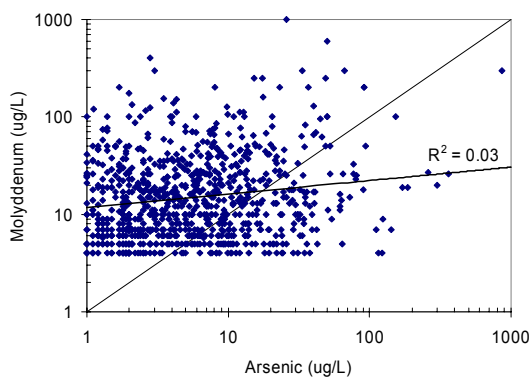
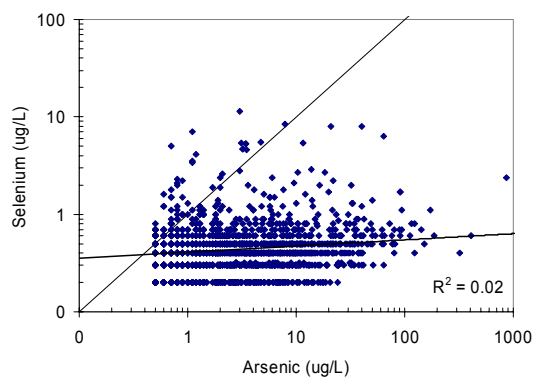


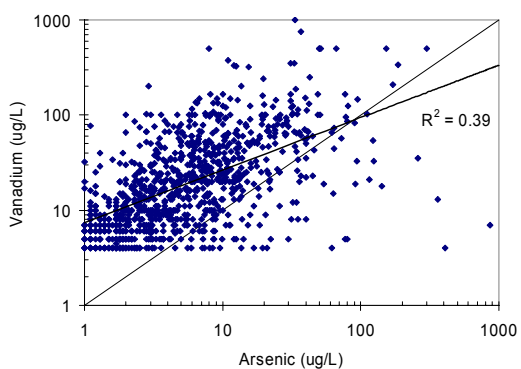
Figure 54. Spatial distribution of As (a), Mo (b), Se (c), V (d), B (e), F (f), U (g), silica (h), Fe (i), chloride (j), sulfate (k), TDS (l), and pH (m) in Gulf Coast aquifers. All plots use only TWDB data except As and U where NURE data are also included. (continued)



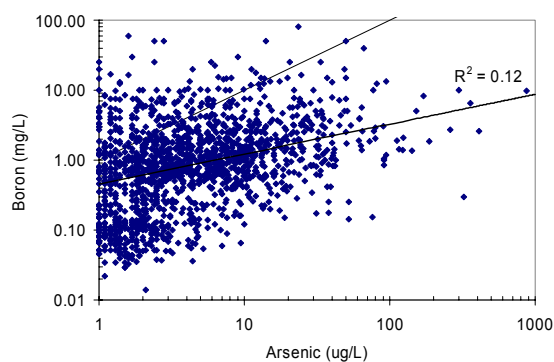
(a)



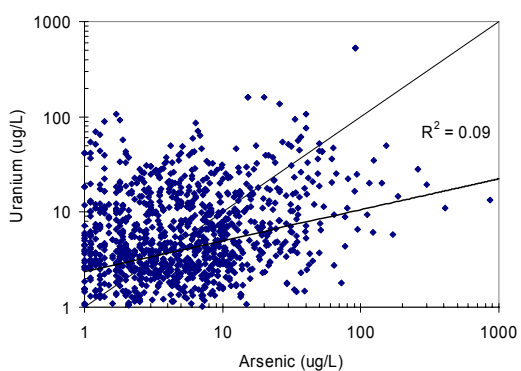
(b)



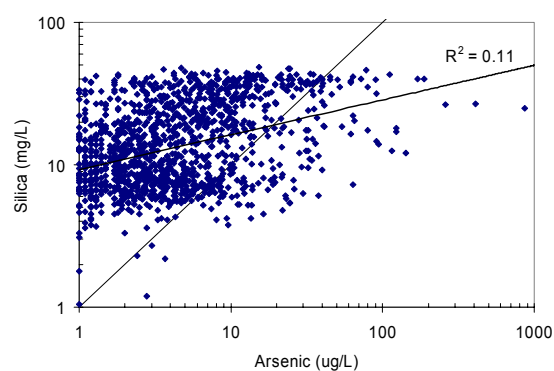
(c)



(d)

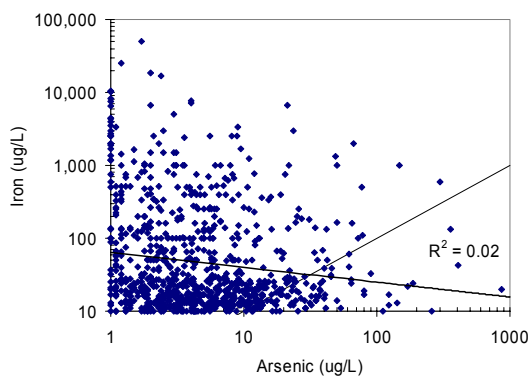


(e)

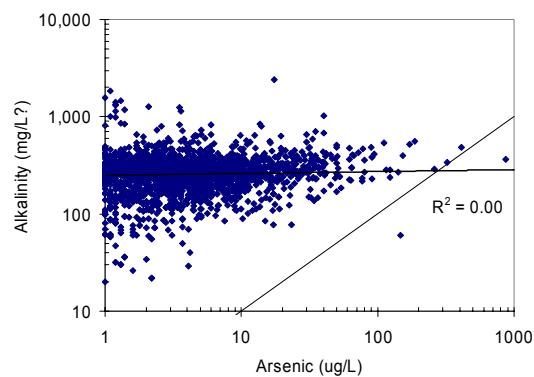


(f)

Figure 55. Cross-plots of (a) As vs. Mo, (b) vs. Se, (c) vs. V, (d) vs. B, (e) vs. U, (f) vs. silica, (g) vs. Fe, (h) vs. alkalinity (~bicarbonate), (i) sulfate, (j) vs. chloride, (k) vs. conductivity (~TDS) and (l) vs. pH (NURE data set), southwestern Gulf Coast aquifers.

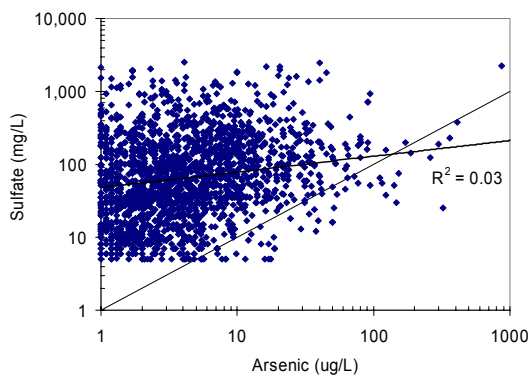


(g)

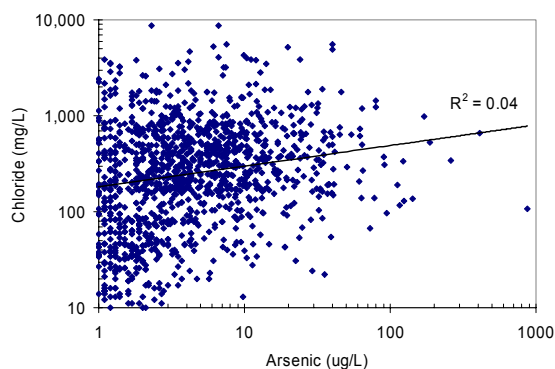


(h)

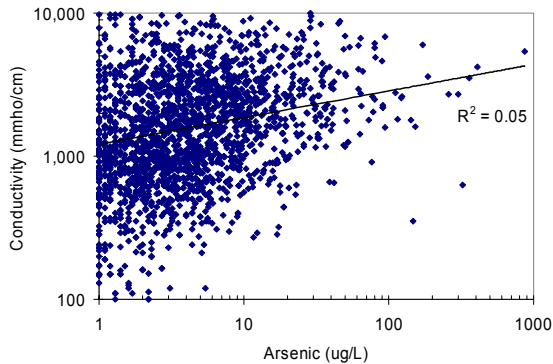
NOTE: Reporting unit was not given (mg/L?)



