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Alaska Community Action on Toxics' (ACAT) report: "Red Dog and Subsistence. Analysis of Reports on Elevated Levels of Heavy Metals in Plants Used for Subsistence near Red Dog Mine, Alaska"

Evaluation and Response
Alaska Division of Public Health
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Introduction

On June 9, 2004, Alaska Community Action on Toxics (ACAT) released a report "Red Dog and Subsistence. Analysis of Reports on Elevated Levels of Heavy Metals in Plants Used for Subsistence near Red Dog Mine, Alaska." The report criticizes the Alaska Division of Public Health (ADPH) investigation, conclusions, and recommendations published in 2001. ACAT calls for more environmental and human testing, restricting areas for subsistence food gathering, and increasing efforts to control pollution sources and environmental contamination.

The purpose of this report is to identify and correct errors in the ACAT report and update the public health recommendations in our original report.[1]

Background

The ACAT report of June 9, 2004 presents no new data. The report is based upon a re-analysis and re-interpretation of data that were reported in 2001 and 2002. ACAT reviewed four primary documents in preparing its new report.[1-4]

ACAT commissioned Fred Youngs, Ph.D. an occupational and environmental research chemist, University of Massachusetts Lowell, and director of the Citizens Environmental Laboratory in Boston to review these reports.

ACAT raises concerns that berries and sourdock located near the haul road and the port have been impacted by fugitive dust emissions of lead and zinc ore concentrate and residents of Kivalina collect these berries near the port and haul road.

First, the ACAT report incorrectly states that ADPH reviewed all the information in Ecology & Environment, Inc. (2002),[2] Exponent (2002),[3] and Ford and Hasslebach (2001)[4] for our 2001 report.[1] Actually, the only data available at the time of our report was Ford and Hasslebach

(2001)[4] and 10 composite salmonberry samples (5 washed and 5 unwashed) of salmonberries approximately 2 miles north and 10 composite samples (5 washed and 5 unwashed) approximately 2 miles south of the port. The majority of the data in Ecology & Environment, Inc. (2002)[2] and the Exponent (2002)[3] data were not available.

Second, an "anomaly" reported by Dr. Youngs in the Ecology & Environment, Inc. report for the lead concentration detected in salmonberries from Point Hope was due to erroneous data that were provided by ADEC. These erroneous data were not contained in the original results from the laboratory. In November 2001, ADEC prepared a summary to accompany the initial raw laboratory data. Unfortunately, an error occurred in preparing the spreadsheet, and data from the wrong columns were switched. These erroneous summary data were provided by ACAT to Dr Youngs and were the cause of the "anomaly" in the Point Hope results.

Table 1 contains the correct data for Point Hope from Appendix C of the Ecology & Environment report.[2] Wet weight = (percent dry weight/100) x dry weight.

Table 1. Lead and Cadmium detected in salmonberries from Point Hope.

Sample ID	Percent Dry Wt	Matrix	dry weight (mg/kg)		wet weight (mg/kg)	
			Pb	Cd	Pb	Cd
01DMT048SY	11.3	Salmonberries	0.00992	0.155	0.00112	0.0175
01DMT049SY	11.0	Salmonberries	0.009816	0.121	0.00108	0.0133
01DMT050SY	10.9	Salmonberries	0.0117	0.223	0.00128	0.0243
01DMT051SY	10.7	Salmonberries	0.009555	0.281	0.00102	0.0301
01DMT052SY	11.3	Salmonberries	0.0100	0.242	0.00113	0.0273
01DMT053SY	11.4	Salmonberries	0.0187	0.195	0.00213	0.0222
01DMT054SY	10.8	Salmonberries	0.0141	0.231	0.00152	0.0249
01DMT055SY	11.7	Salmonberries	0.0113	0.295	0.00132	0.0345
01DMT056SY	12.2	Salmonberries	0.0126	0.162	0.00154	0.0198
01DMT057SY	12.3	Salmonberries	0.0153	0.171	0.00188	0.0210
average					0.00140	0.02350

For the salmonberries collected at Point Hope, using the erroneous data, Dr. Youngs calculated an average wet weight concentration of 1.9 mg/kg for lead and 1.3 mg/kg for cadmium. The actual average values were 0.0014 mg/kg for lead and 0.023 mg/kg for cadmium (Table 1). Thus, the salmonberries collected from Point Hope contain the lowest level of lead detected in berries as reported in E & E (2002)[2] and Exponent (2002),[3] not the highest level as reported by Dr. Youngs and ACAT. Metal concentrations in Pt. Hope samples were not elevated.

