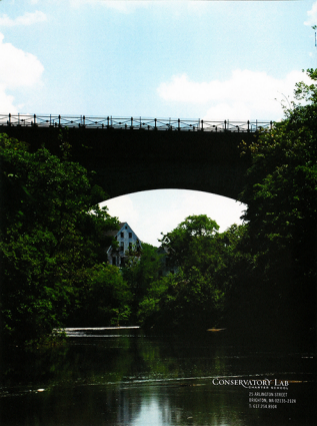


YOU GROTTO GO TO HEMLOCK GORGE

& OTHER SMALL CAVE STORIES

BY THE CONSERVATORY LAB CHARTER SCHOOL
2012-2013 6TH-GRADE CLASS



CONSERVATORY LAB

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ABOUT CONSERVATORY LAB

Conservatory Lab is a K1 – 8 music-infused charter school in the heart of Boston. We believe in the power of music to transform the lives of children and adolescents.

We use **Expeditionary Learning** as a framework for our unique, interdisciplinary curriculum that deepens students' appreciation of the role of music in the world and promotes opportunities for students to achieve scholastic benchmarks.

Our learning expeditions are discovery operations. They start from scratch and travel light, relying on courage, compassion, and creativity as much as on intellectual acumen. We cherish active, hands-on situations where what we are doing matters to us and has consequences.

The 6th grade science expedition that produced this book is an excellent example of our interdisciplinary approach that integrates the arts with content-based instruction. Teacher Sarah Perkins ignited students' passion for learning by tapping into their interest in graphic novels and giving them the opportunity to connect to a local place—the beautiful Hemlock Gorge Reservation—to investigate geologic concepts. With the guidance of expert artists, students practiced observational drawing and thought critically about how to sequence images to tell a complex story spanning thousands of years.

To encourage deeper learning, our expeditions demand fieldwork and assistance from experts. Photographs on the following pages show sixth graders working with a seasoned geologist during fieldwork and with professional artists who guided them in creating the drawings for this book. As you can see from the children's faces, when you have a need to know, when you have to do something, a different level of energy kicks in.

Conservatory Lab is also the only school in the country to incorporate **El Sistema** Program and Methods into its core school day. **El Sistema** is a unique program designed to effect social change and nurture promising futures for underserved communities through intensive, ensemble-focused music education.

Our students will remember their experience at **Conservatory Lab** with stories about problems they solved, ways they helped the community, performances they participated in, and exciting projects they worked so hard on. They will remember how one idea led to another and how they followed those ideas like true detectives until they understood them and made them their own. They will remember being challenged to push themselves to accomplish things they did not think they were capable of accomplishing. I am so proud of our sixth graders for taking creative risks to produce this unique and thought-provoking book.

Diana Lam, Head of School



INTRODUCTION

This book, the final product in a four-month geology expedition, was inspired by the work our sixth grade class did at the very beginning of the year with Howard Gardner's theory of multiple intelligences. After thinking about, discussing, and celebrating the various ways that people learn, we discovered that 70% of our class learns best visually. This is one of the reasons that our class loves graphic novels, and it inspired us to express our knowledge about geological formations by creating our own graphic novel at the end of the year.

When we embarked on our investigation of geology, we searched for a local place where we could explore how geological processes shape the world we live in. We didn't have to go far. Hemlock Gorge Reservation, a 23-acre state park that runs along the Charles River in nearby Newton and Needham, is a short drive from our urban school. With acres of woodlands, walking trails, a waterfall, and the historic Echo Bridge, Hemlock Gorge offered an ideal site for us to experience nature, observe and draw land formations, and ask lots of questions about geological processes. A local geologist, Les Tyrula, guided us through a hike of the gorge, answering our many questions. Les, who has "always felt a real connection to understanding everything about the Earth and its glacial history," passed on his lifelong passion to our student geologists.

In the classroom, students actively modeled how geological processes shape the earth. For example, when studying how glaciers carved the land, students slowly bulldozed a melting ice cube studded with gravel across a smooth plate tectonic surface and drew a bird's-eye diagram of the formation they created. We coupled hands-on activities with viewing computer simulations of geologic processes, many of which were educational cartoons.

