Glacial Lake Colour - Get the Right Story

by Nadine Fletcher, Lake Louise

Being an interpreter is often a lesson in humility. After saying something for many years, you might realize that you no longer have any idea what the source of your information is (and thus your confidence that it is accurate). Or you might be asked a question that exposes how little you really know. And that's what happened to me in the summer of 1998!

A very astute client from Australia asked me to clarify the physics behind the fabulous blue-green colour of our lakes. For years my partner Joel and I had been saying that the colour was due only to the size of the "rock flour" particles floating in suspension in the water. We said that the size of these particles matched the size of the wavelength of blue-green light, and therefore reflected blue-green light strongly. We thought we knew it all, but we were very wrong...

It was our Australian who tripped us up. He asked, "If the tiny particles create a blue-green colour... why then are there no red or orange lakes created by slightly bigger particles that reflect only those wavelengths of light?"

It was a darn good question.

To answer it, we turned to a scientific article written by Eyvind Aas (Institute of Geophysics, University of Oslo, Norway) called "Colors of Glacier Water." There was a frightening amount of math and physics in this paper, but we plowed through it and that, along with the help of Jasper geologist and interpretive guru Ben Gadd, allowed us to arrive at a fuller understanding of what's going on.

For starters, we learned that rock flour is nowhere near the size of the wavelength of blue-green light. In fact, it is much bigger than the wavelengths of any visible light. However, it does reflect different parts of the visible spectrum more strongly than others. Here's how it works:

Plain Blue Water

Clear water absorbs longer wavelengths of visible light (red, orange, yellow), but strongly reflects or transmits the shorter blue and blue-green wavelengths. Unless there is some kind of pigment present in the upper layers of water (like green plankton in the ocean or green algae in lake water), clear water will always look blue or slightly blue-

green. To see it best, you need a light coloured bottom that provides a reflective surface to send the blue or blue-green light back out to your eyes. Think of a swimming pool or a clear tropical ocean with a white sand bottom.

Plain Blue Water with a Twist

What makes the lakes of the Canadian Rockies unique is that they are filled with more than just clear water. Along with the H_2O comes billions of tiny, suspended particles created by glacial erosion — "rock flour."

As we all know, this is the magic ingredient. To begin with, the rock flour provides a light-coloured surface for light to be reflected out to our eyes. The fact that rock flour floats near the water's surface makes the lakes of the Canadian Rockies look both opaque and bright at the same time. Looking down at a lake from above adds extra intensity to the effect.

More important, however, is the rock flour's ability to absorb and reflect certain wavelengths. The clay (2 - 4 microns in diameter) and silt (4 - 65 microns in diameter) that compose rock flour have a high absorption coefficient for short wavelength light. In plain English, this means they absorb or eliminate much of the blue light, but reflect some blue, green, yellow, orange and red.

So, the rock flour eliminates part of the blue and the water itself has eliminated the reds, oranges and yellows, so what is left over? Mostly green and some blue light. And that light is what's available to bounce off of the rock flour and out to our eyes.

Now, let's take the logic one step further. Given what we've just learned, if a lake has more rock flour than another lake, will it be greener or bluer? ... Yes, greener! More rock flour means that more blue is absorbed, which results in a greener lake. Compare the colours of Peyto Lake, Moraine Lake, Lake Louise and Sunwapta Lake in August and you'll learn a lot about how much rock flour is being dumped into each.

The Extra Luminosity of Canadian Rockies Water

We learned from Ben Gadd that our lakes seem to attract more superlatives than other glacial lakes around the world. Why? Here's his theory, not yet put to the scientific test:

Green colour is found in glacial lakes worldwide, but the ones here in the Rockies are renowned for their amazing brilliance. What is unique to the Rockies (unlike the Alps, the Himalaya or the mountains of Norway) is that much of our rock flour is made of limestone. Limestone creates flaky and flat particles that are highly reflective and may be the reason our lakes take on a glow that looks almost psychedelic!

But, Peter Duck doesn't agree. He feels that the superlative descriptions our lakes garner just depend on the day and the feeling of being in a beautiful setting. He's seen very similar colour effects in gravel pits in southern Ontario or the northern end of Lake Winnipeg. Sometimes research leads to more questions... another lesson in humility!

We'd like to thank our Australian guest for demanding that we really understand what we were talking about! It's made us far better interpreters.

Bibliography

The best explanation of glacial lake colour that I've found is in an out of print booklet by Richard Kucera called : **Exploring Mountains and Glaciers: A Guide to Lake Louise and Moraine Lake.**

Ideas for Interpreting Glacial Lake Colour

Make comparisons.
- People may have previous experiences with pools, tropical beaches, alpine lakes elsewhere, rivers or lakes they may have already seen here (Bow vs. Kicking Horse or Louise vs. Moraine).

Engage the audience.
- Using questions like the ones in the article, you can get the audience to arrive at the answers themselves. Ask if they've visited other glacial lakes, or if they think the colour lives up to the postcards.

Tell a story.
- Start with light entering a lake with clear water and tell what happens to it. Then move onto light entering a glacial lake and what happens to it. Can the story build to a climax?

Use props.
- You could have a sample of rock flour for people to touch. How? If you dry out some of the glacial sediment dumped in the delta of a lake, it makes a good approximation. If you blow on it, the heavier particles drop, but the finest ones float away on the breeze. If people ask, be honest about what it is and how you got it.