

Fluoride in Drinking Water

Case Study # 4

Presented by: Ian Anderson and Tracy Torrans, Oct. 13th, 2006

Materials Included in Reading Package:

- 1.. The Hindu, 'People of this village suffer in silence' by Raviprasad Kamila, <http://www.hinduonnet.com/thehindu/thscrip/print.pl?file=2003032502630500.htm&date=2003/03/25/&prd=th&> accessed 10/3/06
2. The Hindu, 'Anti-fluorosis drive is yet to take off' by M. Dinesh Varma, <http://www.hinduonnet.com/thehindu/thscrip/print.pl?file=2006052718170400.htm&date=2006/05/27/&prd=th&> accessed 10/3/06
3. UNICEF, 'Fluoride in water: an overview', <http://www.unicef.org/wes/fluoride.pdf> accessed 10/02/06
4. **Environmental chemistry: A global perspective, 2nd ed.**. vanLoon, G.W., Duffy, S.J., Oxford University Press: 2005.
5. Del Rio News-Herald, 'City removes fluoride from water' by Karen Gleason, <http://www.delrionewsherald.com/story.lasso?ewcd=f0647e86863c2eab> accessed 10/11/06
6. Fluoride action network, <http://www.fluoridealert.org/health/bone/> accessed 10/04/06
7. Fluoridation.com, <http://www.fluoridation.com/> accessed 10/11/06
8. Steven Earle and Erik Krogh, Elevated Fluoride and Boron Levels in Groundwater from the Nanaimo Group, Vancouver Island, Canada, Proceedings of the International Association of Hydrology: Geotechnique 2006, in press, accepted June, 2006.

Further Resources:

1. Canadian council of resource and environment ministers, 'Canadian Water Quality Guidelines', http://www.hc-sc.gc.ca/ewh-semt/water-eau/drink-potab/guide/index_e.html
2. D.R. Boyle and M. Chagnon, An incidence of skeletal fluorosis associated with groundwaters of the maritime carboniferous basin, Gaspé region, Quebec, Canada, *Environmental Geochemistry and Health*, 1995, 17: 5-12.

TABLES AND FIGURES

Table 1 - Average fluoride concentrations of components of Earth (Source, Environmental chemistry: a global perspective)

Crustal	Seawater	Freshwater	Canadian Freshwater
950 mg/kg	1.3 mg/L	0.1 mg/L	Average = 0.05 mg/L

Table 2 - Acceptable drinking water limits of various organizations (Source, Chem 311 lab manual, Chem 301 course reference materials). CDWG: Canadian Drinking Water Guidelines. EU: European Union. WHO: World Health Organization

CDWG	EU	WHO	Japan
1.5 mg/L	No Standard	1.5 mg/L	0.8 mg/L

DEFINITIONS

Dental Fluorosis	Mottling and pitting of tooth enamel; is a symptom of chronic excess fluoride.
Skeletal Fluorosis	A very debilitating disease that is caused by mineral deposition around joints; it is a symptom of extreme chronic excess fluoride, and requires years to develop.
Fluorite (“Fluorspar”)	CaF_2 – the most common mineral form of fluoride in the Earth’s crust. Its dissolution is responsible for most naturally occurring fluoride in water.
Hydroxyapatite	$\text{Ca}_5(\text{PO}_4)_3(\text{OH})$ – also known as hydroxylapatite, is the main mineral component of enamel and is quite insoluble; its dissolution is pH dependent.
Fluoroapatite	$\text{Ca}_5(\text{PO}_4)_3\text{F}$ – is a naturally occurring source of fluoride, and is a modified form of hydroxyapatite; it is slightly less soluble than hydroxyapatite, and its dissolution is less pH dependent.
Base-exchange softening	Base-exchange softening is an adsorption phenomenon. A substrate that possesses negative charges on its surface will have cations adsorbed. Different cations have different affinities for adsorption (Ca^{2+} moreso than Na^+). Higher affinity ions will replace lower affinity ions; the concentration of the high affinity ion decreases and the low affinity ion increases. Because of this, Ca^{2+} can be removed from solution, and Le Chatelier’s principle states that calcium-containing minerals’ (such as CaF_2) dissolution will increase. As well, pH increases, and hydroxyl ions can replace fluoride as ligands. In both cases, fluoride concentration increases in solution.
Anion-exchange softening	Anion-exchange softening is a similar adsorption phenomenon as base-exchange softening, except it involves the removal of anions from solution. It can be used as a potential treatment to remove fluoride since fluoride ions will adsorb to a positively charged surface more readily than others (such as OH^-).

