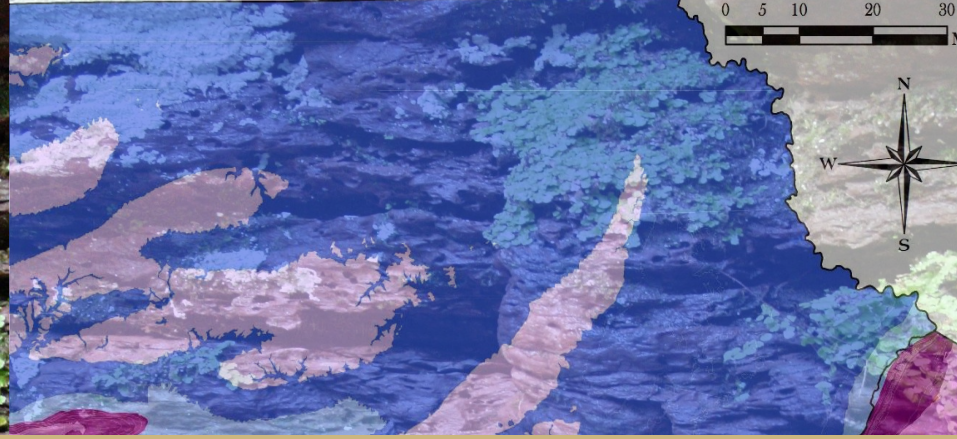
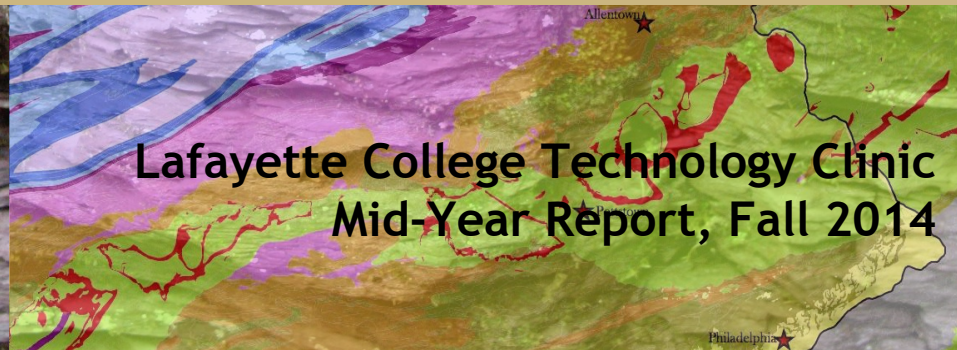


TRAVELING THROUGH TIME AND SPACE: BRINGING GEOLOGY TO LIVES INSIDE AND OUTSIDE THE DA VINCI SCIENCE CENTER



Lafayette College Technology Clinic
Mid-Year Report, Fall 2014

Executive Summary

Identification of Objectives:

- Create detailed plans for a potential exhibit to be installed in the Da Vinci Science Center to engage visitors in learning about local geology.
- Create a means of connecting local geology back to the Da Vinci Center and encouraging independent education and exploration.

Executive Summary (cont.)

Areas of Exploration:

- A “**stationary elevator**” that would simulate traveling back in time to allow patrons to understand the process and history of local geology
- A “**playhouse**” that would allow patrons to walk through different geologic phases and see/interact with a physical representation of the physical geology over time
- Accompanying “**education stations**” that interactively explore the geological processes that shape our world
- Incentivize patrons with children to explore the geology section of the center by giving out a “**geologic passport**” when they enter the Center
- An “**app**” that would be accessible outside the Da Vinci Science Center that brings local geology and the Center together

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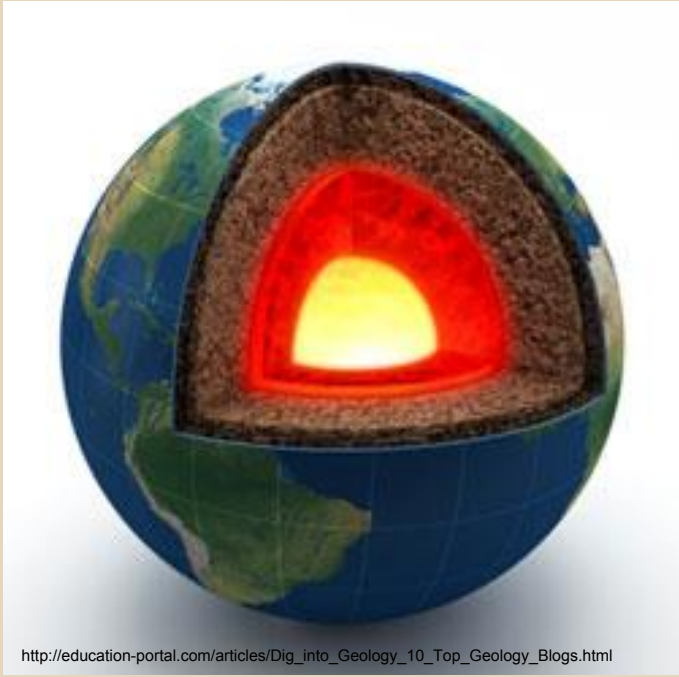


http://education-portal.com/articles/Dig_into_Geology_10_Top_Geology_Blogs.html

Technology Clinic

The Technology Clinic at Lafayette College was established in 1986. The clinic partners with community organizations to address real-world issues. For example, a past technology clinic developed a floating debris harvester concept for the hydroelectric facilities of the Susquehanna which resulted in a machine which is now employed from the Pacific northwest to Korea. Another team used computer and human simulations to develop the procedures for avian flu inoculation designed for rapid pandemic response for two local health bureaus.

