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Impact of the Summitville Mine on irrigation water, agricultural soils, and alfalfa in the southwestern San Luis Valley, Colorado

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Contamination from the Summitville gold mine in the San Juan Mountains has raised concerns over the effects of low pH and metal-laden surface waters carried down the Alamosa River. These waters enter the Terrace Reservoir, which provides irrigation water to the southwestern part of the San Luis Valley. The purpose of this study was to assess whether significant differences exist between the effects of two source waters on the compositions of alfalfa and the associated soils, respectively. The two source waters are Terrace Reservoir water and Rio Grande River water and (or) confined ground water.

Sampling was conducted June 3-6, 1993, just prior to the first cutting of alfalfa. Irrigation water, soils, and alfalfa were collected from four sprinkler-irrigated Terrace Reservoir fields and from similarly irrigated "control" fields using a balanced one-way analysis-of-variance design. Four sites were selected randomly within each of the eight fields.

The water samples were taken from the irrigation system of each field. The pH values of the Terrace Reservoir waters ranged from 5.6 to 6.8 and the samples contained no measurable alkalinity. Preliminary chemical data indicate that these waters contained anomalous concentrations of copper (60-350 μg/L), zinc (150-190 μg/L), and manganese (360-520 μg/L) in unfiltered samples. In contrast, the pH of irrigation waters originating from sources other than Terrace Reservoir ranged from 7.6 to 9.2, and the concentration of metals was less than 2 μg/L, 25 μg/L, and 20 μg/L for copper, zinc, and manganese, respectively. It appears that fields irrigated with waters originating from the Terrace Reservoir receive more acidic water and higher concentrations of dissolved metals than do fields using irrigation waters from another source.

Results of total analyses of soils from sites irrigated with Terrace Reservoir water are similar to those of the soils irrigated with other sources of water. Differences in element concentrations were not significant at the 0.01 probability level, but were significant at the 0.05 level for copper and phosphorus. When compared with geometric means for soils from the western United States (Shacklette and Boerngen, 1984), soils we collected from the southwestern part of the San Luis Valley contain higher concentrations of aluminum, barium, beryllium, cobalt, copper, iron, manganese, potassium, sodium, strontium, titanium, vanadium, and zinc. These higher concentrations probably reflect the composition of the alluvial parent material from which the soils were derived. This fan material is detritus shed from weathering of volcanic rocks and mineralized areas in the Alamosa River drainage basin. All of our soil data from the southwestern part of the San Luis Valley are within geochemical baselines for soils from the western United States (Shacklette and Boerngen, 1984).

Stem-and-leaf samples of alfalfa were collected from 10 points within a 1-m radius of each soil pit. An analysis-of-variance for 15 elements showed no significant differences in alfalfa irrigated by the two source waters when tested at the 0.01 probability level. However, concentrations of copper and manganese between the two sources were significantly different at the 0.05 level. More importantly, concentrations of these metals in alfalfa affected by both water sources (i) meet published nutritive requirements for ruminants, (ii) are far below concentrations reported to be toxic to cattle, and (iii) are comparable to concentrations in alfalfa found in other parts of the country.

In conclusion, preliminary results indicate that the metal concentrations of the irrigation water affected by the Summitville mine may be anomalous. Yet these waters have no measurable effects on the total soil chemistry and seem to have had a minimal impact on the associated alfalfa.

Reference

Shacklette, H.T., and Boerngen, J.G., 1984, Element concentrations in soils and other surficial materials of the conterminous United States: U.S. Geological Survey Professional Paper 1270, 105 p.

Element	Western U.S. Soil + Baseline	Western U.S. Soil + GM *	Southwestern San Luis Valley Agricultural Soil Observed Range	Southwestern San Luis Valley Agricultural Soil GM *
Aluminum (%)	1.5 - 23	5.8	7.0 - 8.1	7.4
Barium (ppm)	200 - 1,700	580	820 - 910	859
Beryllium (ppm)	0.13 - 3.6	0.68	2 - 2	--
Calcium (%)	0.19 - 17	1.8	1.0 - 3.1	1.5
Cerium (ppm)	22 - 190	65	57 - 87	70
Chromium (ppm)	8.5 - 200	41	21 - 33	26
Cobalt (ppm)	1.8 - 28	7.1	12 - 17	15
Copper (ppm)	4.9 - 90	21	26 - 51	34
Gallium (ppm)	5.7 - 45	16	15 - 19	17
Iron (%)	0.55 - 8.0	2.1	3.9 - 5.6	4.7
Lanthanum (ppm)	8.4 - 110	30	32 - 47	37
Lead (ppm)	5.2 - 55	17	13 - 32	19
Lithium (ppm)	8.8 - 55	22	12 - 21	16
Magnesium (%)	0.15 - 3.6	0.74	0.62 - 0.84	0.72
Manganese (ppm)	97 - 1,500	380	620 - 1,000	787
Neodymium (ppm)	12 - 110	36	25 - 39	30
Nickel (ppm)	3.4 - 66	15	11 - 15	12
Phosphorus (%)	0.0059 - 0.17	0.032	0.09 - 0.14	0.12
Potassium (%)	0.38 - 3.2	#1.8	2.3 - 2.6	2.4
Scandium (ppm)	2.7 - 25	8.2	9 - 10	10
Sodium (%)	0.26 - 3.7	0.97	1.5 - 2.1	1.8
Strontium (ppm)	43 - 930	200	400 - 510	450
Thorium (ppm)	4.1 - 20	9.1	7 - 10	9
Titanium (%)	0.069 - 0.70	0.22	0.44 - 0.53	0.48
Vanadium (ppm)	18 - 270	70	87 - 140	120
Ytterbium (ppm)	0.98 - 6.9	2.6	1 - 2	2
Yttrium (ppm)	8.0 - 60	22	13 - 23	18
Zinc (ppm)	17 - 180	55	83 - 110	93

+ Data from Shacklette, H.T., and Boerngen, J.G., 1984, Element concentrations in soils and other surficial materials of the conterminous United States: U.S. Geological Survey Professional Paper 1270, 105 p., table 2.

* GM is the geometric mean except as noted.

Arithmetic mean.

CONCENTRATIONS OF SELECTED METALS IN ALFALFA COLLECTED FROM FIELDS IRRIGATED BY TERRACE RESERVOIR (ALAMOSA RIVER) WATER AND FIELDS IRRIGATED BY WATER FROM OTHER SOURCES

µg **Cu/g**		µg **Mn/g**		µg **Zn/g**	
Mean	Range	Mean	Range	Mean	Range
		4 Terrace-water fields			
11	9.0 - 14	50	42 - 63	29	19 - 36
		4 "Control" fields			
8.4	4.2 - 11	32	22 - 43	20	11 - 29
		Probable dietary requirement for cattle:			
		Church (1971)			
10±		20		30-40+	
		National Academy of Sciences (1976)			
4		1-10		20-30	
		Agricultural Research Council (1965)			
10		40		50	
		Possible toxic levels in cattle (National Academy of Sciences)			
115		150		900	

References

Agricultural Research Council, 1965, The nutrient requirements of farm livestock, No. 2—Ruminants, Technical reviews and summaries: Agricultural Research Council, London.

Church, D.C., 1971, Digestive physiology and nutrition of ruminants, volume 2—Nutrition: Albany Printing Co., Albany, OR

National Academy of Sciences, 1976, Nutrient requirements of domestic animals, number 4—Nutrient requirements of beef cattle: National Academy of Sciences, Washington, D.C.