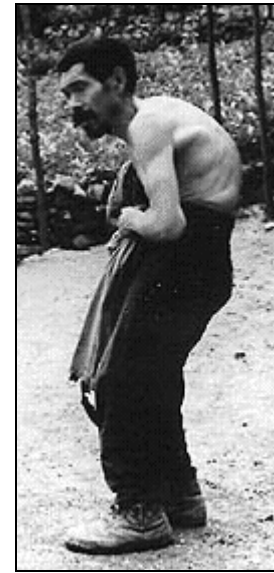
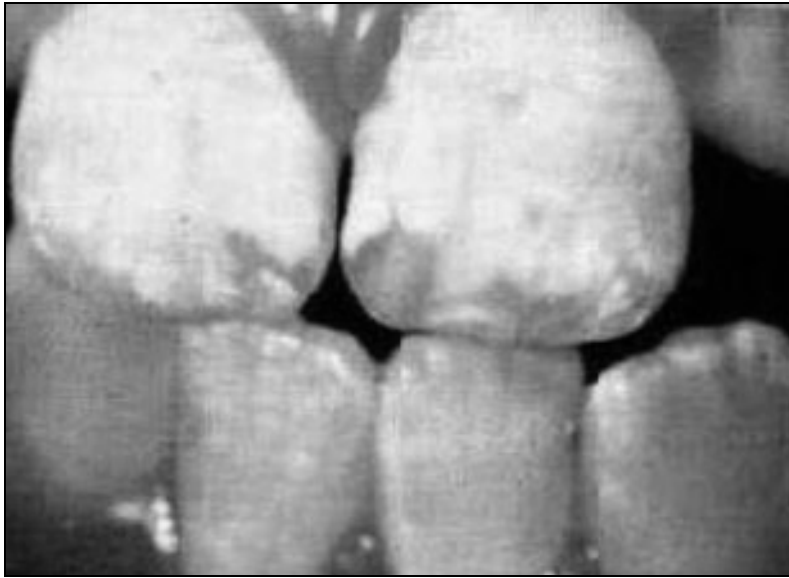


Figure 1 - Dental fluorosis is a symptom of chronic excess fluoride intake; skeletal fluorosis is a debilitating disease caused by mineral deposition affecting joints and is an extreme symptom of long-term high fluoride intake. (Sources, fluoridation.com, fluoride action network)

