Hole no.	HD	DI (m)	Description
Holes drilled by Weaco Minerals, Ltd.			
CR91-1	-50	0-12.2	Silicified tuff cut by quartz veins.9
		12.2-13.7	Quartz vein with amethyst and pyrite.
		13.7-16.8	Quartz vein with galena, sphalerite and chalcopyrite.
		16.8-36.6	Quartz vein.
		36.6-54.9	Silicified tuff cut by quartz veins with pyrite and sericite.
CR91-2	-50	0-42.7	Green-gray andesite porphyry, Summit Mountain formation, chloritized and silicified.
		42.7-61.0	Black to dark gray andesite with epidote, pyrite, and silicified, Summit Mountain formation.
		61.0-73.1	Dark gray to green-gray andeiste with increasing chlorite and sericite.
		73.1-103.6	Hematite increases.
CR91-3	-60	0-13.7	Silicified tuff.
		13.7-19.8	Quartz vein.
		19.8-39.6	Silicified andesite with sericite and pyrite, Summit Mountain formation.
		39.6-67.1	Chloritized, silicified andesite with epidote and pyrite.
CR91-4	-60	0-33.5	Green to brown to red tuff with increasing amount of epidote, pyrite, sericite, and quartz with depth.
		33.5-38.1	Stope, no sample.
		38.1-61.0	Quartz vein with pyrite.
		61.0-73.1	Green-gray andesite with pyrite and quartz, Summit Mountain formation.
CR91-5	-90	0-9.1	Silicified tuff.
		9.1-21.3	Quartz vein with pyrite, amethyst, sphalerite, and galena.
		21.3-29.0	Stope, no sample.
		29.0-36.6	Silicified green-gray andesite, Summit Mountain formation.
CR91-6	-60	0-1.5	Silicified tuff.
		1.5-9.1	Quartz vein with pyrite.
		9.1-13.7	Stope, limited sample.
		13.7-15.2	Quartz vein.
		15.2-18.3	Gray to black, chloritized and silicified andesite porphyry, Summit Mountain formation.
CR91-7	-60	0-1.5	Overburden.
		1.5-16.8	Quartz vein with pyrite and sulfides.
		16.8-19.8	Stope, no sample.

Hole no.	HD	DI (m)	Description
		19.8-22.9	Quartz vein.
		22.9-24.4	Dark gray, silicified andesite with pyrite and epidote.
		24.4-36.6	Stope, no sample.
		36.6-42.7	Dark gray, silicified andesite with pyrite and epidote, Summit Mountain formation.
CR91-8	-90	0-3.0	Dump material.
		3.0-13.7	Green-gray silicified andesite, Summit Mountain formation.
		13.7-61.0	Silicified andesite, Summit Mountain formation.
		61.0-67.1	Silicified andesite, Summit Mountain formation.
CR91-9	-60	0-1.5	Overburden.
		1.5-10.7	Quartz vein with pyrite.
		10.7-24.4	Green-gray, silicified andesite porphyry with epidote and pyrite, Summit Mountain formation.
CR91-10	-60	0-1.5	Overburden.
		1.5-61.0	Green-gray to brown andesite porphyry with varying amounts of quartz, pyrite, chlorite, and epidote; Summit Mountain formation.
CR91-11	-60	0-1.5	Overburden.
		1.5-48.8	Green-gray to brown andesite porphyry with varying amounts of quartz, pyrite, chlorite, and epidote; Summit Mountain formation.
CR91-12	-90	0-1.5	Overburden.
		1.5-18.3	Silicified and brecciated tuff.
		18.3-59.4	Quartz breccia vein with fragments of andesite and pyrite and sulfides. Wood in some samples suggesting stopes nearby.
		59.4-67.1	Green-gray, chloritized and silicified andesite porphyry, Summit Mountain formation.
CR91-13	-60	0-3.0	Overburden.
		3.0-10.7	Silicified tuff.
		10.7-97.5	Quartz breccia vein with pyrite, amethyst, and sulfides and breccia fragments of tuff.
CR91-14	-90	0-24.4	Green-gray to brown tuff, silicified.
		24.4-61.0	Green-gray to brown, chloritized and silicified andesite with varying amounts of quartz, epidote, and pyrite.