Using our field sketches, notes, and photographs, as well as internet resources, we created an information comic about Hemlock Gorge. Two professional artists and educators, Mathuranti Anantharajan from the Harvard Graduate School of Education, and Andrea Kantrowitz, a researcher with Teachers College, Columbia University in New York, helped guide our artistic vision by offering professional input and facilitating many opportunities for drafting, experimenting, and peer editing. Through this highly interdisciplinary process, we integrated literacy, the arts, and science to produce a comprehensive, scientific inquiry into the ancient geologic history of Hemlock Gorge.

The seeds of this expedition were planted during the 2012 New England Comic Arts in the Classroom Symposium at Lesley College, where we had the invaluable opportunity to work directly with two outstanding graphic artists, Jay Hovler and Maureen Bakis. Both of these artists work at the college and high school levels and use comics as a means of education. Our expedition is based largely on the pioneering work of these educators, as well as the work of Katie Morrin, author of *Teaching Graphic Novels: Practical Strategies for the Secondary ELA Classroom* (2009) and Scott McCloud, a cartoonist and comic theorist, best known for his non-fiction books about comics, including *Understanding Comics* (1993), *Reinventing Comics* (2000), and *Making Comics* (2006).

As teachers, we saw the rich potential for teaching Common Core reading standards and engaged students in a comprehensive study of this medium, maintaining a graphic novel library covering five distinct writing genres. Together, we read and discussed two acclaimed works, Shaun Tan's *The Arrival* and Gene Luen Yang's *American Born Chinese*, identifying the elements of a quality graphic novel. Students read deeply to make inferences beyond the text, compared and contrasted different traits and genres, and developed their verbal and visual literacy skills.

Sixth grade can be a transformative year for young people. It's a year of personal growth and self-discovery. It's a year for questioning boundaries and grappling with the fine line between childhood and adulthood. In tackling how to express their scientific knowledge through the innovative format of a graphic novel, sixth graders crossed many boundaries and stretched their creative and collaborative skills. The product is an informative, imaginative book that dances the line between fanciful illustrations and cartoons on one side, and professional, scientific research, on the other.

Sarah Perkins, Grade 6 Teacher
Caitlin Dwyer-Huppert, Science Specialist

DEEP IN THE WOODS OF NEEDHAM, MASSACHUSETTS IS HEMLOCK GORGE. IN THE HEMLOCK GORGE LIES A LONG HISTORY OF GEOLOGIC FORMATIONS. IN THIS BOOK, YOU'LL FIND STORIES ABOUT GLACIERS, ROCKS, WEATHERING AND EROSION, AND EVEN A STORY WITH A DINOSAUR!

THIS BOOK IS NOT STRUCTURED LIKE A REGULAR STORY. IT IS A WHOLE BUNCH OF SHORT STORY COMICS THAT SHOW HOW THE HEMLOCK GORGE WAS FORMED. EACH STORY IS ONE TO THREE PAGES AND IS BASED ON A RESEARCH QUESTION THE AUTHOR CAME UP WITH WHILE STUDYING HEMLOCK GORGE.

THE HEMLOCK GORGE WASN'T ALWAYS A GORGE. IT STARTED OFF AS A LAND NAMED ... GEORGE. READ ON TO SEE WHAT IT IS ALL ABOUT.

HEMLOCK GORGE RESERVATION IS MAINTAINED BY THE MASSACHUSETTS DEPARTMENT OF CONSERVATION AND RECREATION.

FOR MORE INFORMATION, VISIT THE FRIENDS OF HEMLOCK GORGE WEBSITE AT WWW.HEMLOCKGORGE.ORG.

HEMLOCK GORGE RESERVATION

MAP BY JASON WEI

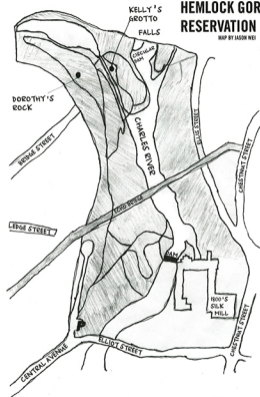


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Jose

Jason

Mechemiah

Rayne

Kelly

Tastaya

Chavez

Pedo

Brandon

Dorothy

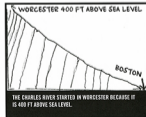
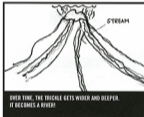
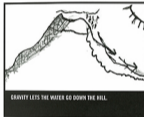
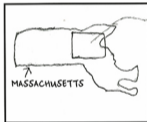
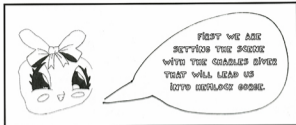
Dorothy



