MiningWatch Canada
Mines Alerte

MiningWatch Canada Chromite Series Fact Sheet # 02

WORKING with CHROMITE:

things you should know[1]

Introduction

Chromite is a mineral that contains the element chromium. The major use for mined chromite is the production of ferrochrome, an iron-chromium alloy used to make stainless steel.

Recently, chromite deposits have been identified in Northern Ontario, Canada. Located 500 km north-east of Thunder Bay in a pristine area dubbed the “Ring of Fire”, they are the largest deposits found in North America. Cliffs Natural Resources is evaluating a plan for an open pit/underground chromite mine and ore processing facility in the Ring of Fire and a ferrochrome production facility to be located somewhere in Ontario. A number of other companies also have plans for mining chromite and other metals in the area.

This fact sheet is part of a series produced by MiningWatch Canada about the risks of chromium mining and processing. Additional fact sheets and a more extensive review of relevant scientific research entitled *Overview of Chromium*, *Chromite and Toxicity*, are available on our website (www.miningwatch.ca/chromium). References for the information presented in this fact sheet can be found in the full review.

Is chromium dangerous?

The two most common types of chromium are trivalent chromium (Cr-III), which is found in the mineral chromite, and hexavalent chromium (Cr-VI). While Cr-III is considered an essential trace element in human diets, high doses can cause health problems and harm sensitive plants and animals. Human activities such as chromite mining and ferrochrome processing can convert Cr-III into Cr-VI, which is 100-1000 times more toxic than Cr-III and is known to cause cancer.

[1] Information taken from: An Overview of Chromium, Chromite and Toxicity by MiningWatch Canada, 2012.

A study of male ferrochrome production workers in Norway who were first employed before 1965, analyzed their health from 1953 - 1985 and found more cases of lung, prostate and kidney cancer in the workers than would be expected based on the national cancer rates (Langard et al. 1990).

A recent human health risk analysis was conducted for lifetime ferrochrome production workers in China considering inhalation, skin absorption and ingesting contaminated soil. The calculated increased cancer risks that are 3 to 1000 times greater than the “acceptable” increase in risk (1 in a million) (Wang et al. 2011).

Chromium (III) Sulfate

Though the intent of chromite mining is to remove the chromite from the ore for production of ferrochrome, the process is not 100% effective, so mining and smelting wastes including dust, wastewater, tailings, waste rock and slag (produced during ferrochrome separation from the ore) can still contain chromium (including Cr-VI). Other heavy metals and chemicals of concern may also be in the wastes. As with other types of mining wastes, chromite mine wastes have the potential to cause serious environmental contamination, as has occurred in places around the world where these wastes have been improperly managed. Soil, sediment, water, air and living things can all become contaminated with chromium.

Workplace exposure to chromium

Working at a chromite mine or ferrochromium production plant could result in exposure fto chromium through:

- skin contact with contaminated wastes, dust, water or soil;
- breathing contaminated air;
- drinking contaminated water or eating contaminated food, dust or soil (for example, from dirty hands or food)

In the workplace, proper planning, design and health and safety practices are necessary to minimize exposure and risks. To the extent possible chromite ore processing techniques and facility design should be chosen to minimize the amount of Cr-VI produced during activities such as crushing, grinding and smelting and to limit exposure of workers.

How can chromium affect human health?

Occupational exposure of Cr-VI to the skin can cause inflammation, eczema, open sores and permanent sensitization leading to a skin condition called allergic contact dermatitis (ACD).

Ingestion of large amounts of Cr-VI can cause nausea, vomiting, stomach and intestine damage, anemia, kidney and liver damage. Cr-VI ingestion has been linked to a number of cancers and is starting to be considered a likely human carcinogen.

Breathing in Cr-III and Cr-VI can irritate the nose, throat and lungs and produce inflammation. Additionally, Cr-VI inhalation is known to cause nosebleeds, ulcers and holes in the septum (structure between your nostrils), asthma, lung cancer, sinonasal cancer and possibly other cancers. Breathing Cr-VI seems to be the most dangerous route of exposure.

Very few studies exist regarding potential reproductive and development effects on humans. Links between chromium exposure in the workplace and decreased sperm production and health have been documented. Informal observations have noted a high number of birth defects and pregnancy complications in people exposed to chromium.

Are there cases of occupational chromium exposure that resulted in worker health effects?

As with other workplace health studies, investigating chromium exposure is inherently challenged by factors such as: finding comparable reference populations, estimating doses of chromium and their forms (Cr-III or Cr-IV), the effect of other workplace contaminants, statistical power, lifestyle/other variables affecting cancer/health problem occurrences.

Few studies of chromite miner health have been conducted, adding to the limitations note above. Studies in the 1950s and 60s found evidence of lung disease in chromite miners from dust inhalation, but their conclusions may not be relevant to the improved health and safety conditions in mines today.