Hole no.	HD	DI (m)	Description
CR91-15	-90	0-6.1	Silicified tuff.
		6.1-33.5	Quartz breccia vein with fragments of andesite and tuff and pyrite and sulfides, locally.
		33.5-61.0	Silicified and chloritized andesite porphyry, Summit Mountain formation.
CR91-17	-60	0-1.5	Overburden.
		1.5-48.8	Silicified, hematized tuff.
		48.8-103.6	Quartz breccia vein.
CR91-18	-60	0-1.5	Soil.
		1.5-24.4	Silicified tuff.
		24.4-97.5	Quartz breccia vein.
		97.5-103.6	Silicified tuff.
		103.6-106.7	Green-gray andesite, locally chloritized and silicified, Summit Mountain formation.
CR91-19	-60	0-12.2	Green-gray to brown chloritized andesite, Summit Mountain formation.
		12.2-42.7	Quartz breccia vein with fragments of silicified tuff and andesite.
		42.7-61.0	Green-gray to brown chloritized and silicified andesite, Summit Mountain formation.
CR91-20	-60	0-1.5	Overburden.
		1.5-83.8	Silicified tuff.
		83.8-91.4	Green-gray silicified and chloritized andesite, Summit Mountain formation.
		91.4-100.6	Silicified tuff.
		100.6-112.8	Quartz breccia vein with pyrite.
CR91-21	-90	0-1.5	Overburden.
		1.5-6.1	Silicified tuff.
		6.1-18.3	Quartz breccia vein.
		18.3-54.9	Silicified tuff.

orebodies from throughout the mine. The miners were forced to mix high-grade with low-grade ore to maintain a constant shipment. Also the miners mixed high-fluorine with low-fluorine ore to keep fluorine concentrations below maximum standards set by ASARCO.

Statistical analyses of these data confirm a significant correlation between gold and silver and a strong correlation between lead and zinc (Fig. 4.24). Factor analysis confirms this correlation. Also factor analysis provides additional information. Factor group 1 indicates correlation between copper, zinc, lead, iron and a negative correlation with silica. This association is confirmed by field observations; copper, lead, and zinc minerals are associated with a decrease in quartz. Factor group 2 indicates a correlation between calcium and fluorine which corresponds to the late stage fluorite mineralization. Factor group 3 indicates a correlation between gold, silver, alumina, and negative correlation with silica. This corresponds to the association of gold and silver with illite, chlorite, and perhaps adularia. Factor group 4 indicates a correlation between antimony and alumina, whereas factor group 5 indicates a correlation between arsenic and iron. This suggests that antimony, arsenic, and iron are either late stage and not associated with the precious- and base-metals or are remobilized by subsequent supergene and oxidation. This is supported by occurrence of iron oxides and mimetite coatings.

4.3.2 Carlisle mine

Weaco Exploration Ltd. collected samples on a 100 m spaced grid at the

Carlisle mine. Rock chip samples were collected at each location over approximately 0.5 m^2 and analyzed for multielements. Areas of mine tailings were not sampled. The data are summarized in Table 4.8. Correlation coefficients and factor analysis are summarized in Tables 4.9 and 4.10.

Statistical analyses confirm a strong correlation between gold and silver, lead and zinc, and bismuth, cadmium, zinc, and lead (Table 4.9; Fig. 4.25). These associations and other correlations are confirmed by factor analysis. Factor group 1 indicates a strong correlation between calcium, aluminum, nickel, cobalt, manganese, vanadium, phosphorus, lanthium, magnesium, titanium, sodium, and negative correlation with arsenic and molybdenum. This group most likely represents gangue and alteration mineralogy, because these elements are common to gangue and alteration minerals found at the Carlisle mine. Factor group 2 consists of lead, zinc, bismuth, and cadmium. Factor group 3 consists of gold, silver, manganese, and vanadium. Factor group 4 consists of arsenic, iron, and chromium. Factor group 6 consists of copper and calcium. The other factor groups are less important. The associations represented by factor groups 4 and 6 may be related to mobilization by supergene alteration and oxidation, because these elements are found in supergene minerals at the Carlisle. Iron and copper staining and chalcanthite are common along pit and adit walls and were deposited recently by acid mine water. The separate associations of gold-silver and lead-zinc represented by factor groups 2 and 3 are confirmed by field and production data. The veins in the upper levels of the Carlisle consist of a gold-silver (low base-metals) ore shoot and a parallel lead-zinc-copper