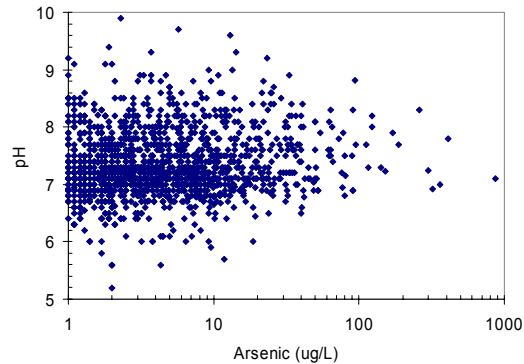
(i)



(j)

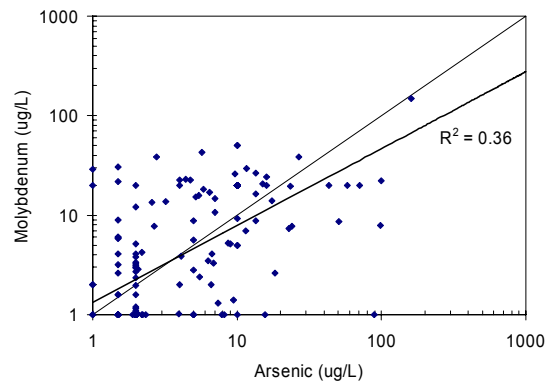
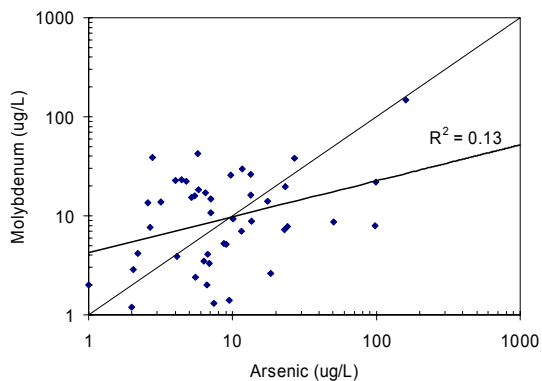


(k)



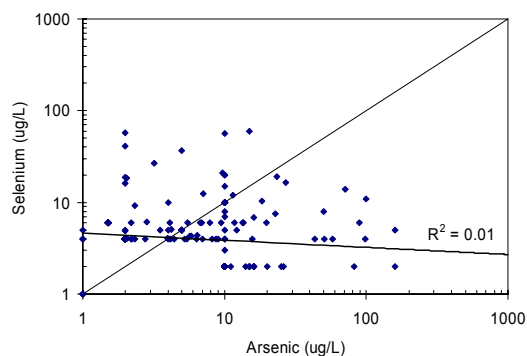
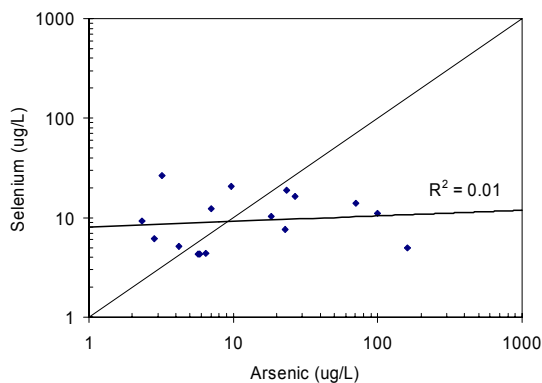
(l)

Figure 55. Cross-plots of (a) As vs. Mo, (b) vs. Se, (c) vs. V, (d) vs. B, (e) vs. U, (f) vs. silica, (g) vs. Fe, (h) vs. alkalinity (~bicarbonate), (i) sulfate, (j) vs. chloride, (k) vs. conductivity (~TDS) and (l) vs. pH (NURE data set), southwestern Gulf Coast aquifers. (continued)



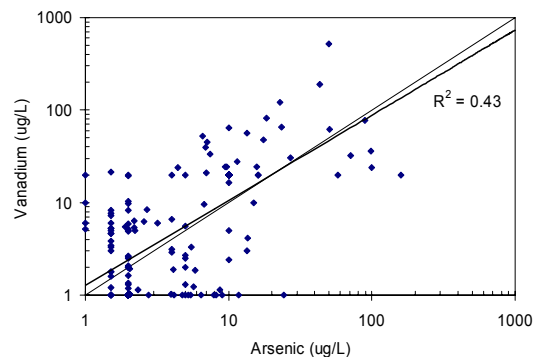
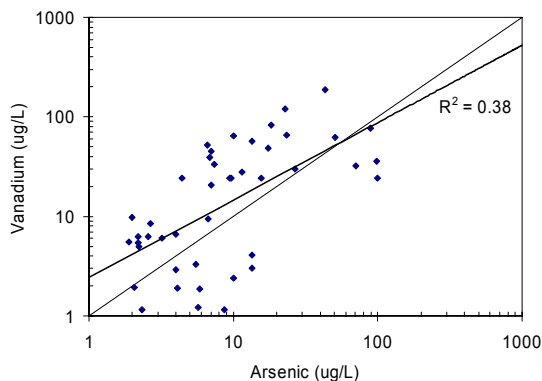
(a)

(b)



(c)

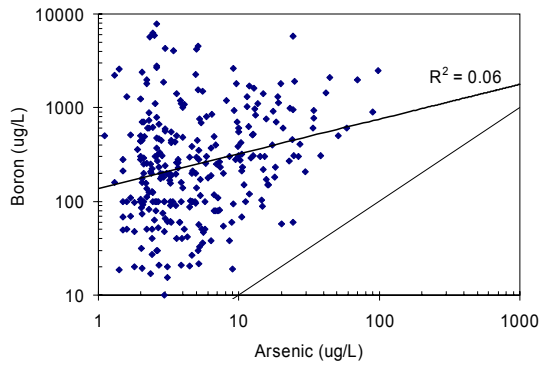
(d)



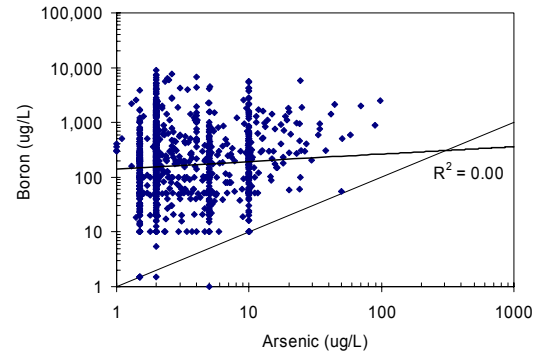
(e)

(f)

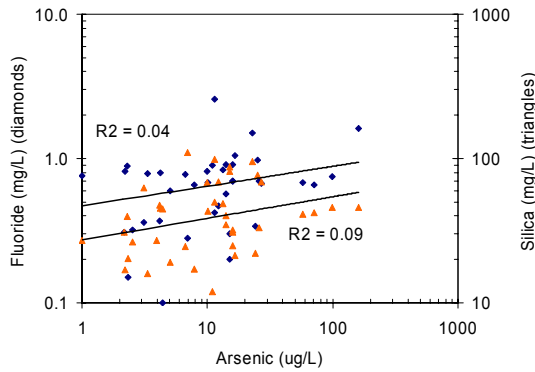
NOTE: Left-hand side plots include only those sample points where both variables are above detection limits; right-hand side plots include all sample points
Figure 56. Cross-plots of (a,b) As vs. Mo, (c,d) vs. Se, (e,f) vs. V, (g,h) vs. B, (i) vs. fluoride and silica, (j) vs. bicarbonate and sulfate, (k) vs. nitrate, and (l) vs. TDS and pH (TWDB database), southwestern Gulf Coast aquifers.



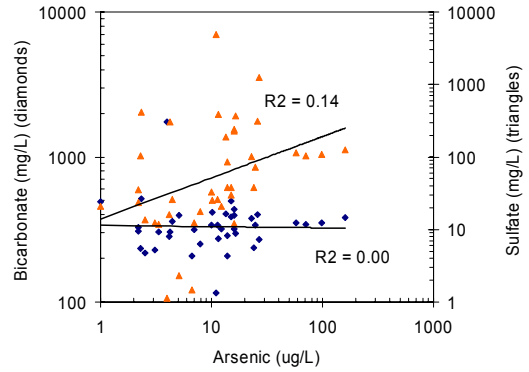
(g)



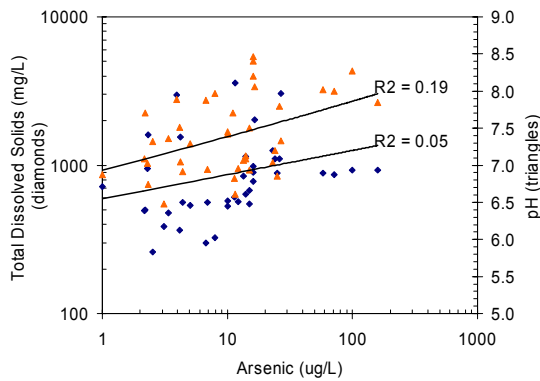
(h)



(i)



(j)



(k)

NOTE: all plots include only those sample points where both variables are above detection limits except (h) that include all sample points.

