MCEN 4151: Flow Visualization
First Team Report
4/24/14
By Ben Healy
Prof. Jean Hertzberg

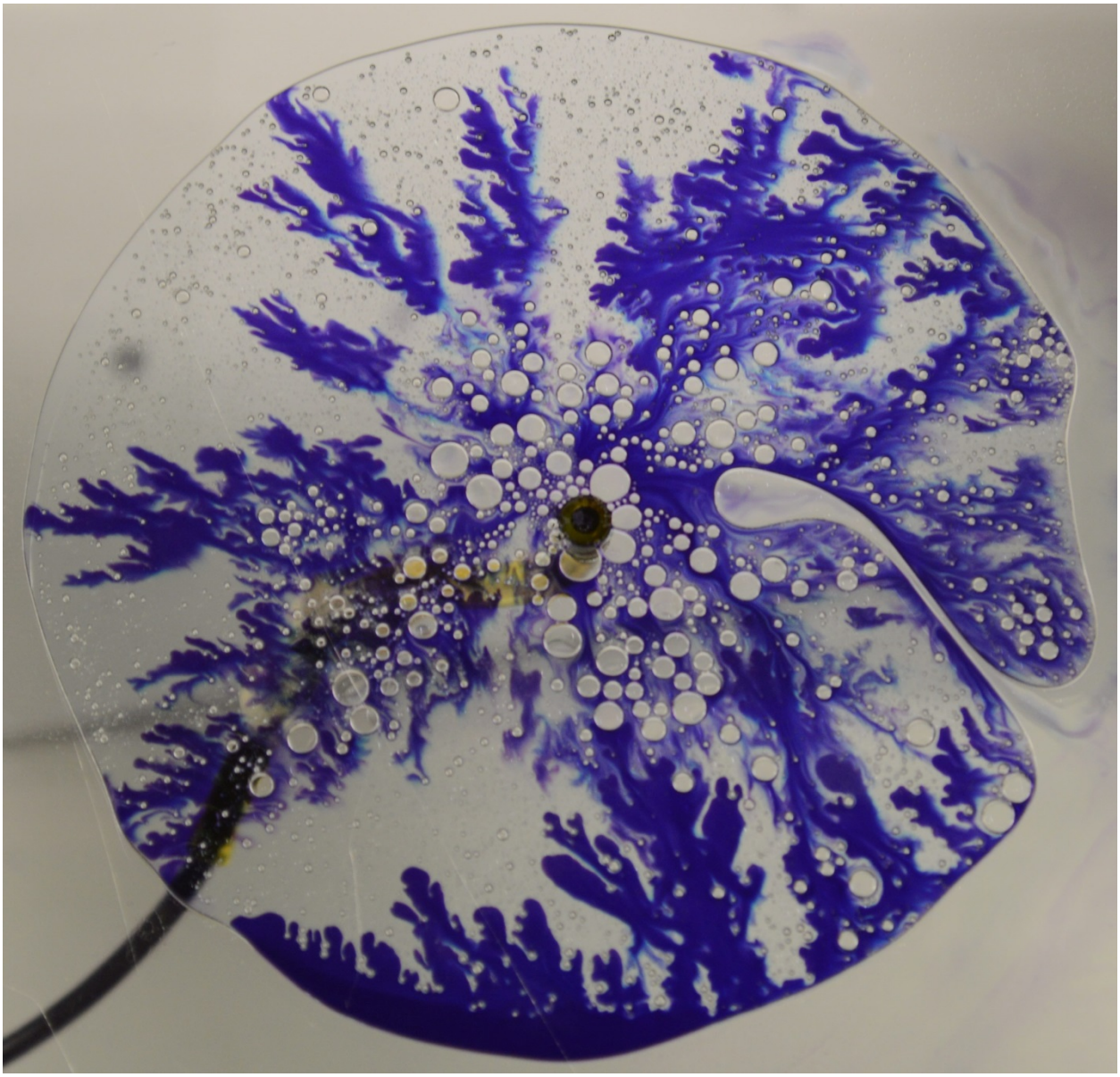

Figure 1: Final Image

The photo in figure 1 was taken for the first team photo assignment. After seeing an example of a Hele-Shaw cell used to visualize the Saffman-Taylor instability, my team wanted to work with Prof. Hertzberg's Hele-Shaw cell to see what kinds of flows we could produce. Our team consisted of Ryan Lumley, Jason Brownstein, David Zilis, and I.

The Hele-Shaw cell is shown below in figure 2.

Figure 2: Hele-Shaw Cell

The Hele-Shaw cell consists of a metal frame, upon which sit two planes of glass. The bottom pane of glass has a small hole drilled in it and a tube inserted into the hole. To visualize the Saffman-Taylor instability, a small amount of viscous liquid is poured onto the center of the lower pane of glass. The top pane of glass is carefully laid upon the bottom pane of glass, sandwiching the viscous liquid and spreading it out. Then a less viscous liquid is injected through the tube using a syringe. The injected fluid spreads and "fingers" out, displacing the more viscous fluid and creating an unstable interface[1].