Table 4.8—Statistical data of assays of surface samples from the Carlisle and Sec. 2 mines. Total sample population is 202 samples. Values in ppm unless otherwise specified.

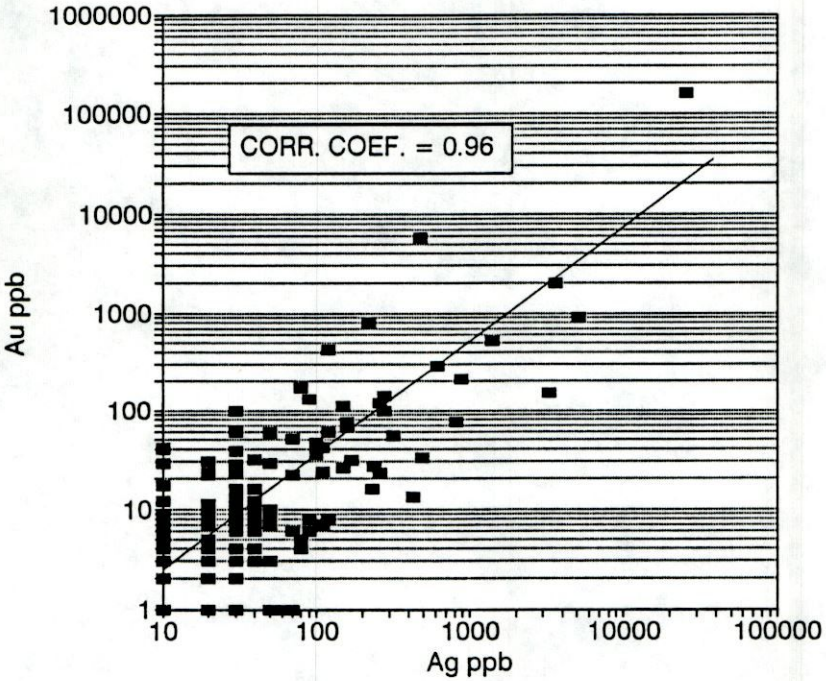
	Mean	Standard deviation	Range of values
Au ppb	858	11198	1-159100
Ag	2.5	18.6	0.1-255.4
Cu	131.8	688.6	10-9030
Pb	216.5	862.5	2-9622
Zn	202.0	953.3	6.0-13148
As	9.0	8.3	2.0-52.0
Sb	2.2	1.3	2.0-19.0
Bi	2.3	1.5	2.0-22.0
Ni	18.9	10.1	1.0-60.0
Cd	1.4	3.6	0.2-39.8
Fe%	3.4	1.2	0.86-7.59
Ca%	0.4	0.3	0.02-2.87
Al%	1.2	0.6	0.05-3.23
Mo	7.6	11.1	1.0-95.0
Co	10.9	6.2	1.0-26.0
Mn	346.7	274.4	15.0-2384
Sr	48.8	39.2	8.0-447.0
V	43.3	27.3	3.0-297.0
P%	0.05	0.02	0.001-.117
La	14.1	7.9	2.0-47.0
Cr	19.3	11.3	1.0-117.0
Mg%	0.62	0.48	0.01-1.85
Ba	99.5	71.4	21.0-552.0
Ti%	0.08	0.08	0.01-0.26
B	3.7	4.7	2.0-36.0
Na%	0.03	0.03	0.01-0.17
K%	0.17	0.1	0.01-0.65
W	1.0	0.2	1.0-3.0

Table 4.9—Pearson correlation coefficients for chemical analyses of samples from the Carlisle and Sec. 2 mines.