Figure 56. Cross-plots of (a,b) As vs. Mo, (c,d) vs. Se, (e,f) vs. V, (g,h) vs. B, (i) vs. fluoride and silica, (j) vs. bicarbonate and sulfate, (k) vs. nitrate, and (l) vs. TDS and pH (TWDB database), southwestern Gulf Coast aquifers. (continued)

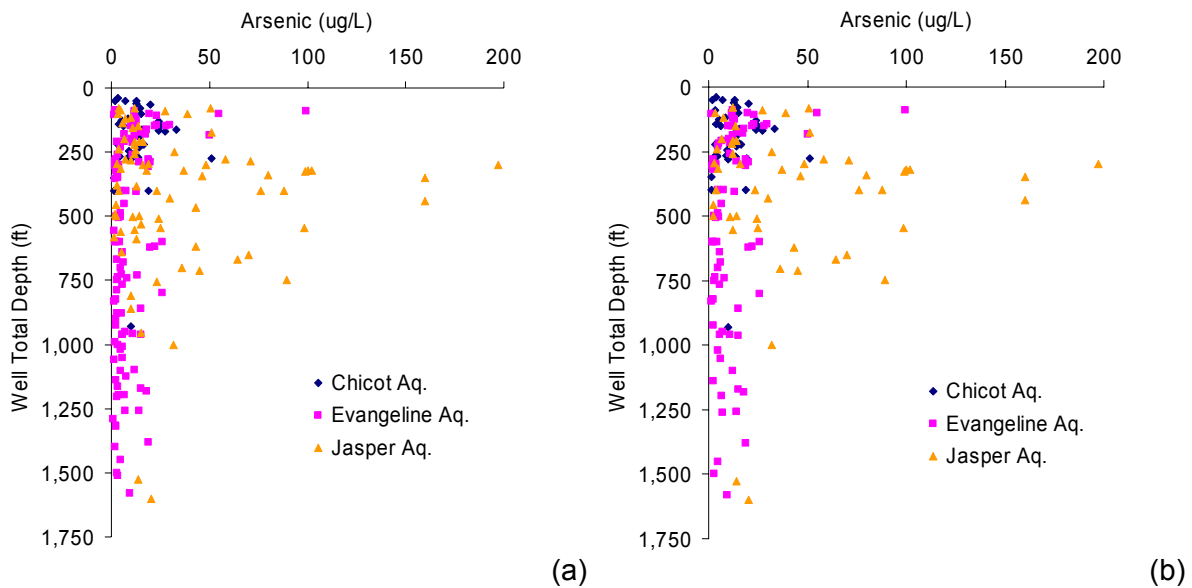


Figure 57. Arsenic concentration vs. total well depth in Gulf Coast Aquifers (a), only southwestern Gulf Coast (b)