http://media-cache-ec0.pinimg.com/236x/ae/4b/14/ae4b147d03bbfc0be246329081bfd5fd.jpg

Technology Clinic (cont.)

At the heart of the Tech Clinic lies the the idea that the most effective solutions are the products of an interdisciplinary approach. This approach fosters critical thinking, troubleshooting, and an open flow of ideas between faculty advisors and five or six Lafayette students from different disciplines and backgrounds. Each member of the Tech Clinic brings their own expertise and perspective to contribute to the overall problem-solving effort.

The Team

The Team

- Anna Wissler (‘16) is a junior at Lafayette. She is studying Economics and Studio Art as a part of a double major, and hopes to pursue interests in architecture or design after Lafayette. She is a member of the Lafayette Women’s Soccer team and gets involved on campus through the Peer Tutor and Peer Mentor programs.

- Kaitlin Kinsella (‘17) is a sophomore at Lafayette. She is double majoring in Government & Law and Philosophy. Kaitlin is a member of Lafayette’s Speech and Mock Trial teams. She is also heavily involved in the Landis Center as a program coordinator.

The Team

- Robyn Henderek (‘15) is a senior at Lafayette. She is studying Geology and Anthropology and is interested in pursuing a graduate degree in zooarchaeology/paleontology with respect to early hominin sites in South and East Africa. At Lafayette, Robyn is the Teaching Assistant for Structural Geology, a Resident Advisor, and she is a member of the Lafayette Women’s Diving team.

- Madison Murray (’16) is a junior at Lafayette. She is a member of the Lafayette Women’s Soccer team, and is a double major in Studio Art and Spanish, with a minor in Art History and a concentration in Architectural Studies. She is the Director of Studio Production for Ed Kerns, and hopes to attend graduate school for design and marketing.

The Team

- Sarah Woodruff (‘15) is a senior at Lafayette. She is a Biology major who hopes to pursue a graduate degree in conservation biology or a related field. On campus, Sarah tutors, serves as a Teacher’s Assistant for Comparative Vertebrate Anatomy, and leads a community outreach program through the Lafayette Landis Center. She is working towards an Honors Thesis in Biology and interns at Safe Harbor, a homeless shelter in Easton.

- Sinan Dundar (‘15) is a senior at Lafayette. He is a mechanical engineering major with a minor in economics. Sinan is the supplemental instructor of a sophomore level physics course and the president of the Tau Beta Pi engineering honor society. He plans on pursuing a masters degree in finance.

The Team

- Prof. Dan Bauer, one of the faculty facilitators on the team, is a Professor Emeritus of Anthropology at Lafayette College and Director Emeritus/Founder of the Technology Clinic program. His interests have ranged from engineering and technology to journalism and photography. Throughout his career as an anthropologist, he has done research around the globe, such as Peru, Mexico, and Ethiopia.

- Prof. David Sunderlin, one of the faculty facilitators on the team, is an Associate Professor of Geology at Lafayette College. His specialties are in paleobiology, stratigraphy, and evolutionary biology. His research is primarily on fossil plants and reconstructing ancient high-latitude forested ecosystems in terms of their climate and ecology.

Our Community Partner

This Technology Clinic has partnered with the **Da Vinci Science Center** in Allentown, PA. The Da Vinci Science Center's mission is: "To bring science to life and lives to science". The center has both permanent and traveling exhibits to foster a unique and fun experience with every visit. Named after Leonardo da Vinci, the center works to "promote curiosity, creativity, and the qualities of greatness embodied" after their name-sake. Patrons of the Da Vinci Science Center are educated about science and technology through fun, interactive, and educational experiences.

http://en.wikipedia.org/wiki/Da_Vinci_Science_Center#mediaviewer/File:Da_Vinci_Science_Center_Building.jpg

Initial Observations

After visiting the Da Vinci Science Center we had a much clearer idea of the types of exhibits featured in the Center, and which of these were most popular and effective.