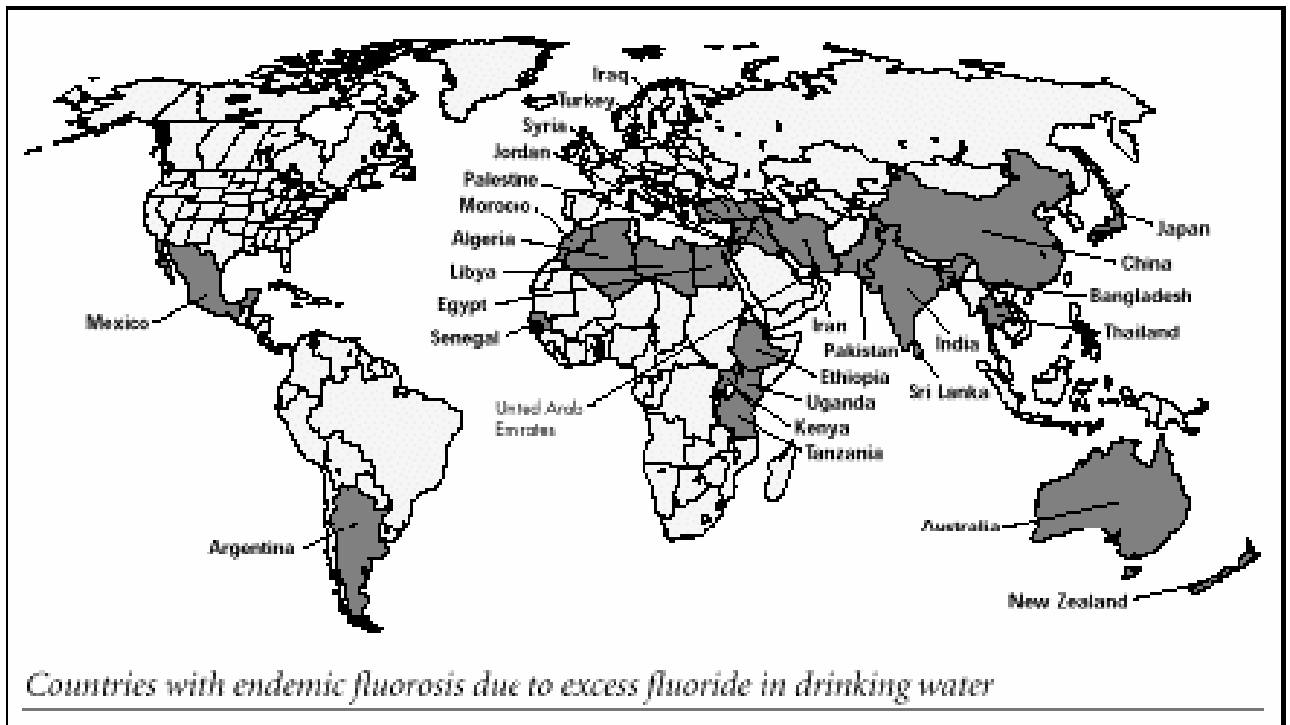


Figure 2 - Countries with endemic fluorosis due to excess fluoride in drinking water (Source, UNICEF)

Most people come into contact with fluoride every day. It is in most toothpaste, and there are trace amounts in our food and in the air; however, the major source of fluoride that most people come into daily contact with is in their water. Fluoride is not known to be a dietary requirement; however, it has been known for decades that a small amount of fluoride can help prevent dental caries (“cavities”). For this reason, some cities with low concentrations have resorted to adding fluoride, in an attempt to promote healthy teeth.

Some waters contain very high natural concentrations of fluoride, due to the presence of fluoride containing minerals that the waters leach through and collect upon. As well, certain industrial processes can produce wastes with high fluoride concentrations that can end up in the water supply. It was observed that children who were raised on drinking water with high fluoride concentrations tended to have mottled, pitted, and stained teeth. This condition, known as dental fluorosis, is a symptom of chronic high fluoride intake. Another symptom of chronic high fluoride intake is skeletal fluorosis, although it only occurs after years of consuming water with fluoride concentrations many times higher than drinking water guidelines. Skeletal fluorosis occurs when mineral deposits create denser, more brittle bones, which impacts joints and significantly impairs movement; skeletal fluorosis can occur in people of all ages. In some areas of the world where drinking water has consistently high concentrations of fluoride, dental and skeletal fluoroses are endemic problems. However, waters with fluoride concentrations above drinking water guidelines can be found locally. Wells around Nanaimo and the Gulf Islands have been found to have very high fluoride concentrations (in some cases, more than double that of Canadian drinking water guidelines), due to interactions with soils and minerals that release fluoride into solution.

Because of health implications, some communities, under the pressure of vocal minorities, have ceased public water fluoridation. There is a lot of debate surrounding the value of protecting children, who are the only ones who benefit from fluoride in water since it only helps in the development of healthy teeth, against the possibility of exposing everyone to unknown health risks. While it is not well understood if fluoride could cause diseases in lower concentrations, some say that it is worth avoiding the potential risk.

In communities where excess fluoride is a problem, there are few practical treatment options. While it is easy to reduce fluoride concentrations in solution, no treatments can reduce extremely high concentrations (>10 ppm) to within drinkable limits (~1.5 ppm). Because of the persistence of high fluoride concentrations in drinking waters of developing countries, it is important that we develop affordable and effective water treatment options.

City removes fluoride from water

By Karen Gleason
Del Rio News-Herald

Published September 13, 2006

Fluoride will no longer be added to Del Rio's drinking water.

The Del Rio City Council made that decision Tuesday night after a presentation by John Morony, a retired college biology professor, who characterized fluoride as a poison and showed the council numerous research references that link fluoride to higher rates of cancer and other health hazards.