The available data for salmonberries, blackberries and sourdock are presented in Table 2.[2, 3] As expected, vegetation collected near the port and haul road have the highest levels of lead and cadmium most likely derived from fugitive dust emissions of lead and zinc ore concentrate. Average lead and cadmium concentrations decreased with increasing distance from the port and haul road. Lead contained in the ore concentrate is in the form of lead sulfide. As documented in our 2001 report, this form of lead has very low bioavailability compared to other forms of lead.[1]

Table 2. The concentration of lead and cadmium detected in subsistence foods.

Study	Location	Washed or Unwashed	Number of Samples	Lead		Cadmium	
				Average	Std. Dev.	Average	Std. Dev.
				mg/kg wet weight			
Sourdock							
E&E 2002	Noatak	washed	10	0.014	0.0072	0.021	0.012
E&E 2002	Noatak	unwashed	10	0.015	0.005	0.029	0.018
E&E 2002	5 (approx.) miles north of port	washed	4	0.044	0.017	0.0029	0.00056
E&E 2002	5 (approx.) miles north of port	unwashed	4	0.032	0.011	0.0036	0.0012
E&E 2002	2 (approx.) miles north of port	washed	6	0.22	0.073	0.0109	0.0027
E&E 2002	2 (approx.) miles north of port	unwashed	6	0.29	0.075	0.0131	0.0054
Salmonberries							
E&E 2002	Point Hope	unwashed	10	0.0014	0.0004	0.0235	0.0062
E&E 2002	Noatak	washed	10	0.0016	0.0021	0.0297	0.0082
E&E 2002	Noatak	unwashed	10	0.0054	0.0095	0.029	0.0065
E&E 2002	2 (approx.) miles north (5 samples) and south (5 miles) of Port	unwashed	10	0.027	0.0089	0.0208	0.0053
E&E 2002	2 (approx.) miles north (5 samples) and south (5 miles) of Port	washed	10	0.024	0.0096	0.022	0.0069
E&E 2002	Port	unwashed	4	0.23	0.069	0.0647	0.012
Exponent 2002	Port	unwashed	3	0.099	0.018	0.049	0.018
Exponent 2002	Port 3 meters from haul road	unwashed	1	1.77		0.21	
Exponent 2002	Port 100 meters from haul road	unwashed	1	0.13		0.042	
Exponent 2002	30 miles from Port-3 meters from haul road	Unwashed	1	0.48		0.048	
Exponent 2002	30 miles from Port-100 meters from haul road	Unwashed	1	0.054		0.0068	
Blackberries							
E&E 2002	Noatak	Unwashed	8	0.0053	0.0026	7/8 ND (<0.0012), 0.00139	
E&E 2002	4 to 5 (approx.) miles north of port	Unwashed	10	0.0211	0.008	8/10 ND (<0.0012), 0.00212, 0.00255	
E&E 2002	4 to 5 (approx.) miles north of port	Washed	10	0.0171	0.0044	10/10 ND (<0.0012)	

Lead risk-based screening levels

ACAT used the World Health Organization's (WHO) *Codex Stan 230- 2001* maximum level for lead in berries (0.2 mg/kg, FAO/WHO 2004) to compare with lead levels detected in collected berries.[5] The average concentration of all berry samples was below this value except berries collected at the port or within approximately 10 feet of the haul road. The lead detected on berries collected near the port or haul road likely reflect ore concentrate. The average concentrations in all sourdock samples were below the WHO lead *Codex* value for leafy vegetables of 0.3 mg/kg.[5]

Cadmium risk-based screening levels

Currently, there are no *Codex* standards for cadmium in berries. The WHO provisional tolerable daily intake and USEPA reference dose for cadmium is 1 µg cadmium/kg body weight/day.[6, 7] Assuming an ingestion rate of 17.5 g/day for berries (estimated based on mean harvest rates reported in the Alaska Department of Fish and Game Community Profile Database,[8] the acceptable concentration in berries would be 4 mg/kg for adults and 0.88 mg/kg for children.[1] All cadmium concentrations detected in berries were below these values. There are draft *Codex* values for leafy vegetables of 0.2 mg/kg. All sourdock values were below this value.