Initial Observations

- Hands-on stations that allowed visitors to “play” with science seemed to be the most popular, like the building blocks and water channeling activities
- There seemed to be plenty of space available for our use; the temporary exhibit room had just been expanded, and the main exhibit rooms on the upper and lower levels seemed very spacious
- Exhibits seem to encompass all age ranges, from the foam building block room for toddlers to activities that would entertain even adults like the building blocks and the physics exhibits on the second floor
- Wide range of scientific topics covered

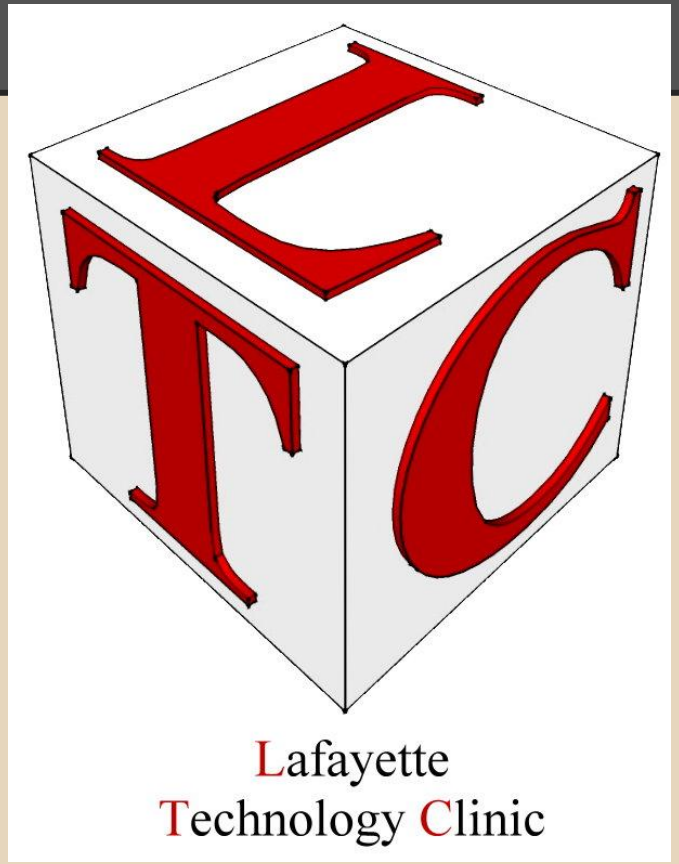
The Problem

This tech clinic seeks to generate more interest in the local geology through a series of connected and interactive experiences. We want to foster scientific thinking so that patrons of the Da Vinci Science Center become observant, educated, and fascinated by the geology they encounter in their everyday lives. By giving patrons the tools to understand their local geology we hope to stimulate further exploration. Inside and outside the Da Vinci Science Center, we want patrons to want to understand the legacy of their local geology through time and space.

Mission Statement

The goal of this Technology Clinic is to provide the Da Vinci Science Center with suggestions on how to integrate an interactive, engaging exhibit on local geology within their center that simultaneously addresses the areas that the Center wishes to improve upon.

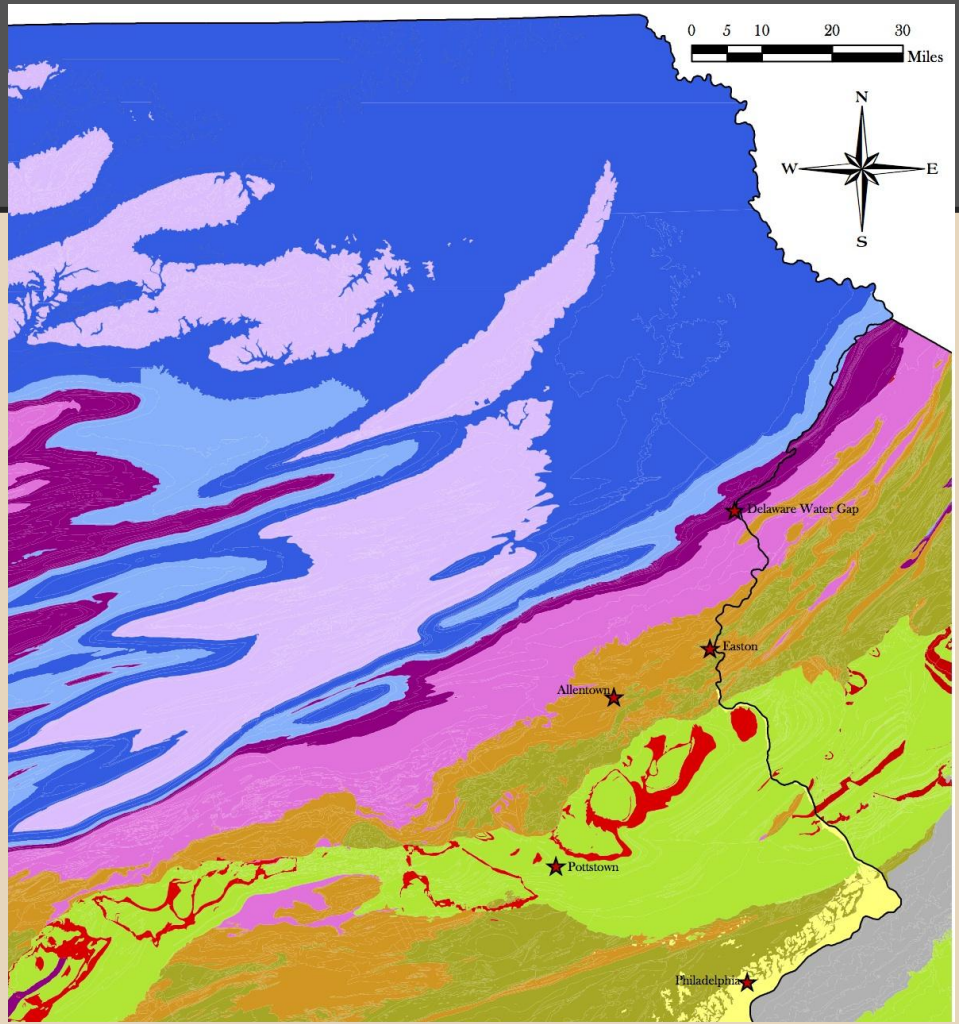
Additionally, our group will develop a means to connect the experiences that patrons have at the Center with experiences that are available in their everyday lives, thereby “bring[ing] science to life and lives to science.”