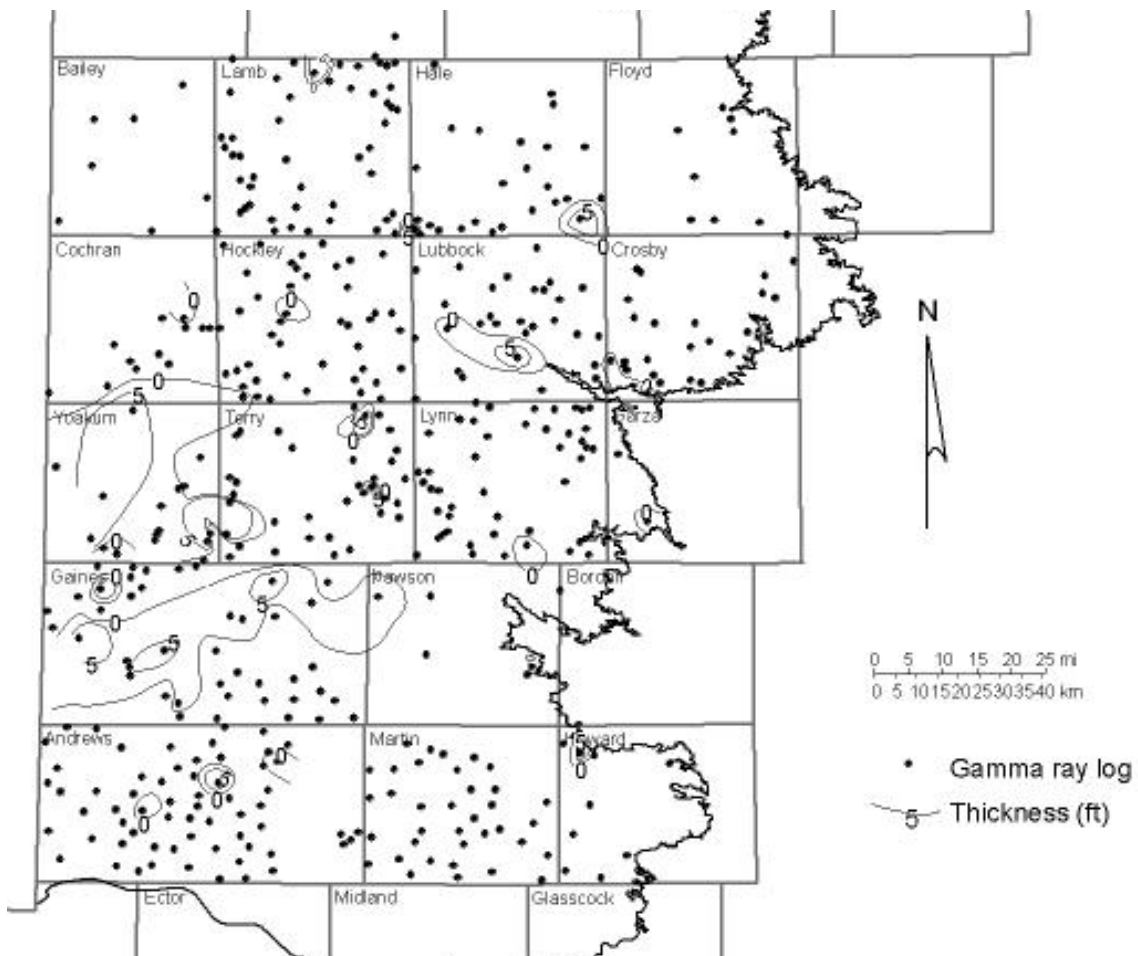


Figure 58. Thickness map of Ogallala-age ash beds based on geophysical logs

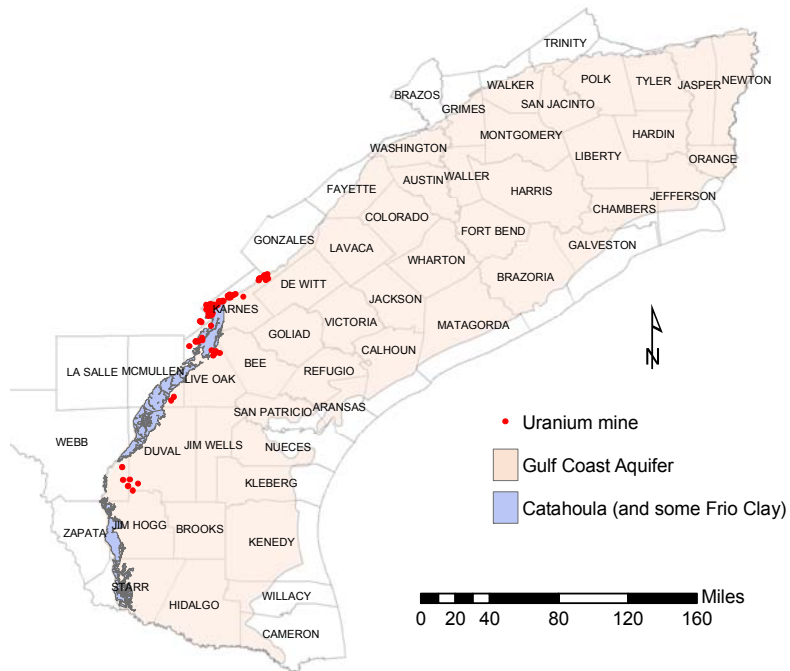
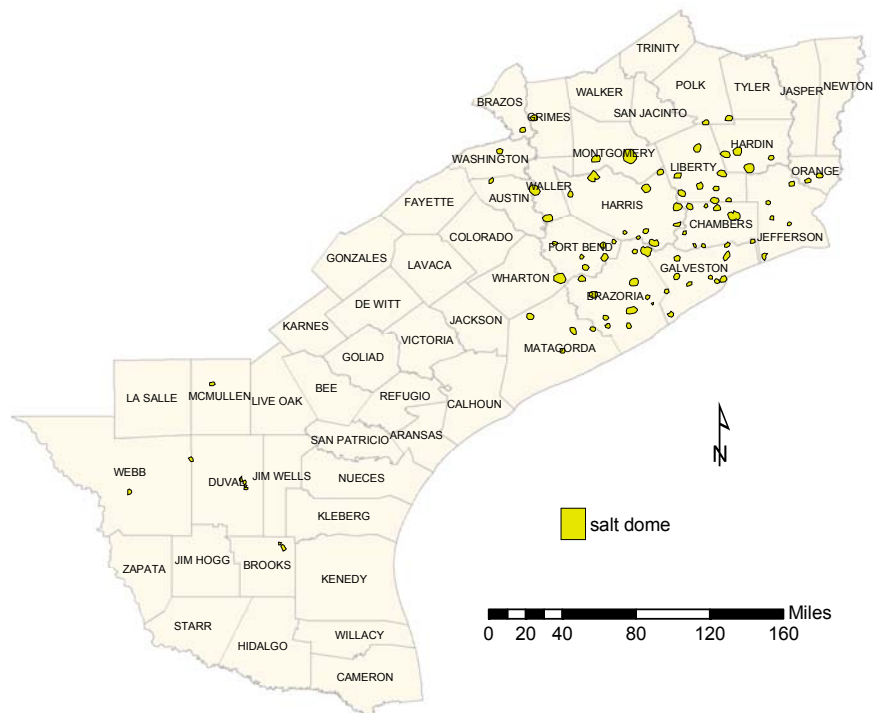
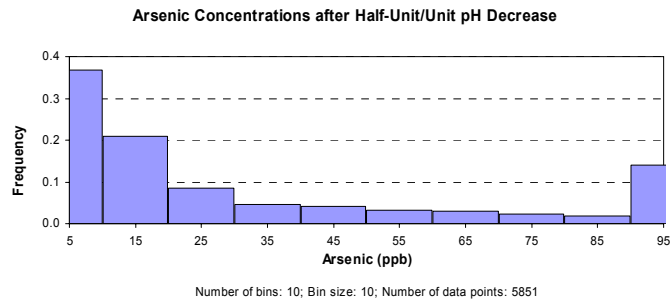


Figure 59. Map of selected uranium mines in the southern Gulf Coast area

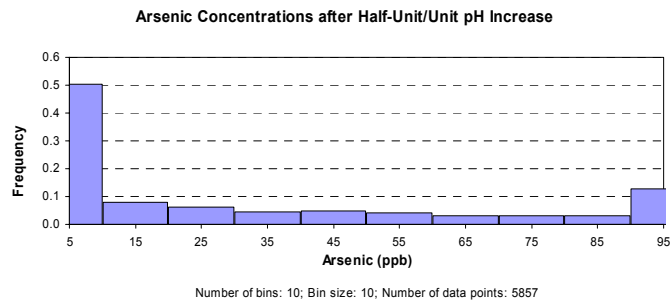


NOTE: locations from Lopez (1995), depth information from Halbouty (1979) and Ewing (1990)

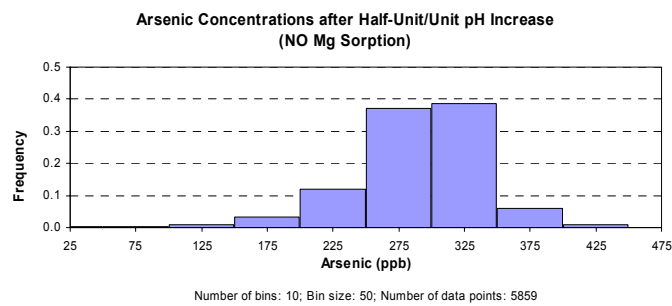
Figure 60. Map of salt domes along the Gulf Coast



(a)

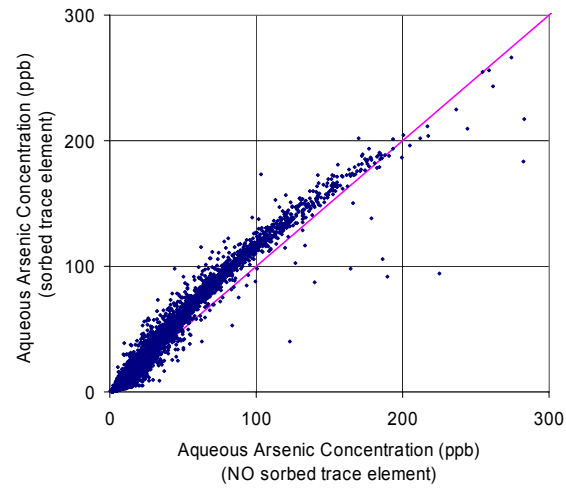


(b)

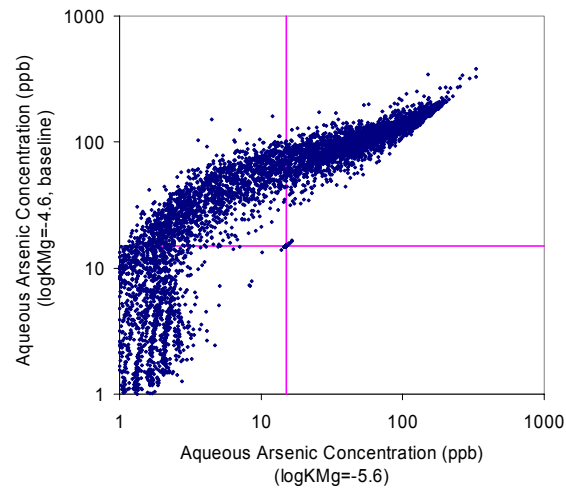


(c)

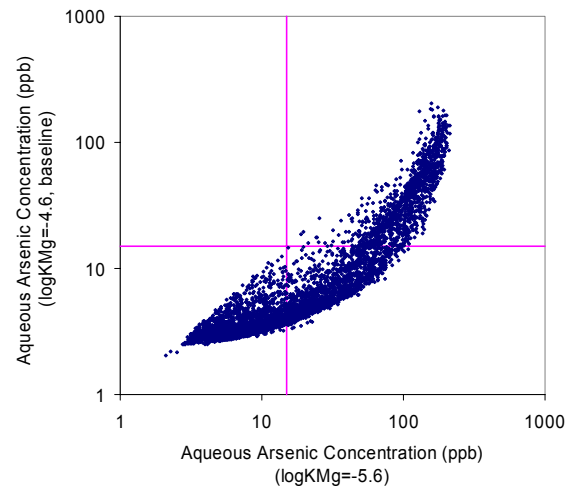
Figure 61. Histograms of arsenic distribution showing modeling results



(a)



(b)



(c)

Figure 62. Crossplot of arsenic concentration with and without including trace elements in the modeling