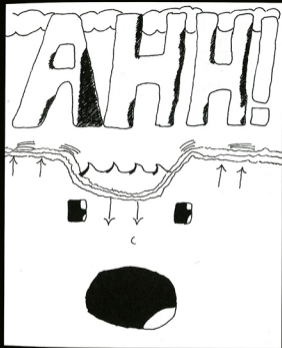
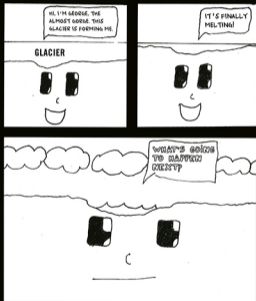
HI, I AM GEORGIA.

You may wonder why we created a comic book about Hemlock Gorge. We think it's more exciting for kids to learn about geology from a comic than an essay. Drawing shows what something looks like, and writing explains what something looks like. Don't get me wrong. Creating a comic about geological facts isn't easy! You have to make your story both realistic and unrealistic at the same time. You also have to make your characters say funny things in the middle of a scientific storyline. Turn the page to take in our stories about the land formations of Hemlock Gorge. Enjoy! —Pedro Pascual

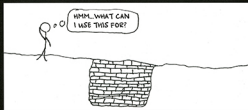
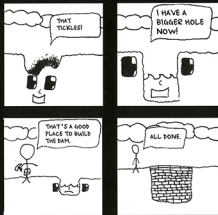
HOW DID THE CHARLES RIVER FORM?



THE CHARLES RIVER ALSO HELPED FORM HEMLOCK GORGE.



GEOLOGIC UPLIFT:
THE EFFECT OF THE EARTH'S PLATES CRASHING, CAUSING THE LAND TO RISE AND FORM ELEVATION

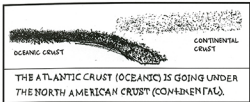


ALL AROUND THE WORLD, INCLUDING BELOW THIS DAM, LIES BEDROCK.

HOW DOES BEDROCK FORM?

THE CREATION OF BEDROCK

BEDROCK IS THE ROCK THAT IS UNDER THE EARTH'S SURFACE



THE ATLANTIC CRUST IS HEATED ENOUGH. IT TURNS INTO MAGMA.

THE MAGMA COOLS AND TURNS INTO A GRANITE DOME.

WEATHERING & EROSION



THE TOP OF THE MOUNTAIN FALLS DOWN, AND THE GRANITE IS EXPOSED. GRANITE IS THE ROCK THAT MAKES UP THE BEDROCK IN MOST OF NEW ENGLAND.

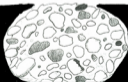
HOW DOES PUDDINGSTONE FORM?

MOST BEDROCK IS MADE OF GRANITE, BUT THE BEDROCK AT HEMLOCK GORGE IS MADE OUT OF PUDDINGSTONE.



WHAT IS PUDDINGSTONE?

THIS IS PUDDINGSTONE!



PUDDINGSTONE IS MADE OF FINE PALE SAND, CEMENT, AND PEBBLES.



IT ALL STARTED 550-570 MILLION YEARS AGO WHEN AVALONIA SPLIT FROM GONDWANA, WHICH IS WHERE AFRICA IS NOW.



BUT HOW DID IT ALL START?

WELL...

AVALONIA THEN CONNECTED WITH LAURENTIA.



LAURENTIA IS AN OLD NAME FOR NORTH AMERICA.



LAURENTIA



AVALONIA CARRIED OVER ITS ROCKS, AND SOME WERE USED IN PUDDINGSTONE.

WAIT! WE'RE NOT FINISHED YET...



AT THE END OF THE DINOSAUR AGE: 65 TO 75 MILLION YEARS AGO...



THEN, DISSOLVED SILICA CHEMICALLY FORMED INTO HARD STONES IN THE CHALK.



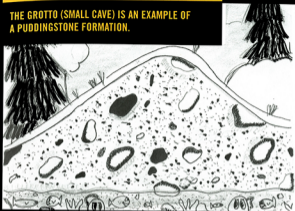


NEXT, RISING AND FALLING WAVE ACTION ON BEACHES MADE PEBBLES ROUNDED.

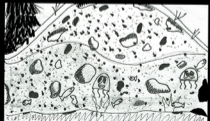


HOW WAS THE GROTTO AT HEMLOCK GORGE FORMED?

