Delineating Karst Groundwater Flow Paths by Fluorescent Dye Tracing on Quadra Island, BC

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Introduction

In the Fall of 2019 a dye trace was conducted at three sink points and four springs near Stramberg Farm, Quadra Island BC. The goal of the project was to delineate subsurface flow paths to better understand the recharge properties of each spring. Three fluorescent dyes: rhodamine WT, fluorescein and eosine were introduced at each sink point and activated charcoal sample packets installed at each suspected (spring) residence site. Using baseline data from background charcoal packets, the spectral results recorded the presence and concentration of each unique dye at the five springs suspected of being linked to injection sites. Additionally, daily water samples were taken after initial injection at Stramberg Farm. Sink points were chosen to supplement previous dye traces in the area, and springs were selected as the most likely discharge points. The study was designed to answer the following hypotheses:

Hypotheses

1. Upper sink point #1 is linked to at least one of the residence sites.
2. Upper sink point #2 is linked to at least one of the residence sites.
3. The Grow-Up sink point is linked to the Missing spring.

The 1oz dye concentrations will be sufficient to display spectral results.

Field and Analytical Methods

Field Methods:

• Field mapping of sinks and springs being studied.
• Water chemistry sampling for pH and conductivity.
• Charcoal packets that detect dyes into the parts per billion were deposited and collected (Figure 2; Figure 3).
• Fluorescent dye deployment.

Lab Work:

• Charcoal packets were prepared and sent on ice for photospectrometry.
• Samples were sent to Ozark Underground Laboratories in Missouri for testing.

Results and Analysis

1. Background testing prior to our dye trace yielded positive presence of eosine that may be from a dye trace 10 years prior. Investigation is currently ongoing.
   a. The eosine in background did not show up in testing after the dye trace.
   b. Fluorescent dyes were traced to at least one of the residence sites.
   c. Upper sink point #1 confirmed both rhodamine WT and fluorescein at Stramberg spring and the Hook-Up spring (32ppb).

   2. Grow Op spring/sink had traceable amounts of fluorescein and rhodamine. However, the concentrations were very low. This is likely due to adverse conditions for dye. With an increased amount of dye it is likely that fluorescein and rhodamine would have also been found at Missing Spring.

3. The connection between Hook-Up and Grow Op is idealized. The presence of fluorescein and rhodamine at Grow Op could be direct from Sink Point 1 & 2 or both.

Table of Dye Trace Results

<table>
<thead>
<tr>
<th>Station</th>
<th>Fluorescein conc. (ppb)</th>
<th>Eosine conc. (ppb)</th>
<th>Rhodamine wt conc. (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hook-Up</td>
<td>124</td>
<td>ND</td>
<td>0.804</td>
</tr>
<tr>
<td>Spring</td>
<td>124</td>
<td>ND</td>
<td>0.565</td>
</tr>
<tr>
<td>Lower</td>
<td>78.7</td>
<td>ND</td>
<td>21.8</td>
</tr>
<tr>
<td>Stramberg</td>
<td>124</td>
<td>ND</td>
<td>26.2</td>
</tr>
<tr>
<td>Upper</td>
<td>124</td>
<td>ND</td>
<td>54.4</td>
</tr>
<tr>
<td>Stramberg</td>
<td>124</td>
<td>ND</td>
<td>26.2</td>
</tr>
<tr>
<td>Missing</td>
<td>124</td>
<td>ND</td>
<td>26.2</td>
</tr>
<tr>
<td>Spring</td>
<td>124</td>
<td>ND</td>
<td>54.4</td>
</tr>
<tr>
<td>Open Bay</td>
<td>124</td>
<td>ND</td>
<td>54.4</td>
</tr>
<tr>
<td>Main</td>
<td>124</td>
<td>ND</td>
<td>54.4</td>
</tr>
<tr>
<td>Grow Op</td>
<td>124</td>
<td>ND</td>
<td>54.4</td>
</tr>
</tbody>
</table>

The results of dye tracing at Stramberg Farm area, Quadra Island. *Grow-Up Spring also features a Sink Point ~25m downstream that is not labeled on map. The study area (Figure 5) is mostly comprised of second-growth forests.

Background Information

This study is primarily concerned with the Triassic (250mya) Quatsino Limestone Formation that originated as a shallow-water carbonate platform. As part of a large superterrene that accreted with North America in the Cretaceous it has been elevated and eroded locally to form parts of the Quadra Island geology (Yorath, 1995). It is this carbonate rich limestone that forms the soluble karst landscape in the study area that receives rainwater directly onto as well as by surface flow from neighboring non-soluble volcanics (Figure 5).

What is Karst?

1. Slightly acidic rain and meteoric water causes the dissolution of soluble bedrock such as limestone, dolomite and gypsum (Palmer, 1991).
2. Forms a topography with underground drainage systems consisting of sinkholes, conduits, caves and springs (Palmer, 1991).

Conclusions and Recommendations

We would like to extend our sincere thanks to the following:

• The Ozark Underground Laboratory for their generous assistance in the analysis of our tracer packets.
• Dr. Tim Stokes for spearheading this project, and Allan and Jude of Stramberg Farm for allowing us to make their drinking water available.
• The VIU Earth Science Department who funded this project.

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References


Technical Report on the Yreka Mineral Claims, Vancouver Island, BC