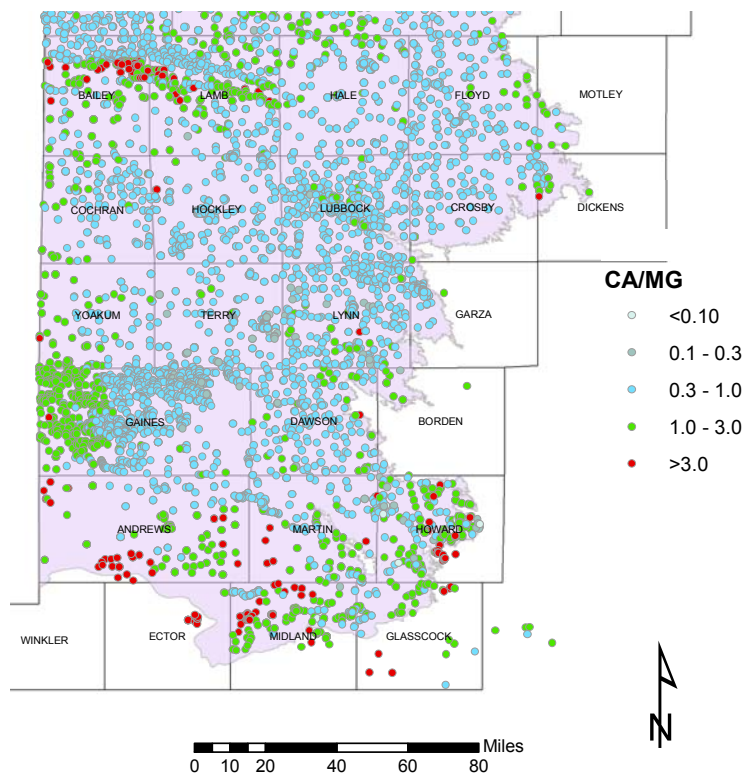
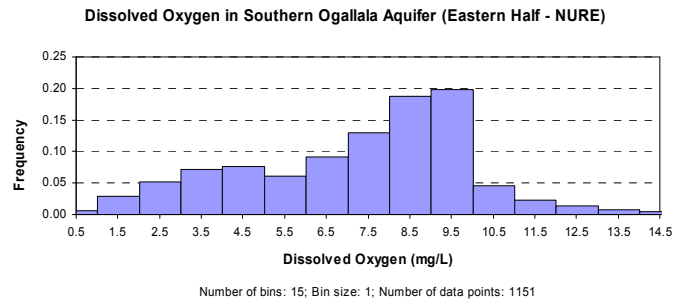
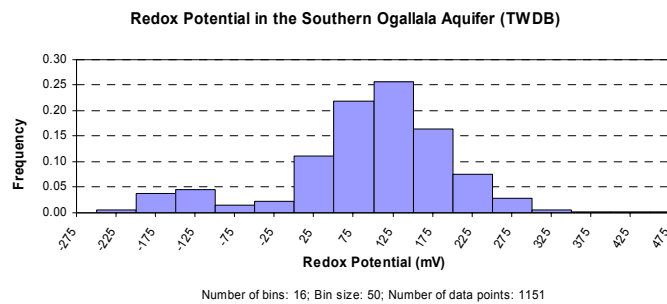
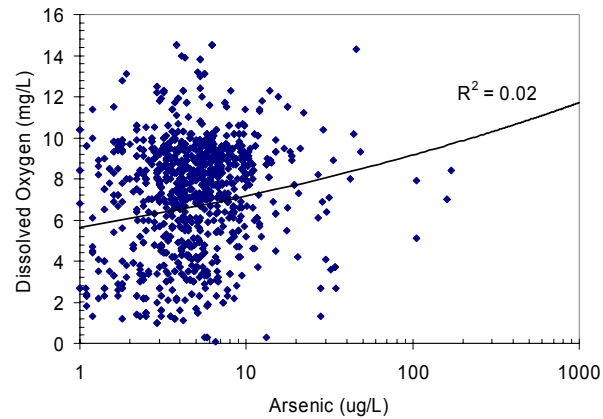


Figure 63. Spatial distribution of the Ca/Mg ratio in the southern High Plains (TWDB database)

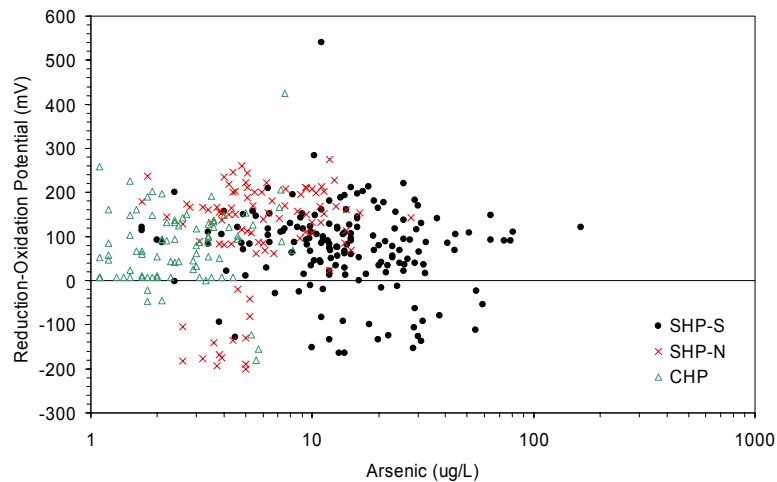


(a)



(b)

(c)



(d)

Figure 64. Distribution of dissolved oxygen (NURE) and redox potential (TWDB) in the southern High Plains aquifer

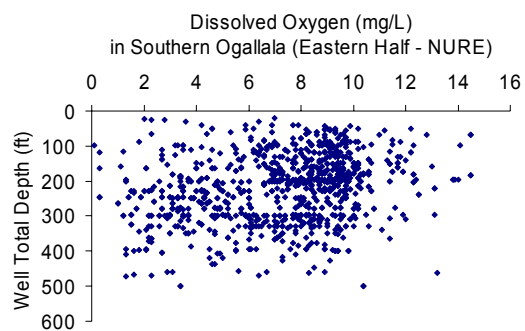


Figure 65. Depth distribution of dissolved oxygen in the eastern half of the southern High Plains aquifer (NURE data)

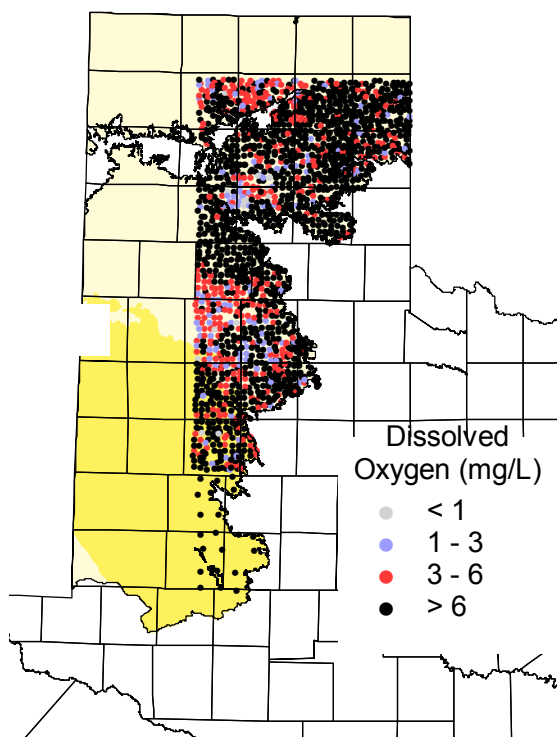


Figure 66. Spatial distribution of dissolved oxygen in the eastern half of the southern High Plains aquifer (NURE data)

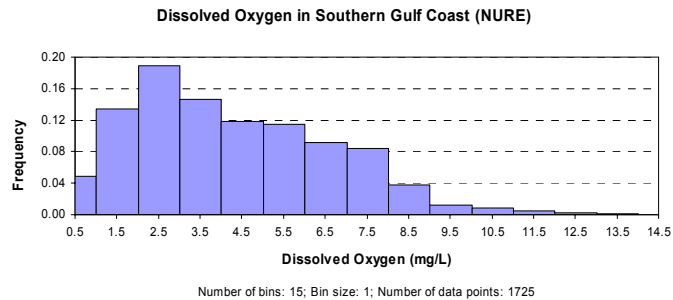
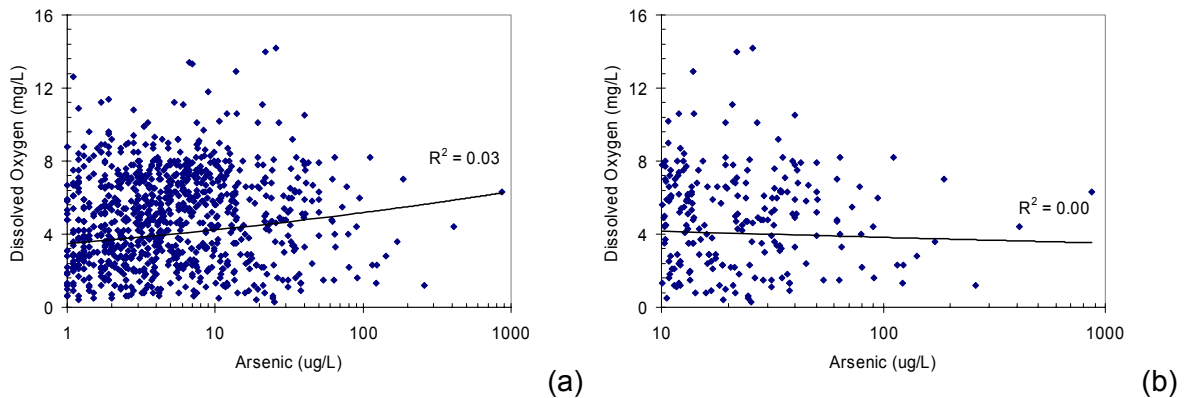