[2] Cancers of: skin, lung, lip/oral cavity/pharynx, breast, liver, kidney, bladder, gastrointestinal tract, urinary tract, testes, prostate, brain, stomach, bone, lymphoma and leukemia

A number of studies have looked at ferrochrome workers and found workers are more at risk of:

- Asthma;
- Damage to skin of the nose and holes in the septum;
- Respiratory disease and decreased lung function from dust exposure
- Cancers of the: lung, esophagus, prostate, kidney, stomach and brain

In contrast, some studies of ferrochrome workers have not found effects and the International Agency for Research on Cancer considers evidence for lung cancer risks from ferrochrome occupational exposure inconclusive.

Additionally, studies of workers in other industrial settings with chromium exposure have observed effects which may be applicable to the exposure situations of ferrochrome workers. These include allergic contact dermatitis, heart disease, sperm damage and other cancers.

Information gaps regarding the health risks of chromium

Although chromium toxicity has been known for over 100 years, there is a lot that is not known or unclear to scientists and regulators about the doses, mechanisms and effects of chromium toxicity. Below are some questions currently without definitive answers:

1. Is there a safe threshold for ingested Cr-VI?
    - Although bodily fluids like saliva and stomach acid can convert Cr-VI to the less toxic Cr-III, it is not proven that this is effective in preventing chromium accumulation or effects.

2. Does Cr-VI inhalation cause any cancers other than lung and sinonasal cancer?
    - Some links have been found to cancers such as stomach and bronchial.

3. Does Cr-VI inhalation cause gastrointestinal, kidney and liver damage?
    - Some evidence suggests this may be the case.

4. Does Cr-VI ingestion cause cancer in humans and if so, what cancers?
    - Some evidence from animal and human studies has linked Cr-VI in food or water to a variety of cancers.

5. Do any Cr-III compounds cause cancer?
    - Cr-III is not classifiable as a human carcinogen due to insufficient information.

6. Are there safe exposure levels to Cr-VI that do not cause allergic contact dermatitis and skin ulcers?
    - “No observed effect levels” have not been documented.

7. What are the reproductive and developmental effects of Cr-VI and Cr-III on humans and at what doses?
    - Animal studies have found that Cr-VI and Cr-III harm reproductive systems and that Cr-VI can cause mutations and development problems in offspring. There is inconclusive evidence for reproductive and development effects of chromium in humans.

Does the government regulate chromium in the workplace?

Ontario’s Ministry of Labour has set standards for chromium concentrations in the air of workplaces (Table 1). The standards allow more Cr-VI than comparable standards set by the US National Institute for Occupational Safety and Health (NIOSH) (1 ug/m^3) and Occupational Safety and Health Administration (OSHA) (5 ug/m^3 soluble VI as CrO_3). All the above mentioned standards allow much more chromium than the air standards set in 2011 by the Ontario Ministry of the Environment for the protection of populations near chromium emitters (Table 2).

Table 1 Ontario Ministry of Labour chromium limits.
ON is Ontario. ug = microgram = 1 000 000 grams. m^3 is cubic metre of air. na means not applicable.

Limit		
Occupational Air (ug/m^3) 1	**Cr-0, III**	**Cr-VI**
ON: 8-hr average Occupational Exposure Limit	500	na
ON: 8-hr average Occupational Exposure Limit to chromate from chromite ore processing	na	50
ON: 8-hr average Occupational Exposure Limit for soluble Cr-VI	na	50
ON: 8-hr average Occupational Exposure Limit for insoluble Cr-VI	na	10

Units of Measurement: 1 million micrograms (ug) equals 1 gram.

Table 2 Ontario Ministry of Environment chromium limits.
PM_{10} is particulate matter <10um in diameter. TSP is total suspended particulate size fraction. ug is microgram, which is 1 000 000 grams. na means not applicable.

Limit			
Environmental Air (ug/m^3)1	**Cr-0, II, III**	**Cr-VI PM_{10}**	**Cr-VI TSP**
ON: 24-hr average Ambient Air Quality Criterion set in 1982 (Cr-II, III)	1.5	-	-
ON: 0.5-hr average Standard based on Cr-III respiratory effects, effective 2016	1.5	na	na
ON: 24-hour average Air Standard and Ambient Air Quality Criterion based on Cr-III respiratory effects, effective 2016	0.5	na	na
ON: 24-hr average Ambient Air Quality Criterion, based on Cr-VI carcinogenicity, effective 2016	na	0.00035	0.0007
ON: annual Ambient Air Quality Criterion, based on Cr-VI carcinogenicity, effective 2016	na	0.00007	0.00014
ON: 0.5-hr average Air Standard, based on Cr-VI carcinogenicity, effective 2016	na	-	0.002
ON: annual Air Standard, based on Cr-VI carcinogenicity, effective 2016	na	-	0.00014

Langard S, Andersen A, Ravnestad V. 1990. Incidence of cancer among ferrochromium and ferrosilicon workers: an extended observation period. British Journal of Industrial Medicine. 47, 14-19.

Wang Z-x, Chen J-q, Chai L-y, Yang Z-h, Huang S-h, Zheng Y. 2011. Environmental impact and site-specific human health risks of chromium in the vicinity of a ferro-alloy manufactory, China. J. Hazard. Mater. In press: doi:10.1016/j.jhaz mat.2011.04.039.

[3] http://www.labour.gov.on.ca/english/hs/pubs/oel_table.php
[4] http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2011/010-6353.pdf