	Au	Ag	Cu	Pb	Zn	As	Sb	Bi	Fe	Ca	Al	Mo	Ni	Co	Mn	Sr	Cd	V	P	La	Cr	Mg	Ba	Ti	B	Na	K	W
Au	1.00																											
Ag	0.96	1.00																										
Cu	0.05	0.13	1.00																									
Pb	0.22	0.40	0.33	1.00																								
Zn	0.10	0.23	0.37	0.85	1.00																							
As	0.25	0.27	0.14	0.11	0.07	1.00																						
Sb	0.05	0.09	0.07	0.09	0.05	-0.01	1.00																					
Bi	0.05	0.16	0.32	0.78	0.91	0.05	0.09	1.00																				
Fe	-0.11	-0.09	0.20	0.10	0.20	0.40	0.00	0.14	1.00																			
Ca	-0.06	-0.05	0.55	-0.02	0.09	-0.20	0.00	0.09	0.24	1.00																		
Al	-0.05	-0.07	0.05	-0.08	0.06	-0.29	0.03	0.01	0.41	0.62	1.00																	
Mo	-0.02	0.02	0.04	0.09	-0.01	0.39	-0.03	-0.03	-0.04	-0.36	-0.40	1.00																
Ni	-0.08	-0.08	0.26	-0.07	0.04	-0.18	0.16	0.02	0.37	0.60	0.73	-0.27	1.00															
Co	-0.07	-0.06	0.10	0.01	0.18	-0.25	0.06	0.15	0.39	0.65	0.82	-0.41	0.82	1.00														
Mn	0.52	0.54	0.19	0.19	0.23	-0.02	0.15	0.15	0.18	0.47	0.60	-0.31	0.54	0.66	1.00													
Sr	-0.07	-0.08	0.00	-0.06	-0.05	0.19	-0.09	-0.07	0.25	-0.01	-0.09	0.06	-0.16	-0.19	-0.21	1.00												
Cd	0.03	0.12	0.33	0.60	0.60	0.04	0.18	0.42	0.18	0.06	0.07	0.04	0.03	0.11	0.25	-0.06	1.00											
V	0.65	0.62	0.05	0.11	0.14	0.24	0.06	0.08	0.43	0.30	0.43	-0.24	0.32	0.45	0.68	-0.01	0.07	1.00										
P	-0.13	-0.13	0.00	-0.10	0.00	-0.10	0.11	-0.02	0.43	0.27	0.70	-0.25	0.67	0.71	0.42	0.10	0.02	0.27	1.00									
La	-0.11	-0.11	-0.05	-0.06	0.05	-0.24	0.07	0.03	0.22	0.29	0.64	-0.32	0.67	0.77	0.47	-0.17	0.04	0.29	0.71	1.00								
Cr	-0.01	-0.01	0.11	-0.03	0.03	0.27	0.22	0.01	0.52	0.47	0.33	-0.14	0.39	0.28	0.25	0.03	0.02	0.47	0.26	0.22	1.00							
Mg	-0.01	-0.02	0.01	-0.07	0.06	-0.33	0.04	0.04	0.28	0.44	0.92	-0.43	0.71	0.81	0.63	-0.16	0.03	0.44	0.67	0.63	0.32	1.00						
Ba	-0.06	-0.06	0.02	0.02	0.02	0.26	-0.04	0.04	0.15	0.01	-0.11	-0.01	-0.09	-0.06	-0.17	0.24	0.01	0.01	-0.02	-0.08	-0.11	-0.20	1.00					
Ti	-0.07	-0.09	-0.06	-0.07	0.04	-0.34	-0.12	0.06	0.08	0.36	0.56	-0.44	0.43	0.68	0.41	-0.01	-0.09	0.36	0.46	0.51	0.14	0.62	-0.01	1.00				
B	0.00	0.01	-0.04	-0.04	-0.02	0.14	-0.04	-0.04	0.04	0.06	0.11	0.07	0.12	0.14	0.12	-0.02	-0.03	0.06	0.16	0.19	0.02	0.11	0.09	0.11	1.00			
Na	-0.07	-0.09	-0.05	-0.08	0.01	-0.22	-0.11	0.03	0.29	0.28	0.46	-0.33	0.37	0.47	0.23	0.39	-0.11	0.28	0.49	0.36	0.18	0.48	0.03	0.68	0.08	1.00		
K	-0.12	-0.09	0.08	0.01	0.07	-0.14	0.01	0.00	0.25	-0.05	0.42	-0.12	0.49	0.44	0.27	0.10	0.12	-0.05	0.52	0.46	0.02	0.29	-0.10	0.03	0.06	0.21	1.00	
W	0.35	0.33	0.00	0.05	0.02	0.13	0.00	0.01	-0.02	0.24	-0.08	0.13	-0.07	-0.07	0.15	0.04	-0.01	0.24	-0.13	-0.09	0.02	-0.07	0.01	-0.07	-0.03	-0.08	-0.16	1.00