ACAT disagrees that lead sulfide in the Red Dog ore concentrate has low bioavailability.

- That lead sulfide has low bioavailability is a scientific fact.[9-12] The solubility of lead sulfide is 9×10^{-29}.[10] This compares to other forms of lead.[10]

Solubility of lead compounds[10]

Lead bromine	6.6×10^{-6}
Lead carbonate	1.46×10^{-13}
Lead chloride	1.17×10^{-5}
Lead fluoride	7.12×10^{-7}
Lead hydroxide	1.42×10^{-20}
Lead iodate	3.68×10^{-13}
Lead iodide	8.49×10^{-9}
Lead oxalate	8.51×10^{-10}
Lead sulfate	1.82×10^{-8}
Lead thiocyanate	2.11×10^{-5}

- The rat feeding study conducted by the National Toxicology Program (NTP) demonstrates that the bioavailability of lead contained in Red Dog ore concentrate is similar to lead sulfide and is much lower than other chemical forms of lead.[11, 12]

- The results of all tests done to evaluate the Red Dog Mine mirror the results of a past extensive investigation conducted by the ADPH and the National Centers for Disease Control and Prevention of lead exposure to lead ore concentrate in Skagway, Alaska.

- The extensive public health investigation in Skagway, AK demonstrated the low bioavailability of lead sulfide from ore concentrates.[11-16] The residents of Skagway, AK were exposed to high concentrations of lead in soil from years of transportation of lead ore concentrate through the center of town. Samples from street gutters along State Street measured as high as 28,000 mg/kg, however 60% of the soil samples collected 5 feet from the road contained less than 1,000 mg/kg lead. Most soil samples taken on residential property contained less than 500 mg/kg lead. Despite these high environmental levels, children of Skagway did not have blood lead levels of public health concern.[13-16] Rat feeding studies conducted by the NTP confirmed the ore concentrate present in Skagway, AK had similar bioavailability to lead sulfide.[11]

Dr. Youngs and ACAT argue that the juvenile swine is a better animal model to determine the bioavailability of lead. We agree that swine are better animals with which to conduct research

on lead bioavailability. However, the purpose of the testing by the National Toxicology Program was to document that the unsmelted ore concentrate had lower bioavailability than other chemical forms of lead. The rat model was valid to use for this purpose. The results were reviewed and published by the National Toxicology Program.

Dr. Youngs compared the results of a juvenile swine-feeding study[17] to the results of the National Toxicology Program's Skagway ore concentrate rat-feeding study.[11] However, these two studies are not directly comparable, because the form of lead tested in the swine- feeding study was not the same as in the Skagway study. According to Casteel et al.,[11] the tested soil that was fed to the swine contained greater than 60 % cerrusite ($PbCO_3$). This form of lead ($PbCO_3$) is more soluble (1.5×10^{-13}) compared to lead sulfide (9×10^{-29}).[18] The amount of lead sulfide in the soil from the Smuggler Mountain site ranged from 15 to 18%, and other more bioavailable forms of lead such as lead oxide were also present.[17] Red Dog mine ore concentrate samples collected from the concentrate storage buildings in August 2001 contained 60 to 70% lead sulfide (PbS), 14 to 21% ZnS, 6 to 15% FeS_2, and 2 to 4.5% SiO_2. Lead sulfide containing mining ores have low bioavailability.[9]