Local Geology

Legend

- Ice Ages
- Triassic Split
- Diabase intrusions
- Carboniferous Forests
- Devonian Delta
- Devonian Seas
- Silurain Drainage
- Ordovician Deep
- Cambrian Rise
- PreCambrian



Geologic Phases

Phase 1 - Precambrian

Age: 570+ million years ago
Geologic Formations: Reading Prong

- In the vastness of time before the Cambrian, Pennsylvania (and all of North America) saw many phases of tectonic convergence and divergence.
- The record of ancient surface conditions is poorly preserved from this phase due to intense tectonic and erosive activity over long timescales.
- The overlying sedimentary layers cover the Precambrian record.

Gneiss, this high grade metamorphic rock makes up most of the Precambrian basement rocks in eastern PA. (http://www.sciencekids.co.nz/pictures/earth/metamorphicrock.html)

Geologic Phases (cont.)

Phase 2 - Cambrian Rise

Age: 570-500 million years ago
Geologic Formations: Allentown-Jacksonburg Formations

- Global sea levels rose in the Cambrian Period.
- On many ancient continental shelves, beaches transgressed onto land, leaving sandstones and their wake and records of shallow marine conditions atop the sands.
- Stromatolites are well-preserved in these units and represent much of the life present during this phase.
    - Stromatolites are algal colonies that oftentimes form in the shape of a mushroom; they are some of the earliest forms of life on earth

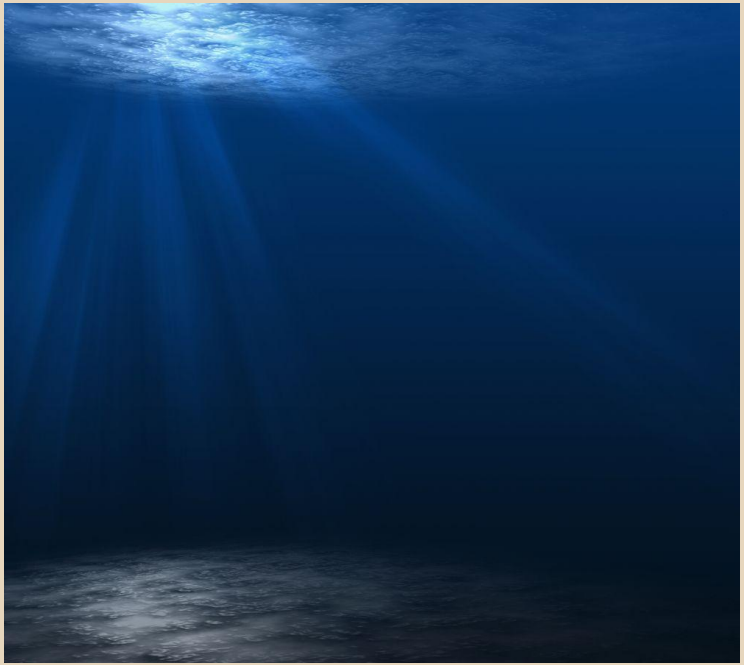
Modern stromatolite colonies in Shark Bay, Australia (http://en.wikipedia.org/wiki/Stromatolite)

Geologic Phases (cont.)

Phase 3 - Ordovician Deep

Age: 500-430 million years ago
Geologic Formations: Martinsburg Formation

- In the peripheral basin of the rising Taconic mountain building event, eastern Pennsylvania subsided to deep ocean conditions.
- The great thickness of fine-grained Ordovician strata, known as the Martinsburg Formation, makes up the “slate belt” in Eastern Pennsylvania.



Deep ocean environment (http://spotlightvalues.org/2012/02/01/diving-deep/)

Geologic Phases (cont.)

Phase 4 - Silurian Drainage

Age: 430-405 million years ago
Geologic Formations: Shawangunk - Palmerton Formations

- With the arrival of the Taconic mountain belt, uplands began to shed coarse gravelly and sandy sediments into Pennsylvania in river drainage systems off of the mountains.
- The Shawangunk and Bloomsburg formations start this succession, sometimes known as the ancient Queenston Delta.
- Some of the earliest land plants evolve during this time.