Table 4.10—Varimax rotated factor matrix, samples from Carlisle and Sec. 2 mines.

	F1	F2	F3	F4	F5	F6	F7	F8
Au	-0.04	0.05	0.99	-0.06	-0.03	0.00	0.01	-0.02
Ag	-0.06	0.19	0.96	-0.06	-0.06	0.03	0.04	-0.01
Cu	-0.01	0.32	0.04	0.11	-0.02	0.86	0.07	-0.01
Pb	-0.08	0.89	0.19	-0.02	-0.02	0.05	0.02	-0.01
Zn	0.07	0.99	0.05	0.03	0.01	0.05	-0.02	0.02
As	-0.41	0.05	0.28	0.49	0.10	0.08	0.00	0.62
Sb	0.01	0.09	0.05	0.19	-0.20	0.03	0.10	-0.13
Bi	0.06	0.87	0.00	0.01	0.01	0.05	-0.10	0.01
Fe	0.24	0.16	-0.05	0.70	0.26	0.08	0.16	0.22
Ca	0.68	0.07	-0.02	0.03	0.08	0.65	-0.08	0.01
Al	0.85	-0.01	-0.01	0.21	-0.04	0.05	0.18	-0.05
Mo	-0.50	0.02	-0.02	0.04	-0.06	0.01	0.10	0.24
Ni	0.73	-0.02	-0.06	0.24	-0.16	0.24	0.29	0.05
Co	0.92	0.12	-0.03	0.13	-0.11	0.07	0.14	0.14
Mn	0.63	0.16	0.56	0.10	-0.20	0.12	0.15	0.00
Sr	-0.13	-0.06	-0.03	0.12	0.77	0.02	0.13	0.01
Cd	0.00	0.59	0.03	0.09	-0.10	0.12	0.15	-0.05
V	0.45	0.05	0.70	0.44	0.06	-0.03	-0.17	0.07
P	0.71	-0.04	-0.10	0.20	0.12	-0.01	0.38	0.17
La	0.75	0.01	-0.08	0.06	-0.14	-0.09	0.26	0.16
Cr	0.25	-0.02	0.05	0.74	-0.03	0.04	-0.08	-0.07
Mg	0.88	-0.01	0.03	0.16	-0.10	0.00	0.06	-0.10
Ba	-0.11	0.04	-0.05	0.02	0.25	0.03	-0.08	0.29
Ti	0.82	-0.01	-0.02	-0.15	0.22	-0.01	-0.36	0.07
B	0.13	-0.04	0.02	-0.02	-0.02	-0.03	0.04	0.33
Na	0.61	-0.03	-0.03	0.02	0.60	-0.04	-0.05	-0.04
K	0.34	0.06	-0.12	-0.06	0.07	0.03	0.73	0.01
W	-0.09	0.00	0.35	0.03	-0.01	0.00	-0.07	0.02



