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## Third addendum to report on Texada “goop” used on Gabriola

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### 1. Impure limestone

#### *Strong-acid extractable tests*

An analysis of the strong-acid extractables of a whole sample performed on behalf of the Gabriola Residents and Ratepayers' Association showed that only 2.9% of the metal/metalloid contents (by element and weight) were extractable. Hydrofluoric acid was not used, so presumably most of the insoluble residue is silicate. This is a remarkably low carbonate content for a material considered to be limestone.

To check this result, I soaked selected “limestone chips”, comprising about 61% by weight of the washed and dried material, in concentrated hydrochloric acid to eliminate the carbonate. The clasts remained intact—the carbonate appears to be surficial—and the loss in weight was only about 10%, confirming that *calcite* is not the main component of the “limestone chips”.

Overall general appearance of the residue was that of a granodiorite, but with perhaps a more sugary texture than normal, and micas and amphiboles (if that's what they are) more weathered. Examination under a microscope (reflected light only) showed a white to translucent crystalline mass with minor mafic lamellar inclusions (<10%) with a greenish tinge. Hardness appeared to be around 5.5 but may be variable. Abundant basal cleavage, some vitreous luster. Without a thin section, hard to say what this is exactly, but it could be *plagioclase* with *quartz*.

A strong-acid test of the material identified in the main report as *calcite*, 11% of the washed and dried material by weight, confirmed that that is what it is.

#### *Conclusion*

The total composition of the gravel must be modified from around:

72% carbonate (by weight); felsics 15%; mafics 11%

to:

felsics 63%; 21% carbonate (by weight); mafics 16%.

The term “limestone” is thus not a good descriptor. If the felsic material is *feldspar* and *quartz*, then it should be perhaps described as “calcareous granite”.

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This change is quantitatively important, but doesn't impact the report conclusions significantly other than perhaps to draw attention to the fact that the material is more likely to contain metamorphic material than previously thought.

## **2. Magnesium**

The established presence of magnesium on the road surface is of interest because it may be forming magnesium silicate scaling in car braking systems. The origin of the magnesium is not clear.

Two tests to investigate this were made.

The first was on selected clasts from the gravel, namely those thought to be limestone plus those thought to be *calcite* (with little room for doubt).

The second test, performed on behalf of the Gabriola Residents and Ratepayers' Association, was a strong-acid extractable rock analysis.

### ***Selected clast test***

Of the three water samples taken from potholes in three "gooped" roads, two samples were characterized as being magnesium-type water (Mg-HCO<sub>3</sub> and Mg-Cl) rather than the expected calcium-type water (Ca-HCO<sub>3</sub>).

In earlier parts of this report, my surmise has been that the magnesium comes from application of magnesium chloride to the road surface. There is however another possible source of magnesium, and that is that the limestone itself is partly dolomitic, though rocks that are a mix of *calcite* and *dolomite* are not common.

Although in the reflected light inspection of the clasts in the gravel, I was only able to identify *calcite* for sure, it is quite possible that I mis-identified some of the minerals. To check this, I asked the lab. to autoclave a representative sample of the limestone and calcite chips (only) in strong acid (but not HF) and measure the Mg and Ca content of the solution.

The magnesium:calcium ratio of the *calcite* (by number of atoms) was 0.005.

The magnesium:calcium ratio of the "limestone chips" (by number of atoms) was 0.19, so some  *magnesite* or *dolomite* is present in the carbonate coating of the clasts.

### ***Strong-acid extractable test***

The strong-acid rock analysis performed on behalf of the Gabriola Residents and Ratepayers' Association gave a magnesium:calcium ratio by number of atoms of 0.44, roughly twice that from the "limestone" alone.

### ***Conclusion***

The gravel is a source of magnesium, but if it is the only source, that is, no magnesium chloride has been applied to the road, then some of the magnesium must be coming from the clay component. *Chlorite* is the most common magnesium-rich clay, though smectites

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(including *montmorillonite*) contain some too. It is thus not unreasonable to suppose that all of the magnesium is coming from the gravel should there be no evidence of the application of the chloride.

### 3. Calcium, iron, aluminum, and others

The strong-acid rock analysis has shed further light on the mineral composition of the gravel.

The analysis was for 30 common metals and metalloids.

The total weight of the elements present was only 2.9% of the total, implying a large amount of carbon, sulphur, oxygen, and insoluble silicates.

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.

\* silicon is severely underestimated because hydrofluoric acid was not used for extraction.

The high concentration of aluminium, but not silicon implying the aluminosilicates were not extracted by the acid, may be due to some *gibbsite*, *corundum*, or similar mineral in the clay.

The concentration of iron is high (iron:calcium = 0.48) given that only a few clasts of *magnetite* were found in the visual microscopic analysis, and the “clay” component is not highly coloured. Perhaps some *siderite* present.

Arsenic was present in a concentration (10 ppm by weight) about five times the worldwide average for sandstone, but only about half that for shale.

#### ***Conclusion***

The analysis is consistent with a magnesium-rich (possibly iron-rich also) clay component with a matrix rich in feldpars or other silicates. The “limestone” is definitely impure.

Undesirable trace elements are present but not in unusually high concentrations, though a more expert opinion is required on that (I am not familiar with potable water or contaminated soil standards).

The presence of toxic trace elements needs to be monitored if the material is from an igneous:carbonate contact zone, though it seems rather more likely that the carbonate is a diagenetic coating by groundwater.

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