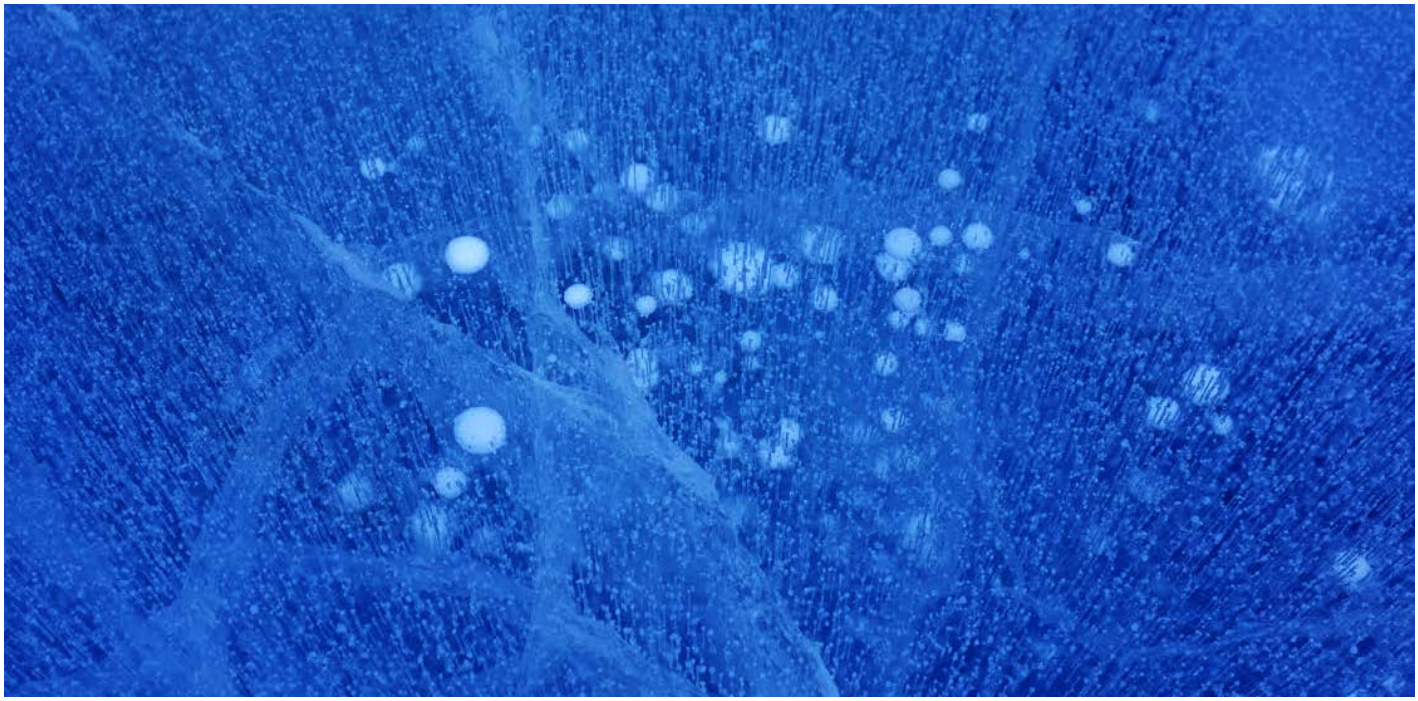

TEAM IMAGE II

MCEN 5151

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I. Introduction

The purpose of the Team Image assignment was to capture any fluid phenomena with a group of students. Each student would attempt to capture their own image in a common set-up and then complete their own post-processing on the image. The specific flow visualization phenomena that was desired to be captured in this report was the presence of frozen bubbles in Dream Lake. In natural lakes, gas bubbles form beneath the ice layer and rise due to living organisms at the bottom of the lake. As they rise, they freeze as the water temperature decreases near surface. These bubbles come in various shapes and patterns and create a beautiful effect that can be seen on the surface due to the clarity of the lake.

II. Experimental Setup

Due to the nature of this particular photo, no experimental set up was required. Rather, a cell phone camera was used to capture the image by holding it 6 inches from the surface of the lake surface. The lake that was photographed was Dream Lake, located in the Front Range Mountains in Rocky Mountain National Park. To give additional context, a picture of the lake is seen in Figure 1.