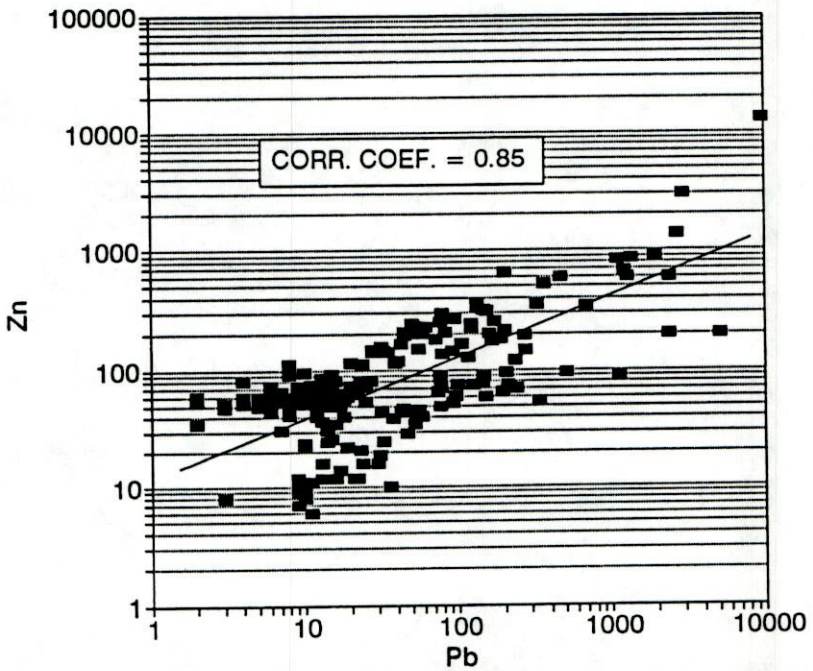


Figure 4.25 - Scatter plots of gold vs. silver and lead vs. zinc of assays from the Carlisle and sec. 2 mines.

(low gold and silver) ore shoot. The lack of a strong correlation of copper in factor group 3 is also confirmed by field and geochemical evidence. In recent weathering, rainwater reacts with pyrite and other sulfides to form acidic water which accumulates and locally drains from the Carlisle mine. The acidic water tends to dissolve pyrite and chalcopyrite before galena and sphalerite. Thus the waters are more concentrated with iron and copper (J. McLemore, unpubl. report, March 1993).

Geochemical concentration maps of the various metals and pathfinder elements were prepared. These maps indicate that gold and silver anomalies occur along the Carlisle fault. A geochemical concentration map of arsenic values reported for each rock chip sample reveals a halo of slightly elevated arsenic concentrations over the Carlisle orebody (Fig. 4.26). This suggests that arsenic may act as a pathfinder element; this needs to be confirmed by additional studies. No other zonations of metals could be detected.

4.3.3 Alabama mine

Great Lakes Exploration Co. collected and assayed samples from the surface along the veins and faults in the Alabama mine area (Fig. 4.27). Channel samples comprised of rock chips from traverses 1 to 2 m long were collected at each location. The data are summarized in Table 4.11. All samples were analyzed for gold, silver, arsenic, antimony, mercury, and fluorine by Skyline Analytical Laboratory; 19–20 samples were also analyzed for major and trace elements by XRF by NMBMMR (Appendix 11.6). Correlation coefficients and factor analysis are in Tables 4.12 and