Following Morony's presentation and a brief discussion by the council, Councilman Pat Cole said, "I make the motion that we cease immediately adding fluoride to our beautiful San Felipe Springs water."

In his letter to the city requesting time to address the council, Morony recommended "that Del Rio cease fluoridating its water supply."

Morony in his letter noted that in the U.S., more than 70 communities have stopped adding fluoride to their water.

He also pointed out that most European countries, Japan and China do not add fluoride to their water supplies.

"Why? Basically for two reasons: fluoridated water cannot be shown to significantly reduce dental caries (tooth decay) and it has proved to be far more toxic than previously thought," Morony wrote.

Morony during Tuesday night's meeting also presented the council with a paper titled "Scientific Facts on the Biological Effects of Fluorides."

The paper listed research references linking fluoride to a variety of medical problems, including the development of bone cancer and premature aging.

The paper stated, "Fluoride consumption by human beings increases the general cancer death rate."

Morony noted that although some fluoride occurs naturally in all water, the fluoride being added to the city's water supply "is a waste product of the phosphate fertilizer industry."

"I'm just trying to get the fluoride out of our water," Morony told the council.

At the end of Morony's presentation, Cole asked him, "So let me clarify: if we continue

adding fluoride, we are putting in our water a byproduct of the fertilizer industry?”

“That’s right,” Morony said.

Councilman Mike Wrob asked, “At what point did we start putting fluoride in our water?”

City administrators asked Mitch Lomas, manager of the city’s water treatment plant, to answer Wrob’s question.

“We started fluoridating in 1990 as a result of a decision by the city council,” Lomas replied.

“At the time we did not have all the information about fluoride that we do now,” he added.

Wrob then asked Lomas to give the council his opinion of adding fluoride to the city’s drinking water, a question Lomas did not answer directly.

Mayor Efrain Valdez noted that the city spends about \$20,000 a year buying the fluoride to add to the city water.

Cole asked Lomas, “How do employees at the water plant feel about handling fluoride?”

“It’s a very corrosive chemical. It eats through concrete and metal. When they handle it, they have to wear respirators and chemical-proof suits,” Lomas said.

“But how do they feel about handling it?” Cole asked.

“They really would rather not handle it,” Lomas replied.

Cole then made her motion to cease fluoridation of the city’s water, with Wrob giving the second.

After the council had voted unanimously to approve Cole’s motion, Morony told the News-Herald as he had left the council chambers, “The council’s decision is very gratifying. Now we can go back to drinking Del Rio water.”

People of this village suffer in silence

By Raviprasad Kamila

CHITRADURGA MARCH 24. At least two persons in each house at Toparamalige village, about 10 km. from here, complain of joint pain. Some men and women aged above 50 are not able to walk properly. A few of the aged are bedridden. The colour of the teeth of youngsters is turning yellowish and their gums are swollen. The villagers attribute these problems to the excess fluoride content in water they have been drinking over the years.

Those aged above 30 say that they need at least an hour to relax and feel comfortable after getting up in the morning due to joint pain and backache.

Pointing at a dried up well, an old man says that nearly 20 years ago, "we used to draw water from it. In those days, we faced no problems. The well dried up after people started drilling borewells in the village. As a result, the groundwater level depleted to 400 ft. Constant use of fluoride mixed water from borewells has affected the health of many people in the village."

Toparamalige has 150 houses with a population of 1,500. Ramachandra Setty, Devappa, Anusuyamma, and Puttamma are bedridden and some use walking sticks as they have problems with their knees. Villagers say that 12 years ago, Anantappa (40) was a healthy man. Unable to stretch his legs, he now crawls. They attribute it to the consumption of fluoride mixed water.

Thimma Reddy says that he has spent nearly Rs. 30,000 in the past three months on treatment in Davangere and Bangalore.

The treatment has not helped him. He is unable to stand for long.

Similar is the case with Puttaranga Setty. Papakka, and Sunandamma, in late thirties, cannot stand up and walk without the help of sticks. Though, they are aware that they too will face such problems in the future, children continue to drink fluoride mixed water from borewells as they have no alternative water source in the village.