Figure 1: Frozen Dream Lake in Rocky Mountain National Park[2]

Dream Lake is a popular subject of interest for many photographers because of its interesting bubble formations in the ice and its gorgeous mountain surroundings[2]. Due to the abundance of natural sunlight, no additional lighting was used. Also, the clarity of the ice provided good focus. A simple schematic of the experimental set up can be seen in Figure 2.

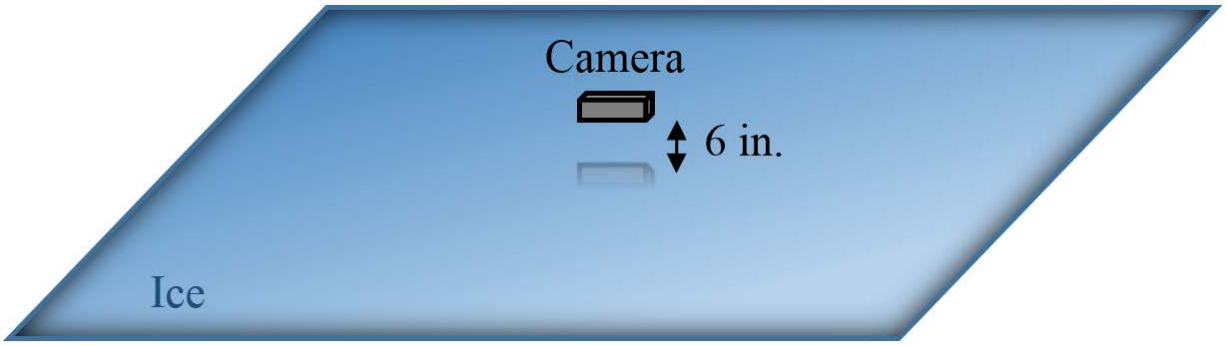

Figure 2: Experimental Set-Up

The fluid dynamics of the frozen bubbles can be explained through the difference in densities of the gas produced at the lake bottom and the water itself. Many natural lakes contain plants and algae that grow at the bottom of the lake. Some of these plants out-gas methane as they grow. The gases (sometimes methane) rise to the surface due to a density difference. As the gases rise, the temperature of the water decreases. Eventually the boundary layer of water that encapsulates the bubble freezes, thus suspending the bubbles in the frozen lake. A particular lake in Canada named Abraham Lake is famous for these frozen bubbles, due to its low temperature climate (-30º C), and abundance of methane gas being produced below the surface[1]. An image of the trapped bubbles at this lake that is similar to the image of this report can be seen in Figure 3:

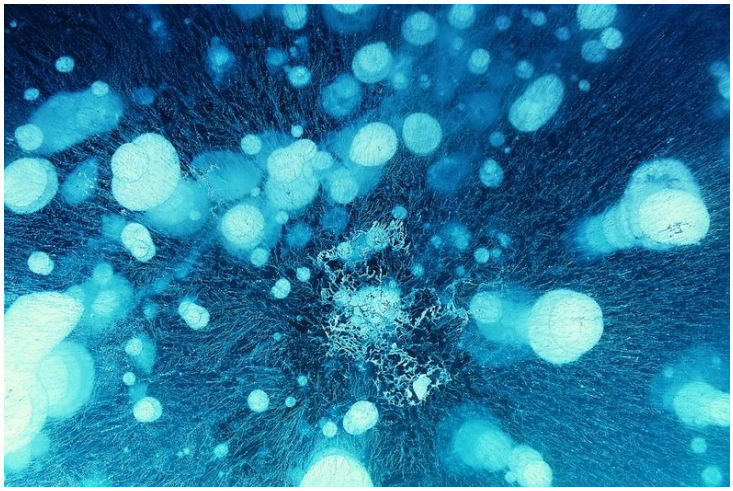

Figure 3: Trapped Methane Bubbles in Abraham Lake[1]

In addition to the spherical bubble shapes seen in the report image and the image of Abraham Lake, there are also "ribbons" in both images. These ribbons were likely caused by cracks in the ice that have trapped gases in small pockets. As temperatures fluctuate, the gases travel through the cracks in attempt to move from areas of high pressure to low pressure. This allows the gas to propagate through the ice, thus forming long ribbons of small trapped gas bubbles.

III. Photographic Technique

A. Image Capture

The image was captured on March 2nd around 2 pm. An iPhone 5 camera (8 megapixel) was used to capture this image. The camera settings were as follows: aperture of 2.4 and an iso setting of 200 with a shutter speed of 1/20 seconds. No flash was fired due to the large amount of natural light that was present on that day.