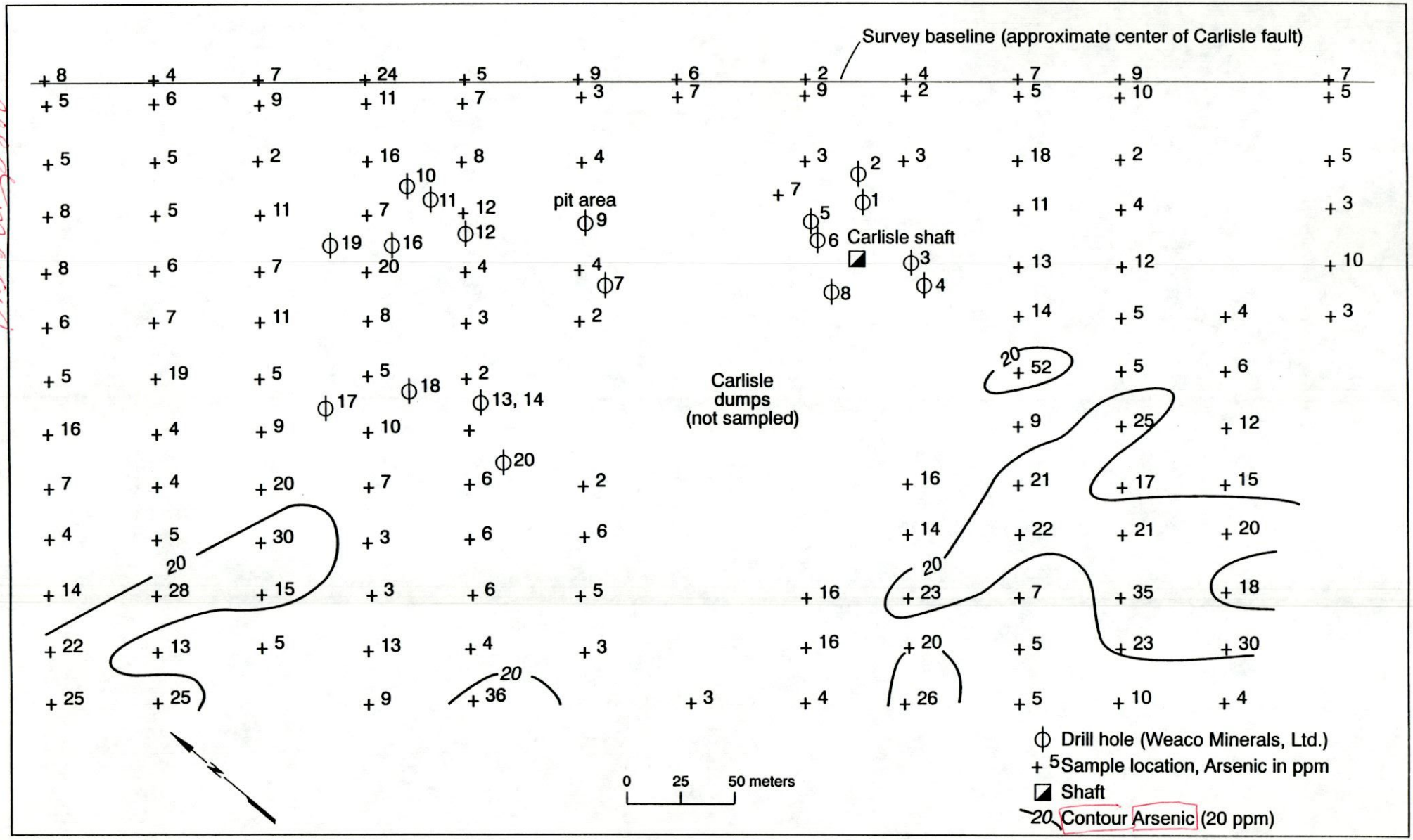


Figure 4.26 - Geochemical concentration map of arsenic at the Carlisle Mine. Weak arsenic anomalies (> 20 ppm As) overly projected ore shoots.

TABLE 11.2—Summary of drill data at the Carlisle mine by WEACO, Ltd., 1991. Holes were drilled by reverse circulation and only drill cuttings are available. Samples were typically taken every 1.5 m and assayed (few exceptions). Only selected assays of drill intercepts are reported here. Depths are drill depths. Note holes CR91-2, -10, -11, -14, and -15 did not intercept the Carlisle vein.