THE GROTTO (SMALL CAVE) IS AN EXAMPLE OF A PUDDINGSTONE FORMATION.

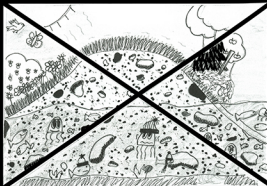


RAINWATER FALLS AND THEN THE WATER RISES.



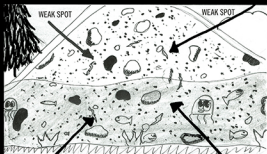
SUMMER

SPRING



FALL

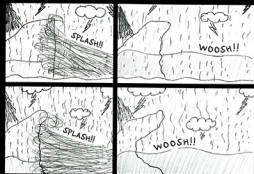
WINTER



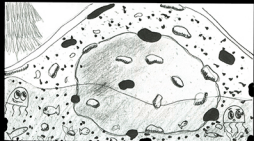
WEAK SPOT

WEAK SPOT

WAVES CRASH ONTO THE ROCK HITTING THE WEAK SPOTS HARDER AND HARDER EACH TIME...



...UNTIL IT MAKES A GROTTO (SMALL CAVE).



HOW DO ROCKS SPLIT APART?

THIS IS CARLY. SHE IS A ROCK. SHE LIVES IN A FIELD. CARLY DOESN'T KNOW IT YET, BUT SHE IS ABOUT TO TAKE A CRAZY JOURNEY THAT WILL LAST MILLIONS OF YEARS.



DURING THE RAINSTORM, WATER SOAKED INTO CARLY'S CRACKS AND STAYED THERE.

THAT NIGHT IT GOT REALLY COLD, AND THE WATER INSIDE CARLY STARTED TO FREEZE. WHEN WATER FREEZES, THE MOLECULES SPREAD OUT AND BECOME LESS DENSE.

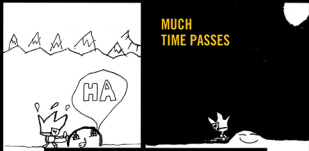


THIS GOES ON FOR THOUSANDS OF YEARS.



NEXT, GLACIER IS COMING!
A GLACIER IS A LARGE BODY OF ICE. A GLACIER COVERED MOST OF CANADA AND NORTH AMERICA MILLIONS OF YEARS AGO.

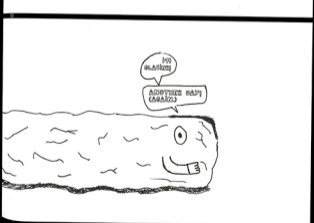
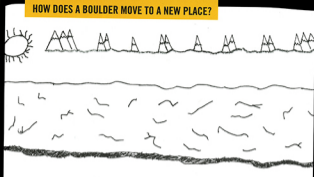
HOW DOES A GLACIER CREATE A BOULDER?



MUCH TIME PASSES



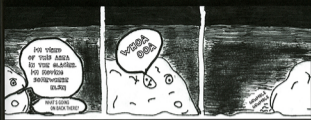
HOW DOES A BOULDER MOVE TO A NEW PLACE?





LATER... (ABOUT THOUSANDS OF YEARS LATER...)

SOMEWHERE IN THE WORLD

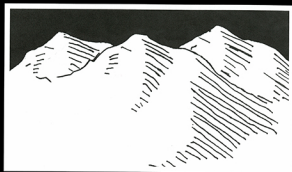
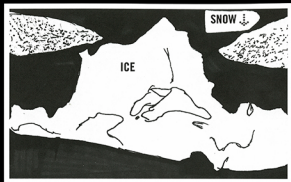


AS YOU CAN SEE, GLACIERS CAN SUCK UP ROCKS, TRANSPORT THEM, AND DEPOSIT THEM IN A NEW AREA. THESE ROCKS ARE CALLED GLACIAL ERRATICS.



HOW DO GLACIERS CREATE HILLS?

MOVING GLACIERS CAUSE ALL KINDS OF CHANGES IN THE LAND.



THAT'S HOW THE HILLS FORMED AT HEMLOCK GORGE IN THE PAST.

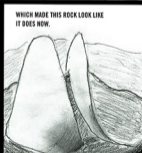
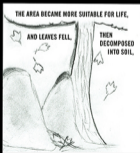
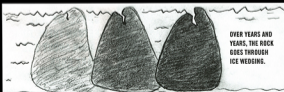
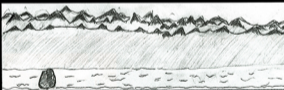


*A SMALL HILL CREATED BY A MOVING GLACIER

NOW THAT YOU'VE LEARNED SO MUCH ABOUT HEMLOCK GORGE, WE WILL RETURN THERE TO LEARN ABOUT ONE MORE ROCK.

