Fourth addendum to report on Texada “goop” used on Gabriola

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A water-extractable analysis of a whole sample has been performed on behalf of the Gabriola Local Trust Committee of the Islands Trust. This provides additional data in a similar form to the acid-extractable analysis performed on behalf of the Gabriola Residents and Ratepayers’ Association.

Acid-extraction data

Acid extraction followed by spectrographic analysis is a way of assessing what cations could potentially leach out of the material in the long term, and of helping identify the minerals present. It is used in the mining industry to assay samples, and by health officials to look for industrial contamination in soil.

The limitation of acid extraction is that it does a poor job of measuring the concentration of electronegative elements (elements other than metals and metalloids); possibly exaggerates contamination of groundwater by leaching out elements that are chemically stable in water; and, if hydrofluoric acid is not used, as it wasn’t for this test, gives no direct indication of the concentration of silicates and aluminosilicates, which is what most minerals are.

For convenience, I will repeat here a summary of the results of the acid extraction test reported on earlier. The analysis was for 30 common metals and metalloids. Total weight of the analysed elements present was 2.9% (as elements, not oxides).

The most abundant elements listed in order of number of atoms present per million analysed were:

Over 10^5 pm: Ca, Fe, Al, Mg
Over 10^4 pm: none
Over 10^3 pm: Mn, K, P, Na, Sr, Cu, Ti, Si, Zn
Over 10^2 pm: Ba, B, As, V, Cr, Co
Over 10^1 pm: Pb, La, Ni, Sc
Over 10^0 pm: Cd, W, Mo, Ag, Be.

Arsenic was present in a concentration of 10 ppm (parts per million, mg/kg). This is about five times the worldwide average for sandstone, but only about half that for shale.

Water-extraction data

Water extractable followed by spectrographic analysis is a way of assessing what cations are actually being leached out of the material by rainwater and will eventually enter aquifers.

The only caution needed to be exercised in the reading of the results of such a test is that concentrations in goop-saturated water will be higher, perhaps much higher, than those in the aquifer because the aquifer contains water from other (unpolluted) sources.

The analysis was for 32 common metals and metalloids. Total weight of the elements present was 0.04% (including carbonate as carbon and sulphur). The most abundant elements listed in order of number of atoms present per million analysed were:

Over 10^5 pm: Na, Ca, S, C
Over 10^4 pm: Si, Mg, Al, Fe, K
Over 10^3 pm: Mn, Sr
Over 10^2 pm: Ti, Cu, B, Ba, Zn
Over 10^1 pm: As, Mo, V, Li, Ni, Co, Cr, Pb
Over 10^0 pm: Sn, Sb, Se.

Toxic elements

The toxic elements most watched for in Gulf Island groundwater are arsenic (As), boron (B), fluoride (F), selenium (Se), lead (Pb), and antimony (Sb).

Arsenic

Arsenic was present in a concentration of 27 ppb (parts per billion, µg/L) by weight of water. This is marginally high compared to the Canadian Standard of 25 ppb and above the WHO standard of 10 ppb.

Of 81 wells tested by Malaspina U-C, none had an arsenic concentration of more than 25 ppb, but one well did register 13 ppb.

Boron

Boron was present in a concentration of 187 ppb by weight of water. This is well below the WHO potable water standard of 500 ppb.

Fluoride

Neither test included fluoride, which is a problem in groundwater with a high pH.

Selenium

Selenium was present in a concentration of only 0.6 ppb by weight of water, and so is not a problem. The WHO recommended limit is 10 ppb.

Lead

Lead was present in a concentration of 4.7 ppb by weight of water. This is below the Canadian Standard maximum acceptable concentration of 10 ppb.

Antimony

Antimony was present in a concentration of 0.9 ppb by weight of water. This is below the Canadian Standard maximum acceptable concentration of 4 ppb.

Comparing the data

In order to compare the two sets of data, I first eliminated those elements that were only analysed in one of the tests. These were in order of concentration:

Acid-extraction only: P, La, Sc, and W. Only the upper limit established for Au, Ag, Sb.

Water-extraction only: S, C, Li, Sn, Se, Bi, and Th. Only the upper limit established for Bi.

Of the elements assayed in both tests, the ratio of the weight of the acid-extractables to weight of water-extractables was 93:1.

When the two sets of data were normalized to the same weight of extractable atoms, the elements that were more abundant in the water by number were:

Na (89:1), Si (44:1), Mo (36:1), K (2:1), B (2:1);

the elements that were more abundant in the acid by number were:

Fe (9:1), Cd (9:1), Cr (6:1), Al (5:1), Pb (5:1), Zn (5:1), Cu (4:1), As (4:1), Sr (3:1), Co (3:1), V (3:1), Mg (3:1), Ti (2:1), Ba (2:1); and

the elements that were in about the same concentrations by number were:

Ca, Mn, Ni, and Be.

The goop water is alkaline (pH = 8.7) so metals likely to be released by acid, such as iron (Fe), cadmium (Cd), and so on, are less likely to find their way into aquifers.

That sodium (Na) appears to be preferentially dissolved by water must be because the acid-extraction sample was already deficient in sodium due to leaching, presumably by rainwater.

That silicon (Si) and boron (B) are preferentially dissolved by water is due to its high pH.

Molybdenum (Mo) is passivated by inert oxide in acids, yet forms molybdates in base solutions. Molybdenum is an essential mineral for the maintenance of good human nutrition.

Conclusions

Goop-saturated water contains no toxic elements in excess of standards for potable water, with the exception of arsenic, which at 27 ppb is fractionally above the recommended level of 25 ppb. Given that such surface water is most unlikely to be consumed without dilution, I would judge this not to be a concern, but samples of the gravel should be tested on a regular basis for toxic elements as the composition of carbonate rock that has been in contact with intrusive igneous rock (granodiorite) can vary very widely.

Acid-extractable tests are less informative than water-extractable tests because of the appreciable variation in the mobility of trace elements in groundwater with pH, redox potential, electronegative element profile (presence of sulphur as sulphide for example), and the presence of high-molecular-weight organic substances.

Excess fluoride in groundwater is a concern on the Gulf Islands and any future analyses of this kind should include fluorine.

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