Hole no.	Collar elevation (m)	Az	HD	Total depth (m)	Vein intercept (m)	Sample intercept (m)	Au oz/ton	Ag oz/ton	Cu ppm	Pb ppm	Zn ppm	Comments
CR91-1	1610.8	230	-50	54.9	12.2-36.6	12.2-13.7	0.006	<0.01	170	790	160	
						13.7-15.2	0.105	1.94	190	1450	195	
						15.2-16.8	0.755	11.49	300	1900	340	
						16.8-18.3	0.016	0.45	80	730	280	
CR91-2	1609.3	230	-50	103.6	-----	65.5-67.1	0.01	<0.01	60	4	80	Did not intersect vein?
CR91-3	1609.3	360	-60	67.1	13.7-19.8	12.2-13.7	0.016	<0.01	75	24	320	
						13.7-15.2	0.002	<0.01	100	210	305	
CR91-4	1606.2	357	-60	73.1	33.5-61.0	38.1-39.6	<0.002	0.02	60	26	485	Stope at 33.5-38.1.
CR91-5	1610.8	vertical	-90	36.6	9.1-29.0	16.8-18.3	0.09	3.97	130	760	940	Stope at 21.3-29.0 m.
						18.3-19.8	0.092	0.6	230	1600	1850	
						19.8-21.3	0.37	0.96	370	1250	1300	
						29.0-30.5	0.016	<0.01	195	265	1900	
CR91-6	1610.8	57	-60	18.3	1.5-15.2	12.2-13.7	0.004	0.01	450	1250	690	Stope at 9.1-13.7
CR91-7	1610.8	5	-60	42.7	1.5-22.9	7.6-9.1	0.34	0.25	670	1200	910	Stopes at 16.8-19.8, 24.4-36.6.
					24.4-36.6	9.1-13.7	0.04	<0.01	190	1300	425	
						13.7-15.2	0.028	0.27	1650	5700	6850	
						15.2-16.8	0.002	0.83	4200	2150	4400	
CR91-8	1610.8	vertical	-90	67.1	13.7-61.0	50.3-51.8	0.13	2.53	450	1600	3150	
						51.8-53.3	0.62	2.2	490	1150	3400	
						53.5-54.9	0.032	0.15	145	155	450	
CR91-9	1578.8	55	-60	24.4	0-10.7	6.1-7.6	0.002	1.64	22000	17000	41500	Drilled in pit.
						7.6-9.1	0.008	2.54	15000	9850	22500	
CR91-10	1606.2	215	-60	61.0	-----	19.8-21.3	0.014	0.31	110	85	235	Did not intersect vein.
						27.4-29.0	<0.002	1.76	70	55	170	
CR91-11	1606.2	215	-60	48.8	-----	16.8-18.3	0.01	<0.01	60	6	150	Did not intersect vein.
						30.5-32.0	<0.002	0.17	75	14	315	
						32.0-33.5	0.022	0.03	65	36	175	
CR91-12	1609.3	vertical	-90	67.1	18.3-59.4	24.4-25.9	0.012	0.03	180	100	100	Wood in some sample - backfilled stope?
						25.9-27.4	0.28	0.01	65	65	120	
						27.4-29.0	0.075	0.32	120	70	90	
						39.6-41.1	0.022	0.18	170	70	135	
CR91-13	1594	55	-60	97.5	10.7-97.5	88.4-89.9	0.046	0.42	1600	8950	7900	
						89.9-91.4	0.002	0.09	1100	1750	1800	
						91.4-93.0	0.034	0.19	1600	3400	2400	
CR91-14	1597.1	vertical	-90	61.0	-----	51.8-53.3	<0.002	<0.01	44	65	145	Did not intersect vein.
CR91-15		vertical	-90	42.7	-----	30.5-32.0	<0.002	<0.01	75	14	90	Section 2 mine, did not intersect vein.
CR91-16		vertical	-90	61.0	6.1-33.5	13.7-15.2	0.038	0.22				
						21.3-22.9	0.41	0.16	185	50	36	
CR91-17		60	-60	103.6	48.8-103.6	74.7-76.2	0.026	<0.01				
CR91-18		50	-60	106.7	24.4-97.5	77.7-79.2	0.016	<0.01	42	16	85	
						79.2-80.8	<0.002	<0.01	180	200	230	
CR91-19		50	-60	61.0	12.2-42.7	13.7-15.2	0.006	<0.01	34	8	24	
						15.2-16.8	0.008	<0.01	34	8	24	
CR91-20		50	-60	112.8	100.6-112.8	54.9-56.4	0.002	<0.01	28	2	75	
						99.1-100.6	0.002	0.18	30	110	90	
						100.6-120.1	0.002	0.02	1050	910	1300	
CR91-21		vertical	-90	54.9	6.1-18.3	19.8-21.3	<0.002	0.07	100	48	325	