Figure 67. Histogram of dissolved oxygen in the southwestern Gulf Coast aquifers (NURE data)



NOTE: (a) all samples; (b) only samples with As > 10 ug /L are retained

Figure 68. Cross-plots of As vs. dissolved oxygen (NURE data set), southwestern Gulf Coast aquifers:

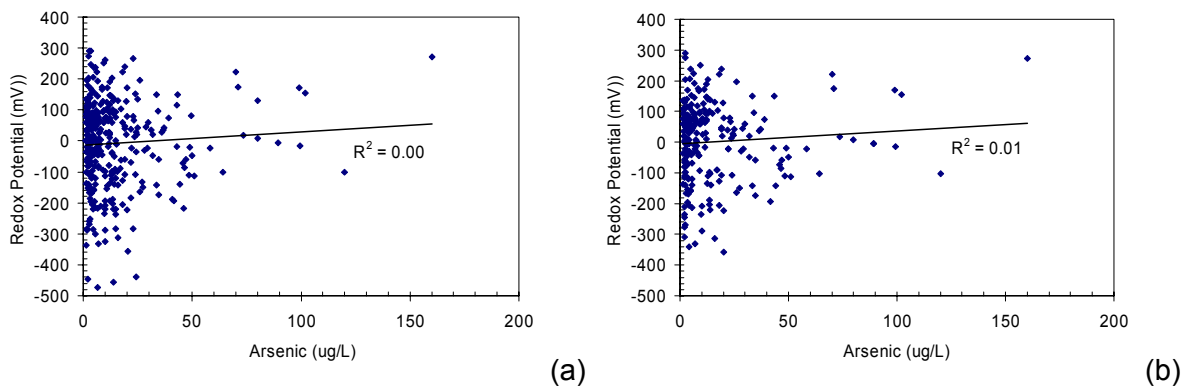
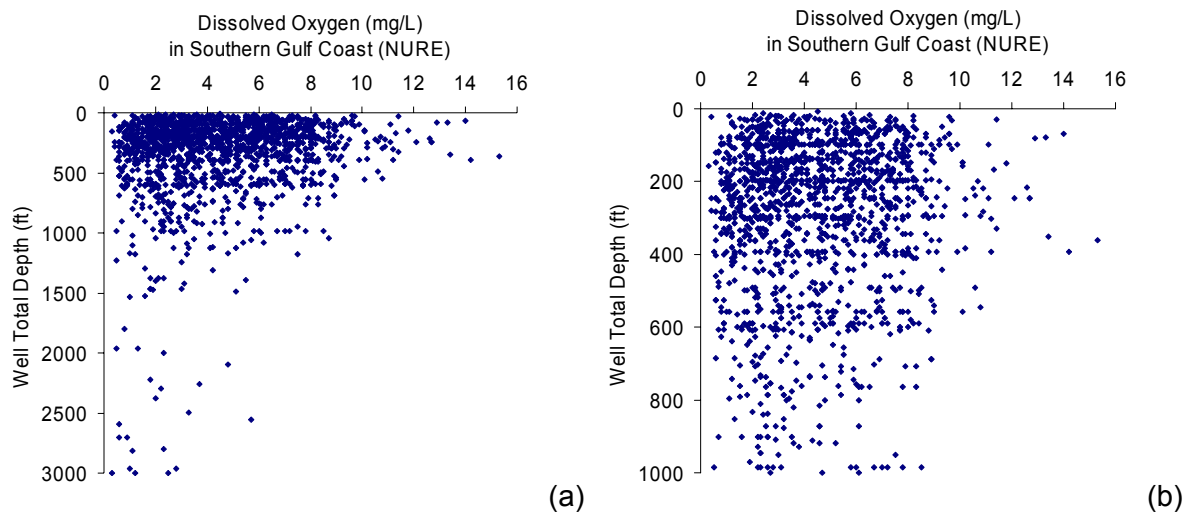


Figure 69. Redox potential in Gulf Coast aquifers (a) and only southwestern section (b)



NOTE: (a) to a depth of 3,000 ft; (b) to a depth of 1,000 ft
Figure 70. Depth distribution of dissolved oxygen in the southwestern Gulf Coast aquifers

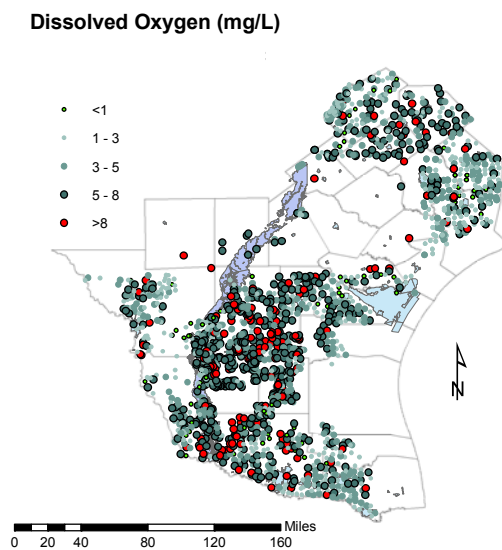
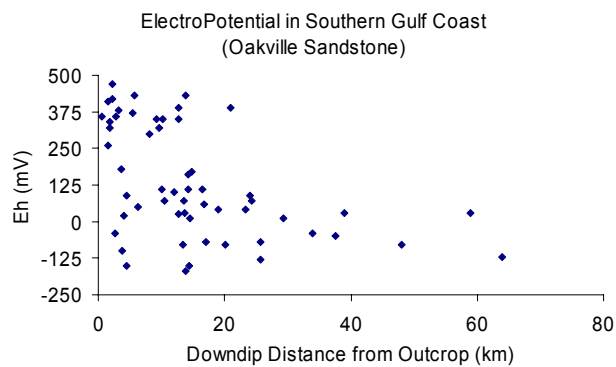


Figure 71. Spatial distribution of dissolved oxygen in the southwestern Gulf Coast aquifers (NURE)



NOTE: data from Henry et al. (1982a, Table A-1)
Figure 72. Eh evolution along groundwater flowlines in Oakville sandstone of the southwestern Gulf Coast

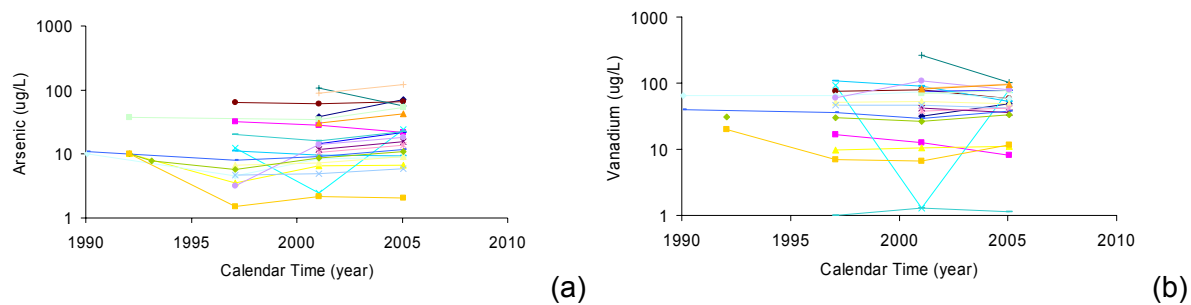


Figure 73. Time series of arsenic and Vanadium aqueous concentrations in wells recently sampled in Duval County