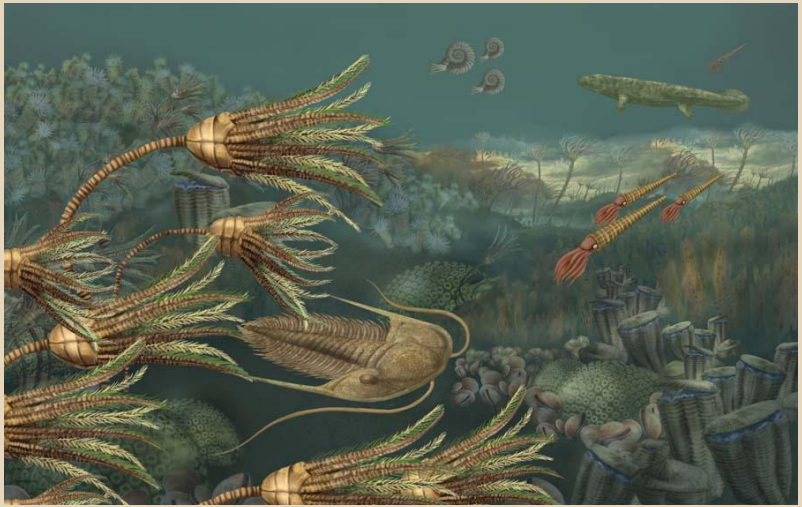
Weathering and erosion of sediments from highlands to basins. (https://www.studyblue.com/notes/note/n/streams-2/deck/1445574)

Geologic Phases (cont.)

Phase 5 - Devonian Seas

Age: 405-365 million years ago
Geologic Formations: Marcellus-Trimmers Rock Formations

- As the Acadian land mass neared the southeast coast of North America in the Devonian, the continental margin was depressed below sea level again.
- Marine mudrocks with abundant and diverse fossils represent continental shelf conditions just prior to the onset of the second major mountain-building event in Pennsylvania's stratigraphic record.



Life in the shallow shelf Early Devonian sea. (http://www.karencarr.com/portfolio-images/Marine-animals-and-fish/Devonian/Audubon-Institute-Insectarium/Audubon-Insectarium-Ancient-Seas-Mural/100)

Geologic Phases (cont.)

Phase 6 - Devonian Delta

Age: 365-330 million years ago
Geologic Formations: Catskill Group

- The Acadian collision and uplift to the southeast produced a mountain-scape that shed sediments westward across Pennsylvania in what is known as the Catskill Delta.
- The red rocks of the Catskill Formation and associated strata comprise this thick dump of sediment that mostly reflects terrestrial (land) environments in eastern PA, while western PA and central NY preserve offshore marine strata at the time.

Heavily wooded rivers as a modern analog to the Catskill Delta environment.
(http://www.audubon.org/images/photos/whiskey-bayou)

Geologic Phases (cont.)

Phase 7 - Carboniferous Forests

Age: 330-290 million years ago
Geologic Formations: Pocono-Lewellyn Formations

- The third of the major mountain-building phases, called the Alleghenian orogeny, resulted from the collision of eastern North America with the northwestern margin of Gondwanaland (an ancient continent which had parts of modern South America, Antarctica, and Africa) and what would eventually become western Africa.
- This event sutured Pangea at equatorial latitudes. Warm tropical forested river basins preserved coals and other fine-grained sedimentary rocks shed off of this Himalayan-scale collisional uplift.

Fossil ferns and seed ferns from the Lewellyn Formation (http://www.fossilera.com/fossils/fossil-seed-fern-plate-pennsylvania)

Geologic Phases (cont.)

Phase 8 - Triassic Split

Age: 250-180 million years ago
Geologic Formations: Newark Supergroup

- Long after North America's fusion with Africa in the Carboniferous and Permian, this suture tore open again sending each continent on a divergent path and opening up the modern Atlantic Ocean.
- Rift basins associated with this extension extend up and down the margins of each continent, one of which is the Triassic-Jurassic Newark Basin through New Jersey and southeastern PA.
- Red mudrocks and sandstones tell of seasonal lake and river systems with early dinosaur inhabitants.

Modern analog in the East African Rift Basin. (Robyn Henderek)

Geologic Phases (cont.)

Phase 9 - Ice Ages

Age: 2 million - 20 thousand years ago
Geologic Formations: Glacial till

Large Ice Age mammals, such as the woolly mammoth, ruled the tundra.
(http://www.earth4567.com/talks/ice.html)

- Since the demise of the dinosaurs at the end of the Cretaceous, erosion has been the dominant process in Pennsylvania. The rock units that contain the chapters of Pennsylvania's history are being exhumed by this erosion so that all the bedrock history described earlier can be read at the surface.
- The last major phase of deposition had to do with the Pleistocene ice ages and the tell-tale glacial till left on top of the bedrock in the northern reaches of the state.
- Mammoths, mastodons, and all sorts of other megafauna wandered these lands in tundra and boreal forest conditions just 20,000 years ago.