B. Post Processing

Post processing of the image included cropping the image. Using the rule of thirds, the largest bubbles were placed at the cross sections of the thirds. This provided nice focus on the most interesting aspects of the image. Improving image quality came from increasing the saturation to improve the blue colors. Contrast was also increased in order to accentuate the shape of the bubbles. Finally, an “S curve” was added to the color curve to accentuate the bright and dark colors. The final size of the image was 1124 x 552 pixels.

IV. Conclusion

This flow visualization project was a success with a nice looking image that captured the desired fluid dynamics phenomena. The fluid dynamics of the trapped bubbles were captured clearly in the ice and could be explained from simple physical occurrences in natural lakes. This image evoked feelings ranging from tranquility to fear of the unknown. Some members of the class also recalled certain films that this image reminded them of including “Avatar” and “Frozen.” This further proves the success of the image because it draws such a wide range of reaction due to its interesting and abstract nature.

V. References

[1] Kaushik. "Frozen Air Bubbles in Abraham Lake." *Frozen Air Bubbles in Abraham Lake*. Amusing Planet, 4 Jan. 2013. Web. 27 Apr. 2014.

[2] Mangan, Thomas. "Photographing Ice At Dream Lake." *Thomas Mangan Photography Blog The Rocky Gallery Blog*. N.p., 11 Mar. 2012. Web. 27 Apr. 2014.

VI. Acknowledgments

I would like to acknowledge my team members for their assistance in the experimental set-up for this image capture and the use of some of their equipment.

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Thank you

VII. Appendix

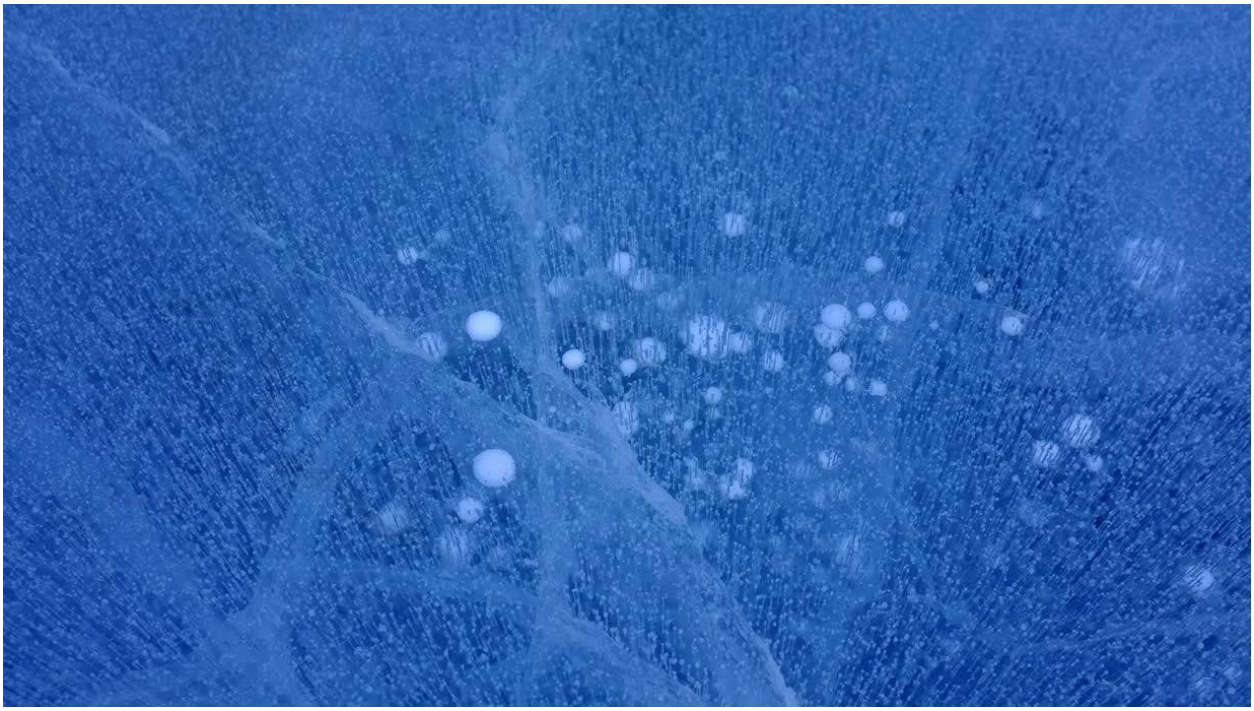

Figure 4: Original photograph