The fluoride problem is not restricted to Toparamalige alone in Chitradurga District. Kallalli, Kasavanahalli, Eennegere, and Tamatakal are among the villages where fluoride content in drinking water is high. People of some villages use painkiller tablets for relief.

According to a survey conducted in 2001, drinking water in 135 villages of the district has excess fluoride.

The fluoride proportion is more than 1.5 parts per million (PPM).

Forty-five such villages are in Challakere taluk, 30 each in Chitradurga and Hiriyur taluks, 13 in Holalkere taluk, 11 in Molakalmuru taluk, and six in Hosadurga taluk.

M.G. Prasad, District Health and Family Welfare Officer, says that constant use of fluoride mixed water (for more than six years) will cause dental fluorosis among children. The colour of the teeth turns yellow and it leads to swelling of gums.

In the later stage, it will lead to "skeletal fluorosis" where bones become fragile or hollow, he adds.

Meanwhile, some residents of Vidya Nagar in Chitradurga are using "aqua cure" machines (each costs about Rs. 17,000) to purify water.

The machine purifies 10 litres of water in an hour, according to a resident.

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Anti-fluorosis drive is yet to take off

M. Dinesh Varma

Campaign faces roadblocks by way of misconceptions, low awareness

- *Studies show that caries is prevalent even among children exposed to fluoride*
- *Fluoride can affect bones and skeleton unleashing severe pain in major joints*
- *One main reason for contracting the disease is consumption of untreated groundwater*
- *66 million people in India, including 6 million children, either affected or at high risk of fluorosis*
- *This includes 6 million children in the 6-14 age group*

CHENNAI: The campaign against fluorosis, an excess of fluoride that has dental and general health ramifications, continues to be stymied by misconceptions and low awareness among the public and medical fraternity.

While at one level, fluoride intake has been associated with dental and skeletal fluorosis and tissue damage, at another level fluoride (toothpaste) continues to be prescribed as a proactive element in the prevention of dental caries.

"It is surprising how this popular misconception about fluoride benefiting dental health has managed to survive against strong clinical evidence to the contrary," said N. Gnana Sundaram, professor, Oral Medicine and Radiology, Saveetha Dental College. Studies have shown that caries was prevalent even among children exposed to fluoride, he said.

Fluoride can affect the bones and the skeleton unleashing severe pain in the major joints, rigidity, inability to walk and eventually paralysis. Unchecked fluorosis can affect soft

tissues — stomach, intestine, muscles, blood cells, ligaments — and organs such as kidney and brain.

As a focus group requiring urgent sensitising, pregnant women and breastfeeding mothers represent one of the most important segments. This segment should stop consumption of fluoride containing foods to avoid anaemia and eliminate risk of low birth weight babies.

One of the most common reasons for contracting the disease is the consumption of untreated groundwater with excessive fluoride levels. In some parts of India, the contamination is as high as 48 mg/l. Other sources of fluoride include black tea, canned foods laced with preservatives, masala powders, dental products and certain drugs.

203 districts hit

According to a UNICEF report, an estimated 66 million people in India are either afflicted or at high risk of fluorosis, which includes 6 million children in the 6-14 age group. It is reported that 203 districts in 19 States in India are seriously affected by the problem. In Tamil Nadu, districts such as Dharmapuri and Salem, are endemic to fluoride contamination of groundwater.

On Saturday, fluoride experts will address practitioners of various disciplines and medical students at the Stanley Medical College on the magnitude of the problem and the need to suspect, diagnose and prevent fluorosis. The resource persons include A. K. Susheela, executive director, Fluorosis Foundation of India, and Rekha Bhatnagar, professor, Department of Community Medicine, RNT Medical College, Udaipur.

Diagnostic facility sought

Experts press the need for Governments to invest in diagnostic facility for fluorosis in all hospitals. The diagnostic procedure involved testing blood, urine and drinking water for fluoride, along with haemoglobin testing and a forearm x-ray. Children require additional tests in the form of thyroid hormone/thyroid stimulating hormone assay and urinary iodine levels.

Prevention is the bedrock of fluorosis management. It involves identifying the source of fluoride entry, cutting out the source and promoting intake of vegetables, fruits and dairy products rich in essential nutrients(calcium, iron, vitamins and other antioxidants).