Anthropocene

- The Anthropocene is an informal term which represents the time-period when human activity begins to significantly affect local ecosystems, global climate and Earth processes which will be reflected in the geologic legacy.
    - The exact time when the Anthropocene began is debated however, it is widely accepted as beginning during the start of the Industrial Revolution in the 19th century.
- Human activity had affected plant and animal biodiversity (which will be seen in the fossil record), climate, water systems, erosion from agriculture and other land-clearing activities as well as waste disposal.

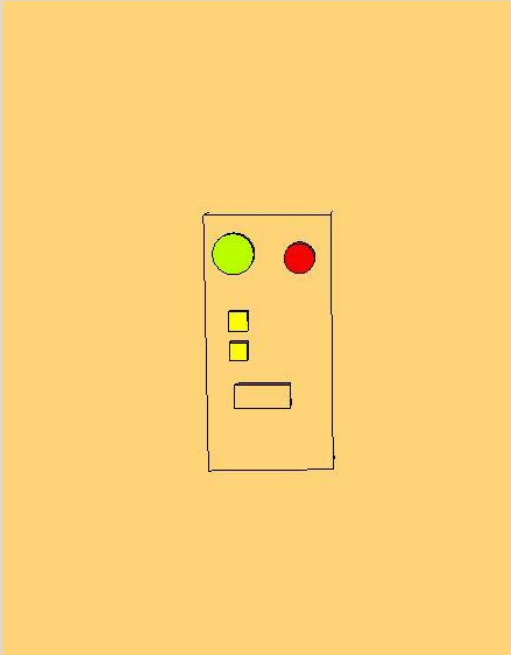
As of 2006, for the first time in human history, the majority of people live in urban areas. (http://news.softpedia.com/news/The-Anthropocene-Began-in-the-18th-Century-200498.shtml)

Stationary Elevator: General Description

- A rectangular chamber will offer the visitors the unique experience of visiting each one of the nine geological phases.
- Lights, temperature control, a screen, and sound effects will work together to create an atmosphere that resembles a particular phase.

Stationary Elevator: The Experience

- As soon as the visitors step inside the chamber, they will see a control panel. This control panel will initiate the “motion” of the elevator.
- Sound effects and vibrations will create the impression of movement.
- When the elevator reaches a floor, a slideshow will begin on the screen.



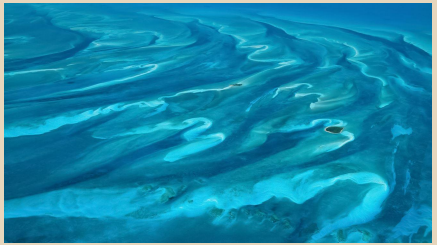
Stationary Elevator: The Experience

- The slideshow will have the following slides for each phase:
  -Image of the rock that is particular for that phase
  -Image that resembles the environment in that phase
  -Image of the representative organisms of that phase
  -Image of the fossils of those representative organisms found in rocks
  -Image of the rock again
  -A map shows the location of the local region on the globe during that phase
- The lights and the temperature controller will enhance the experience.

Stationary Elevator: Slideshow Sample

Cambrian Rise:

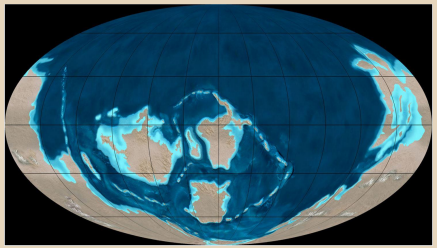
Carbonates (Allentown Formation)



Modern Analog of Cambrian environment, Bahamas (https://www.flickr.com/photos/55497864@N00/8025842375)

Stromatolites (http://static.panoramio.com/photos/large/34194162.jpg)

Stromatolite Fossils, (http://upload.wikimedia.org/wikipedia/commons/thumb/7/7d/StromatoliteUL03.JPG/1280px-StromatoliteUL03.JPG)



Orientation of the continents in Cambrian era (http://en.wikipedia.org/wiki/Cambrian#mediaviewer/File:Blakey_500moll.jpg)