Additional Clarifications

- The National Park Service study did not find that the moss "contained" lead and cadmium. Rather, the moss was chosen because it enables a determination of internal ("contained") amounts of lead and cadmium compared to external contamination. The data from the National Park Service study lead to the conclusion that the lead and cadmium were from fugitive ore concentrate that was deposited upon the moss.
- The ACAT report lacks precision in defining areas and distances, both of which are essential to understanding that no exposure pathway exists for lead from the Red Dog Mine to the villages. The villages of Noatak and Kivalina are many miles from the mine, haul road, and port. Villagers and mining personnel have reported no routine, substantial gathering of berries at the port site or along the haul road.
- The public health recommendations were not derived from extrapolating from rats to humans. We had extensive actual lead measurements from many persons. The bioavailability studies were conducted by the National Toxicology Program to provide additional, direct scientific evidence that the ore concentrate is of lower bioavailability than other chemical forms of lead.
- Mine employees fall under jurisdiction of the Mine Safety and Health Administration. Mine employees are routinely blood tested for lead exposure under federal requirements. All lead levels in Alaska above 10 micrograms per deciliter are reportable to the Alaska Division of Public Health. For children with a blood lead level $\geq$10 micrograms per deciliter and adults with a blood lead level $\geq$25 µg/dl, an investigation is conducted to determine the source of exposure.
- Other than adults employed at or by the Red Dog Mine, no residents of Noatak or Kivalina have had elevated blood-lead levels reported to the Alaska Division of Public Health.

Conclusions

- The ACAT report contains errors of fact and incorrectly interprets past studies and recommendations.
- There are opportunities to consider options for additional voluntary human blood testing with the informed consent of local residents and the involvement and participation of their primary medical care providers.
- Because the Red Dog Mine is expected to operate for at least the next 50 years, mechanisms to improve communications and education are warranted.
- Public health and medical recommendations need to be developed by those with appropriate expertise and experience working directly with affected individuals.
- The lead concentrations of salmonberries from Point Hope were not elevated.
- There is no evidence of long-distance, atmospheric transport of metals in the ore concentrate to any of the villages in Northwest Alaska. Because the particles of ore concentrate are relatively large and dense, they tend to settle near to points of release. Ambient air monitoring for lead in Noatak and Kivalina, reported to ADEC by Teck Cominco, confirms this.
- The concentrations of heavy metals detected in water, soil, caribou, fish, and berry samples collected from the Red Dog mine area do not pose a public health hazard to the residents of Kivalina and Noatak.
- Excluding the port, DMTS road, and mine, the concentrations of heavy metals measured in collected water, soil, caribou, fish, and berries represent low, natural background concentrations.
- As expected, soil samples at the port contained very high concentrations of lead and zinc, but the general public is excluded from the Port Area.
- The bioavailability of the lead sulfide in the ore concentrate is very low.
- When new workers start at the mine, their blood is tested for lead to establish a baseline. Baseline blood-lead levels of persons hired to work at the mine (1995 to 2001) from Kivalina and Noorvik were low and comparable to the general population.
- Past studies documented low blood-lead levels among residents of Kivalina and Noatak.
- Employees working at Red Dog who do not work directly with the ore concentrate have very low blood-lead concentrations.
- There are no identified exposure pathways for the residents of Kivalina or Noatak.
- Red Dog Mine employees should continue to have periodic blood-lead monitoring in accordance with MSHA and OSHA requirements.

Recommendations

- The Alaska Division of Public Health is committed to continuing to collaborate with the residents of Noatak and Kivalina, Maniilaq Health Corporation, NANA, and other key stakeholders. Working together, we can determine if any additional testing of environmental or human samples will be of value to local residents.
- Residents of Kivalina and Noatak should continue unrestricted harvest and consumption of subsistence resources throughout Northwest Alaska.
- Teck Cominco should continue to develop and implement methods to limit fugitive dust emissions at the mine, road, and port.

- Water samples from Kivalina's drinking water system should be routinely collected and analyzed in accordance with ADEC policies and regulations.
- Soil samples should be routinely collected near the port and monitored to determine the impact of lead and ore concentrate on the land available for public access.
- In an effort to limit exposure of the general public to industrial site activities, NANA should continue to limit public access to the Red Dog Mine and port facilities; residents should avoid collecting berries at the mine, port, and close to the haul road. If berries are collected near the mine, port, or haul road, they should be thoroughly washed before consuming.
- DPH believes the size and scope of the mining operation make the development of an ongoing environmental monitoring program essential.
- A formal process with active participation of local residents should be established through which State and Federal regulatory agencies and interested parties routinely review and interpret monitoring data.

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