HOW DID THE ROCK IN NORTHWESTERN HEMLOCK GORGE SPLIT?

THIS IS A ROCK FROM
HEMLOCK GORGE...



HOW DO SCIENTISTS KNOW THAT BOTH PARTS OF THE ROCK WERE ONCE THE SAME ROCK?

STRATA

STUDIES OF THE ROCKS' STRATA PROVED THAT THEY WERE THE SAME ROCK.

STRATA IS THE PATTERN OF SEDIMENTARY LAYERS IN A ROCK, EACH ROCK HAS DIFFERENT STRATA. IT IS ONLY THE SAME IF THE ROCK WAS SPLIT.

AS AN EXAMPLE, A CAKE:



YOU CAN'T SEE ANYTHING IN PARTICULAR, EXCEPT THE OUTSIDE FROSTING.



BUT WHEN YOU CUT IT, YOU CAN SEE THE LAYERS.



CARBON DATING

Carbon dating determines the period of time when the rock was broken into two.

1 THE SUN GIVES OFF RADIATION THAT MEETS WITH AN ATOM TO GIVE OFF AN ACTIVE NEUTRON.

2 WHEN AN ACTIVE NEUTRON MEETS A NITROGEN 14 ATOM, THE NITROGEN 14 ATOM LOSES ITS PROTON AND TURNS INTO CARBON 14.



CARBON 14 IS AN UNSTABLE ATOM THAT GETS ABSORBED INTO PLANTS ALONG WITH THE STABLE ATOM C12.

PLANTS' LEAVES TAKE IN C12 AND C14 THROUGH PHOTOSYNTHESIS.



EVENTUALLY, THE PLANT WILL DIE. THE C14 WILL BEGIN TO DECAY, AND NO MORE C14 CAN COME TO REPLACE IT. THE C12 WILL STAY BECAUSE IT IS STABLE.

SCIENTISTS USE THE RATIO OF C12 AND C14 INSIDE THE PLANT TO TELL WHEN THE PLANT DIED.



THE C12 STAYS WHILE THE C14 STARTS DECAYING.

REFLECTIONS

STUDENTS REFLECTED ON THE RESEARCH AND ARTISTIC PROCESSES THAT WENT INTO CREATING THE PAGES OF THIS BOOK.



JOSÉ

The first time that I started to make the clouds, the lines were all shaky and bumpy. Then Ms. Madhu told me to try to move my whole arm and not only my hand. As I practiced and practiced, I got better. I noticed that making the curved line is similar to playing the violin. It is similar because you use your whole arm to move the bow on the violin, and you move your whole arm to draw on the paper.

A graphic novel technique I used was zooming in and zooming out. I zoom out at the beginning of my story when I show the map of Massachusetts, and then I zoom in to just show the Charles River. This technique is good because zooming out helps to set the scene so readers know where it is taking place.



JASON

When I started my comic, I wanted to have a character or narrator because it would be easier to tell the reader what was happening instead of showing what was happening with a lot of action-to-action gutters. I made the gorge a character and named him George. George helps explain what is happening in the panel.



NECHEMIAH

First I used lines and shading to draw the Earth's crust. Then Ms. Madhu taught us pointillism, and I used it to show the different densities of each layer. I used more dots for the oceanic crust and less dots for the continental crust. I did this because I wanted to show that oceanic crust is denser than continental crust.

Additionally, when I first wrote the captions, I drew lines to write my letters on. Some of my letters went above and below the lines. The letters were overlapping. We went to fourth grade to get feedback and one student said that he couldn't read my captions. So I re-wrote my sentences, tracing the letters. It looked a little bit neater, but there was not enough room to put all of the words in one panel and I couldn't see the paper underneath the tracing paper very well. So I used a light table and different-sized letters. Now I feel proud about the letters.



RAYNE

I came up with my research question when we went on fieldwork to Hemlock Gorge and I saw this rock that appeared all over the gorge with a bunch of other rocks packed together. I wondered: What is this called? How was this made? Later, I found out the rock is called puddingstone. I really wanted to know how all those other sediments got into the puddingstone. To answer my question, I searched the internet to get familiar with the concept of puddingstone formation. When we went back to Hemlock Gorge with a geologist named Les Tyrano, he helped me realize that there are many ways puddingstone can form.