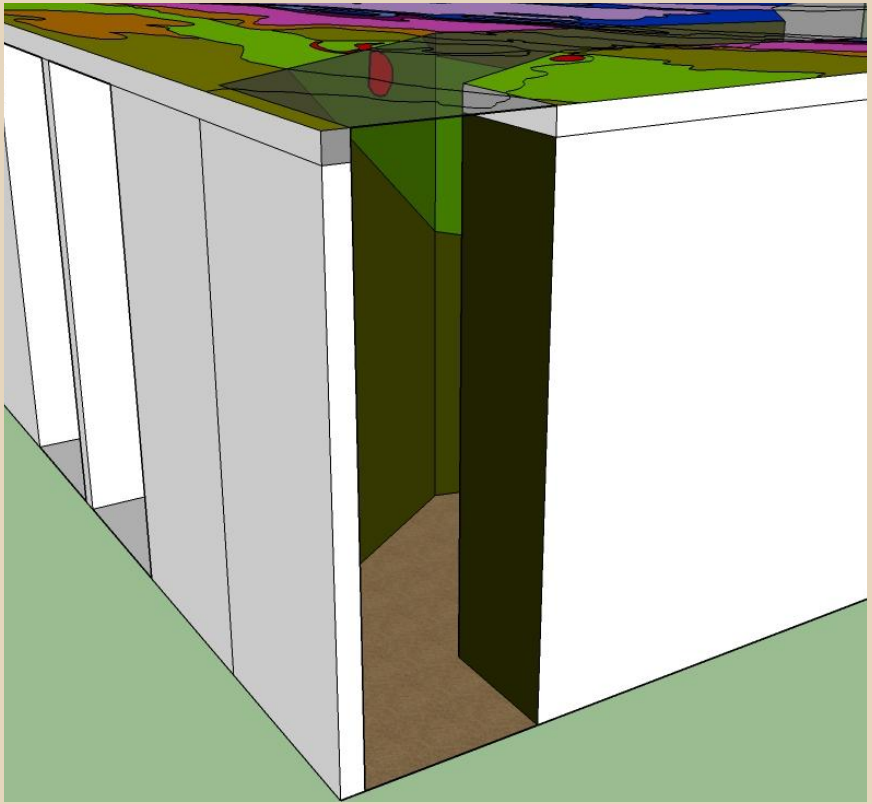
Playhouse

An interactive structure that can provide a variety of experiences. Patrons can…

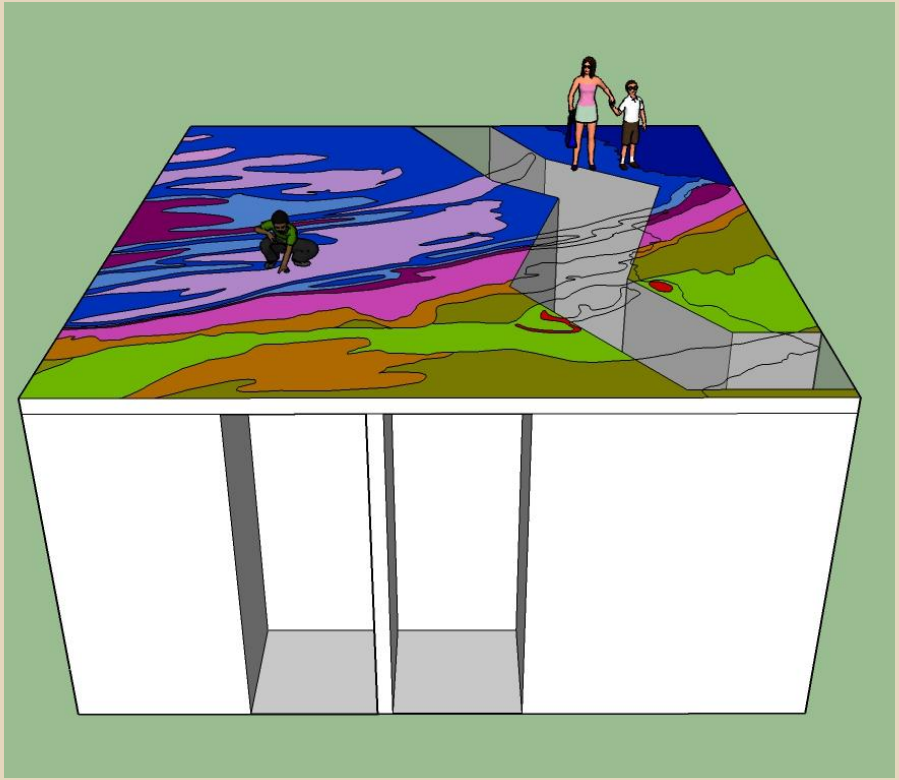
1. Walk through a **tunnel** traversing the strata of the local area
2. Walk along the **“roof top”** to see eastern PA and western NJ’s surface geology as it is today
3. Visit phase-specific **education stations** around the outside of the structure

Playhouse: Tunnel

- Patrons can walk through a tunnel that is “carved” into the state’s strata.
- The geologic features of the rock will be illustrated along the walls of the tunnel.
- Patrons will gain an understanding of how rock is layered beneath their own feet.