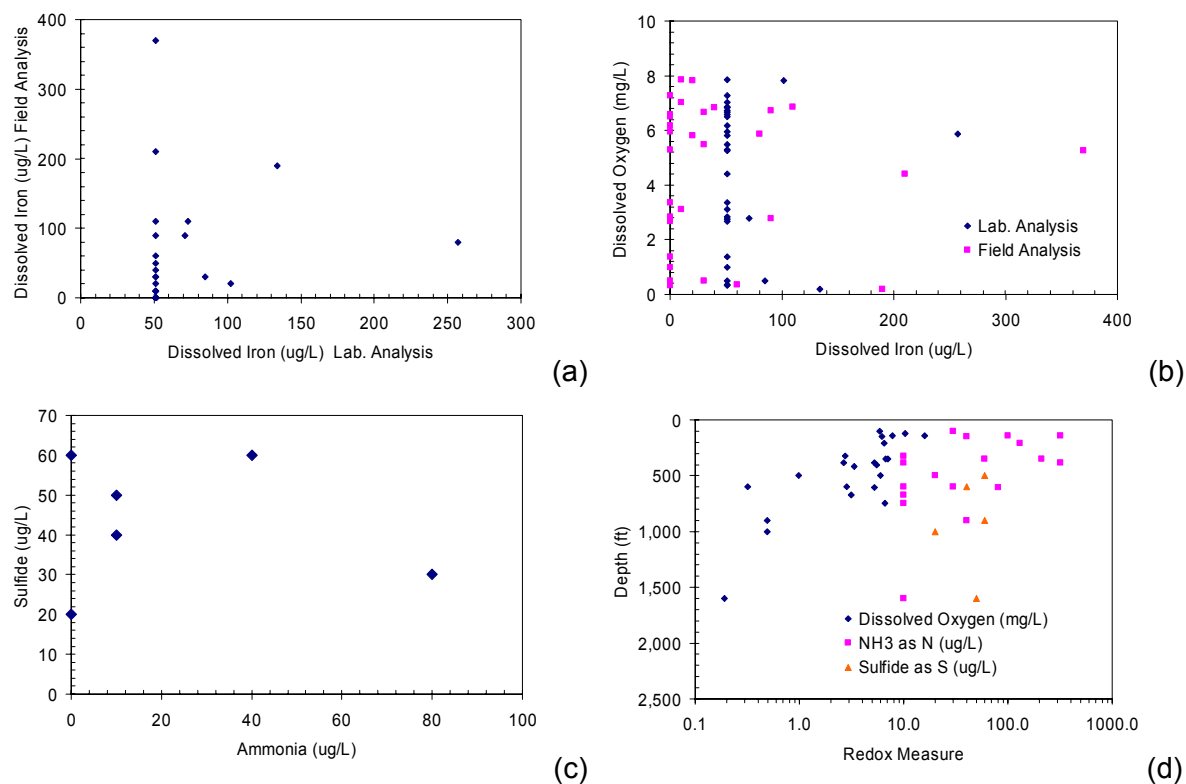


Figure 74. Analysis of redox pairs (Duval County)

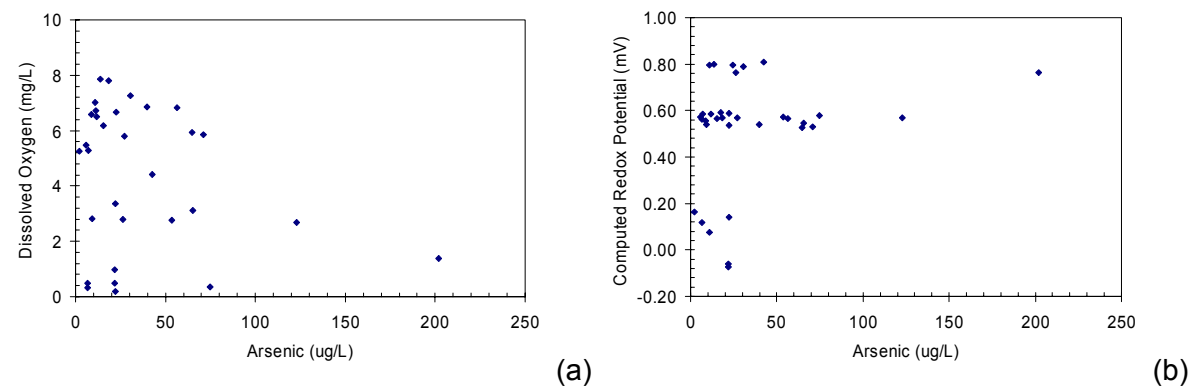
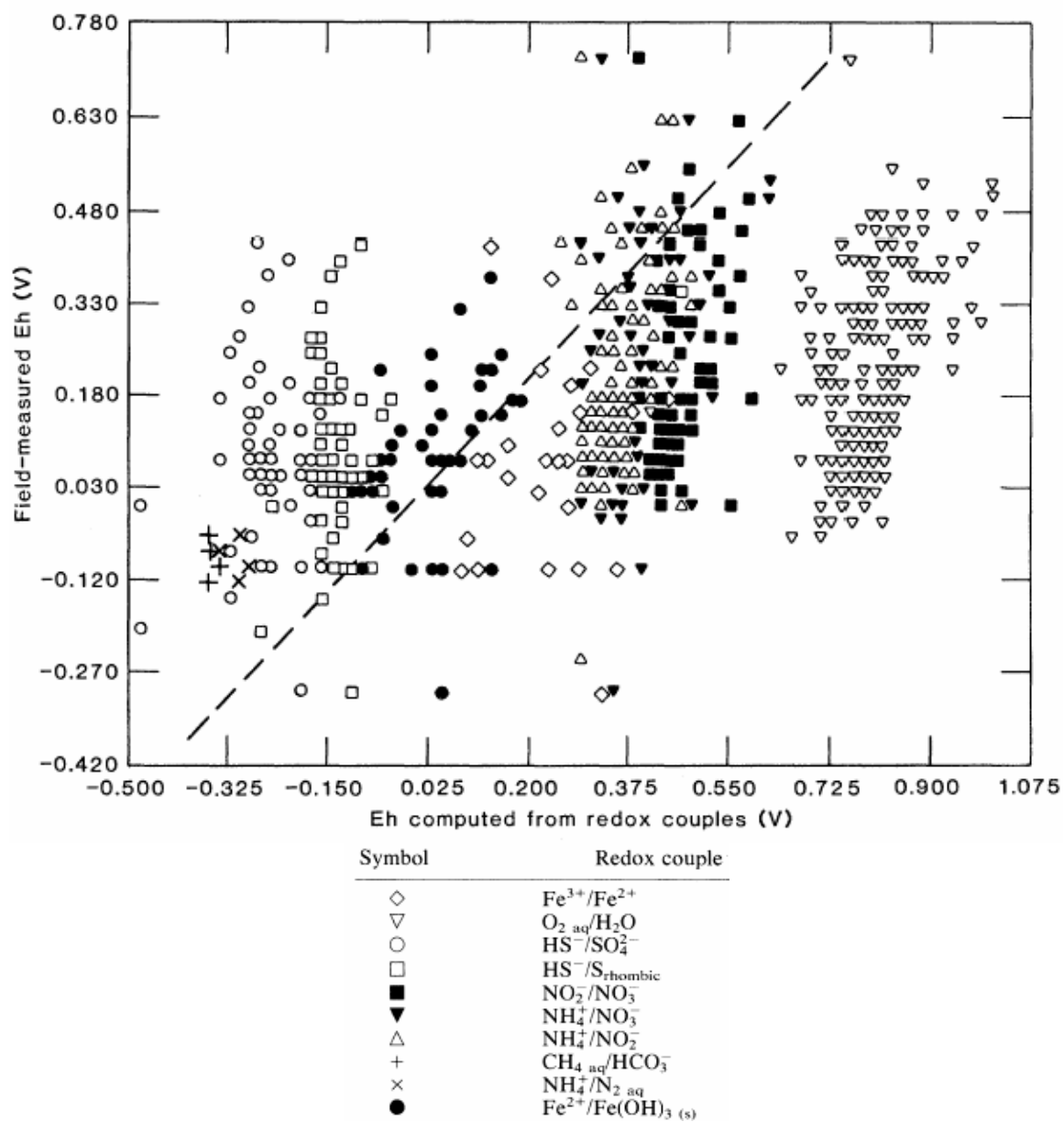
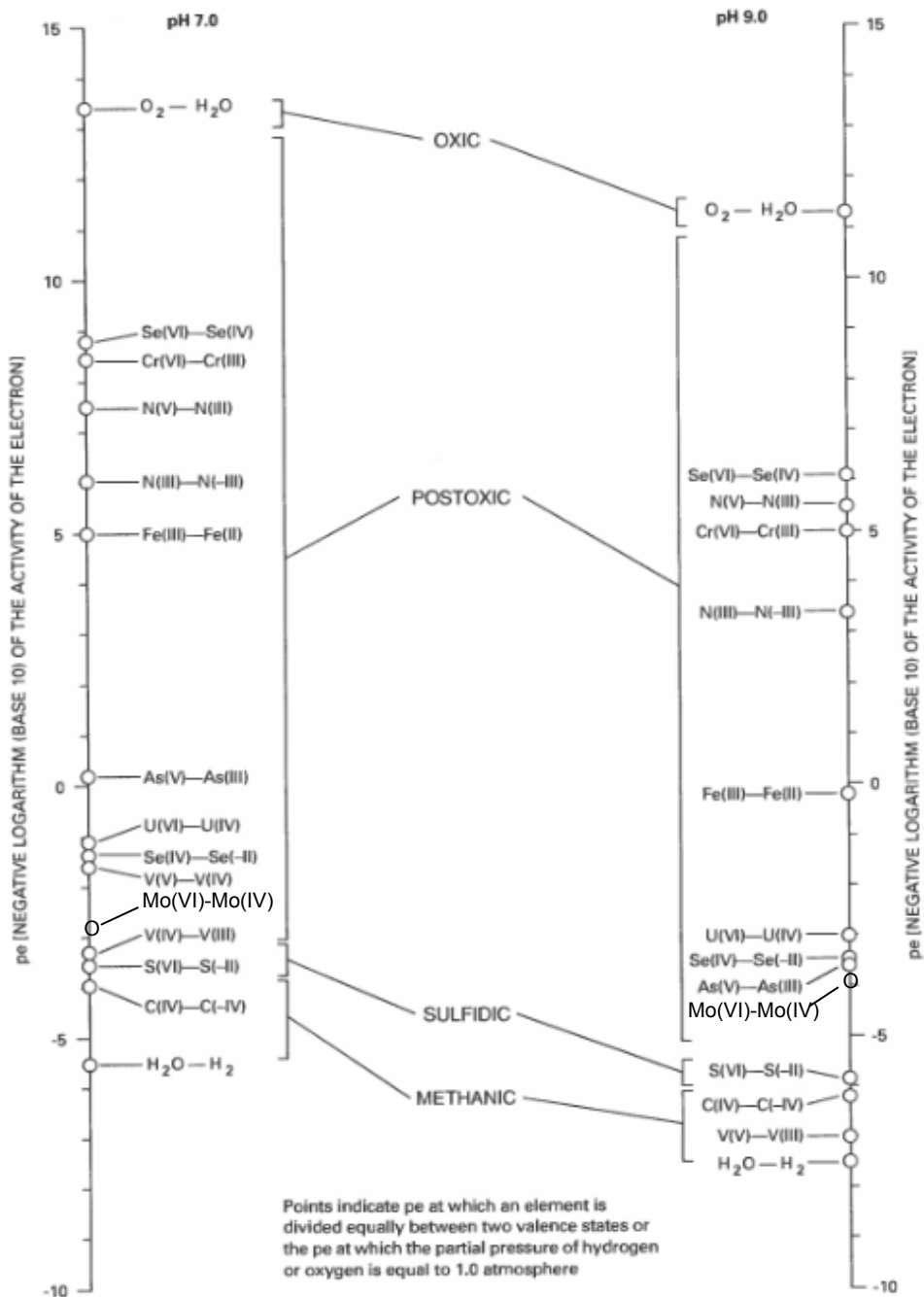