KELLY

In my comic, I paid attention to the gutters (the little white spaces between the panels). In my story, there are a lot of transitions between panels, and it was a challenge to sequence my panels so that people could understand what I was trying to say. In one panel, I had to show a wave crashing into the puddingstone and the rock getting smaller. So I decided to have it be one panel and to break it apart into four sub-panels. I also broke another one of my panels apart to show how time passed.



YANTAYA

Ms. Kantrowitz showed us how to draw different facial expressions. This helped me make my character more emotional. I was able to show when my character was sad or surprised. This helped me set a tone for my character.



CHAVEZ

When I first started my comic, I drew my characters like stick figures, but after the art lessons, my drawings changed from stick figures into people with cool bodies. I also changed my character, Glacier's, hairstyle. Now his hair looks cool and spiky, like a glacier. I made another character, Bedrock, look like she is scared of the glacier. I did this by adding the facial details of a scared person.



PEDRO

When I came up with my research question, I was wondering how the many boulders in Hemlock Gorge got there in the first place. I started to learn the answer from a lab in class when we studied how glacial erratics move. We had an ice cube with rocks inside and used play dough as the landscape. We dragged the ice across the play dough and saw how the rocks from the ice dropped off. Then, when I went to Hemlock Gorge for the second time with Mr. Tyrula, he told me that the glaciers' energy pushed and grabbed the boulders and moved them to many different places.



DOROTHY

I started trying to find a shading technique that could work for me. I tried hatching, cross-hatching, smudging, and stippling. I decided to use smudging and shading with the side of my pencil. The pencil I was using was too light, so I experimented with pencils of different softness until I got just the right effect.



BRANDON

First, I just imagined what a glacier looked like and drew it from memory. I felt that it wasn't a good picture because it was just a rectangle with spikes at the top. So, I got some feedback, I looked on the internet for pictures of glaciers and hills and noticed I was missing details. I redrew my glacier adding more details, such as shading by crosshatching. I also changed the shape.

THANK YOU!

Ms. Sarah Perkins and Ms. Caitlin Dwyer-Huppert, our teachers, for making learning about rocks fun!

Les Tyrula, geologist, for sharing all your stories, for really listening to us, and for helping us put together the pieces of the geological puzzle.

Ms. Madhuvanti Anantharajan, artist, for teaching us so many ways to shade and for inspiring us with your beautiful sketches.

Ms. Andrea Kartowitz, artist, for teaching us how to show emotion in cartooning faces and other art techniques.

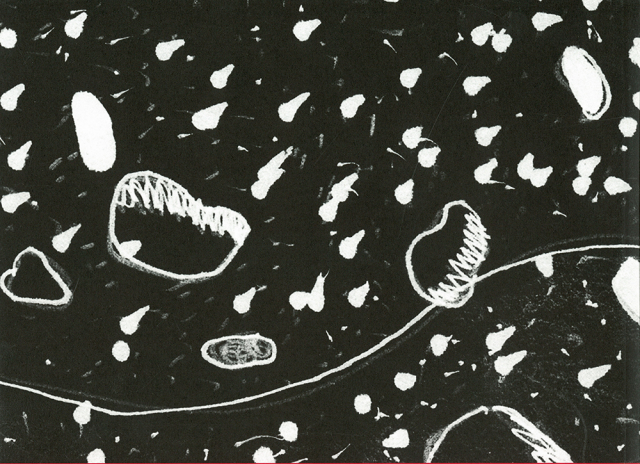
Mrs. Fleming, Dorothy's mom, for accompanying us to Hemlock Gorge.

Ms. Rhonda Berkower, for coming to Hemlock Gorge with us, editing our book, and offering us constant support, energy, and information.

And thanks to all the graphic novelists whose work inspires us.



Sketch of a river at Hemlock Gorge by Rhonda Berkower



YOU GROTTO GO TO HEMLOCK GORGE & OTHER SMALL CAVE STORIES

This graphic novel, created by ten Conservatory Lab sixth graders during an earth science learning expedition, tells the fascinating story of the geological formation of Hemlock Gorge in Needham, Massachusetts. The comic book format brings to life a story hidden in stones to help us understand our geologic past.

JOIN US ON THE WEB AT WWW.CONSERVATORYLAB.ORG

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