In my final image we used Dawn dish soap as our viscous fluid and blue dyed water as our less viscous liquid. We injected the dyed water over a period of five seconds. The final image shows a flow that is roughly six inches in diameter. I chose the image in figure 1 as my final image because it doesn't look like a typical Hele-Shaw cell experiment. After we injected the dyed water we lifted the panes of glass apart a small amount and then put them back together, disturbing the flow. We also injected a little bit of air into the flow to create air bubbles. We used two medium sized studio lights to light the flow.

The field of view in this image is approximately six inches with a distance from flow to camera of two feet. The lens used was a Nikon Nikkor lens with a focal length of 55mm. The camera used was a Nikon D3200 DSLR. The original image was 6016x4000 pixels, but it was cropped down to 3238x3107 pixels. The exposure time was 1/50 second since I wasn't using a tripod. ISO was set to 400 since the room we were shooting in had the overhead lights turned off to reduce glare. An f-stop of f/5.6

was used to keep the focus of the image on the flow, and not what was behind it. Image processing was done in PhotoScape. The photo was cropped and contrast was increased from the original photo, shown in figure 3.

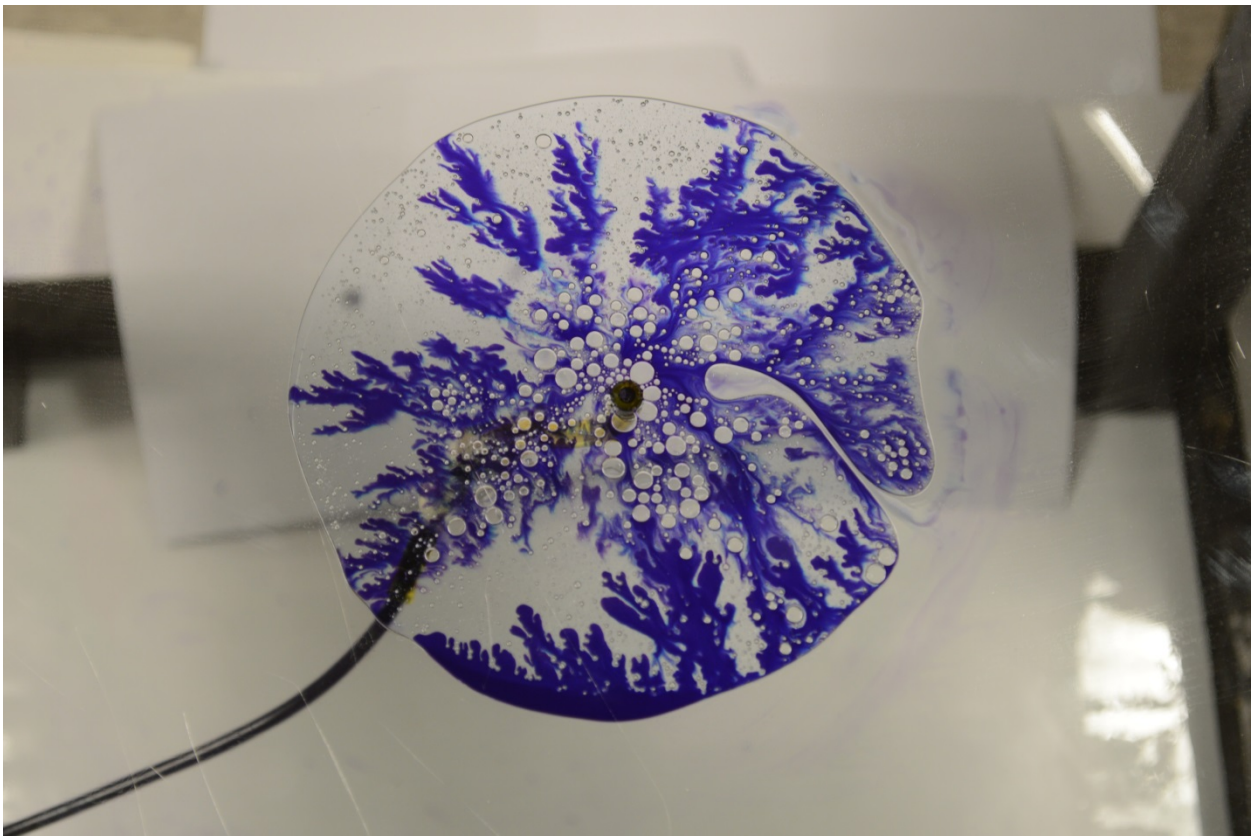

Figure 3: Original Image

This image reveals the basic Saffman-Taylor instability, or the “fingering” of a less viscous fluid out into a more viscous fluid. I like how the image came out overall. Looking back on the image now, I feel that the tube is a bit distracting. I like that the flow is disturbed. I find it more visually appealing than an undisturbed Hele-Shaw cell flow. If I had to do this project again I would remove the tube before taking any photographs. I would also experiment with different fluids and possibly multiple injection points on one cell.

References

1. P. G. Saffman and G. Taylor. The penetration of a fluid into a medium or Hele-Shaw cell containing a more viscous liquid. Proc. Soc. London, Ser A, 245:312-329, 1958.