Figure 75. Cross-plots of As vs. dissolved oxygen (a) and computed redox potential (b) (Duval County)



SOURCE: Lindberg and Runnels, 1994

Figure 76. Literature comparison of measured and computed Eh



NOTE: at 25°C, $pe = 16.9 Eh (V)$ or $Eh (mV) = 59 pe$

SOURCE: Parkhurst et al., 1995

Figure 77. Redox ladder for As, Se, U, and V and major redox couples

System	Series	Group	Geologic Unit	Description
QUATERNARY	Holocene		Floodplain alluvium	Sand, gravel, silt, clay.
			Fluvial terrace deposits	Sand, gravel, silt, clay.
	Pleistocene		Pleistocene Deweyville Formation, Beaumont Clay, Montgomery Formation, Bentley Formation, and Pliocene (?) Willis Sand.	Sand, gravel, silt, clay.
			Goliad Sand	Fine to coarse sand and conglomerate; calcareous clay; basal medium to coarse sandstone. Strongly calichified.
TERTIARY	Miocene		Fleming (Logarto) Formation	Calcareous clay and sand.
			Oakville Sandstone	Calcareous, crossbedded, coarse sand. Some clay and silt and reworked sand and clay pebbles near base.
	Oligocene	Catahoula Formation (Gueydan Formation of some authors)	Chusa Tuff	Calcareous tuff; bentonitic clay; some gravel and varicolored sand near base. Soledad in Duval County, grades into sand lenses in northern Duval and adjacent counties.
			Soledad Conglomerate	
			Fant Tuff	
			Frio Clay (Southwest of Karnes County)	Light-gray to green clay; local sand-filled channels.
	Eocene	Jackson	Fashing Clay	Chiefly clay; some lignite, sand, <i>Corbicula</i> coquina, oysters.
			Tordilla Sandstone, Calliham Sandstone west of Karnes County.	Very fine sand.
			Dubose	Silt, sand, clay, lignite.
			Deweesville Sandstone	Mostly fine sand; some carbonaceous silt and clay.
			Conquista Clay	Carbonaceous clay.
			Dilworth Sandstone	Fine sand, abundant <i>Ophiomorpha</i> .

NOTE: Crossed picks indicate units from which uranium has been extracted

SOURCE: Galloway et al., 1979

Figure 78. Stratigraphic section in the South Texas uranium province

Hazardous Materials Control Resources
Institute (HMCRI)

Data Table

Table
Comparison of OU No. 3 Soil/Sediment Data to Regional
Background Data
RSR Corporation Superfund Site
Operable Unit No. 3

Background Soil Concentrations (mg/kg)						Maximum - Observed OU No. 3 Concentrations (mg/kg)								
Chemical	Range	Arithmetic Mean	Standard Deviation	Number of Samples	Arithmetic Mean + 2 Standard Deviations					Site 3		Site 4		Sediment
						Surface Soil	Site 1 Sub-surface Soil	Sediment	Surface Soil	Sub-surface Soil	Sediment	Surface Soil	Sub-surface Soil	
Alummium	700 - >100,000	72,000	--	1,247	47,000	32,300	10,800	17,000	29,800	27,900	25,500	25,900	19,000	23,500
		47,000	2.48											
Arsenic	1.1 - 18	6.4	3.3	119	13	7,980	309	224	127	12.8	55.8	252	114	19.6
Barium	150 - 1,000	404	200	119	800	2,330	431	272	934	131	426	2,330	1,060	162
Berllium	N.D. - 7.0	0.62	1.06	119	2.7	4.3	0.79	2.5	1.6	1.5	2.5	2.8	1.3	2.4
Cadmium b	N.D. - 11	--	--	1,319	--	637	17.7	43.1	8.4	1.3	9.1	8.7	15.1	0.75
Chromium	3.0 - 150	40	28	119	96	204	40.5	94.1	288	85	66.6	69.1	1,420	41.7
Cobalt	N.D. - 30	4.9	4.5	119	14	86.1	21.1	12.6	19.8	32.6	64.2	264	25.7	12.6
Copper	3.0 - 30	1.5	8.0	119	31	6,610	484	219	286	37.3	213	395	2,090	71.9
Lead	N.D. - 30	1.3	8.1	119	29	105,000	6,540	3,940	71,500	320	2,100	6,390	11,500	364
Manganese b	<2.0 - 7,000	550	--	1,317	340	3,490	3,050	7,630	1,060	680	2,380	970	1,200	1,200
		330	2.77											
Mercury	<0.01 - 0.69	0.064	0.097	119	0.26	2	0.06	0.55	0.61	0.13	1.2	0.86	0.52	0.32
Nickel	N.D. - 50	12	8.8	119	30	1,180	95.1	49.4	162	12,200	62	62.6	95.8	33.2
Silver b	N.D. - 5.0	--	--	1,319	5.0	3.2	0.24	3.4	1.55	1.25	0.55	4.4	6.2	1.75
Thallium	--	--	--	--	---	4.4	1.1	7.95	0.9	2.9	1.25	2.6	5.4	2.55
Vanadium	7.0 - 200	52	37	119	130	64.7	50.2	56.3	72.8	64.7	58.8	52.1	43.7	54.3
Zinc	5.0 - 108	39	22	116	83	4,300	630	2,090	796	116	394	17,500	4,250	276

Source: Dragon. J. and Chasson Andrew, 1991. Elements in North American Soils. Hazardous Materials Control Resources Institute.

aGeometric mean

bSoil of contaminous USA, rather than Texas soils only

cMaximim value