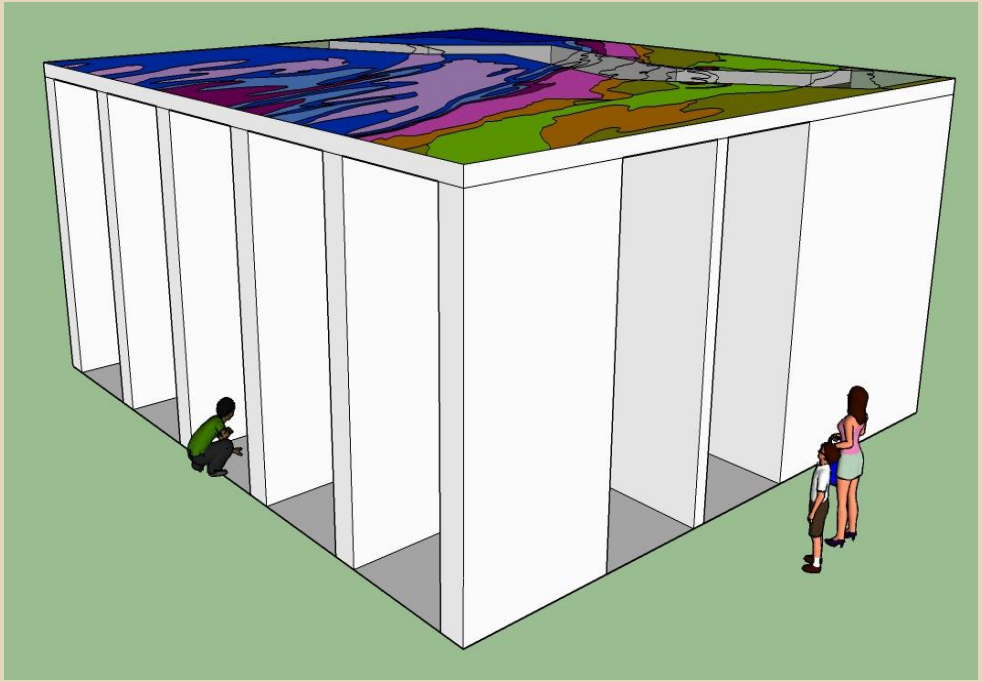
Playhouse: “Roof top”



- The top of the structure will consist of a map of the local area, featuring cities as well as the eight geologic chapters we have outlined.
- A transparent pane over the tunnel will allow patrons to understand the path they just walked (or will soon walk) and see it from a new perspective.

Playhouse: Education Stations

- Eight education stations will be located around the outside of the playhouse.
- Each station will correspond to a chapter in local geologic history and will feature an activity or experience that communicates the gist of that chapter.

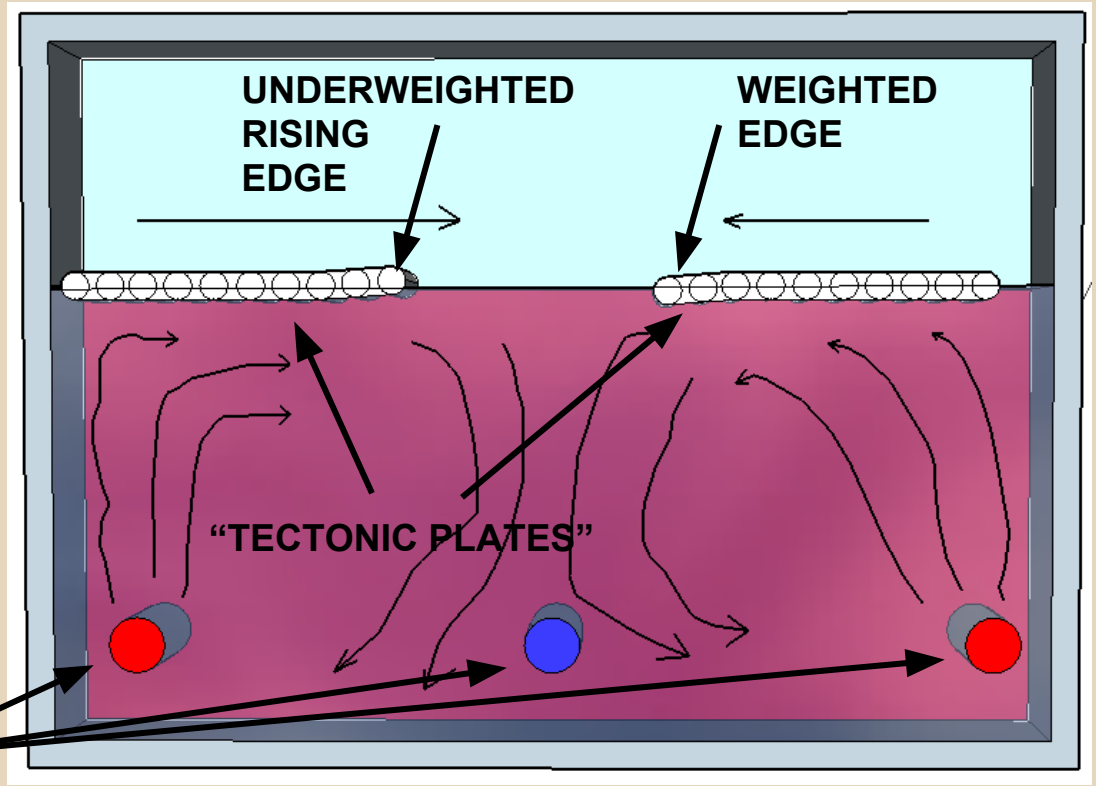


Playhouse: Education Stations

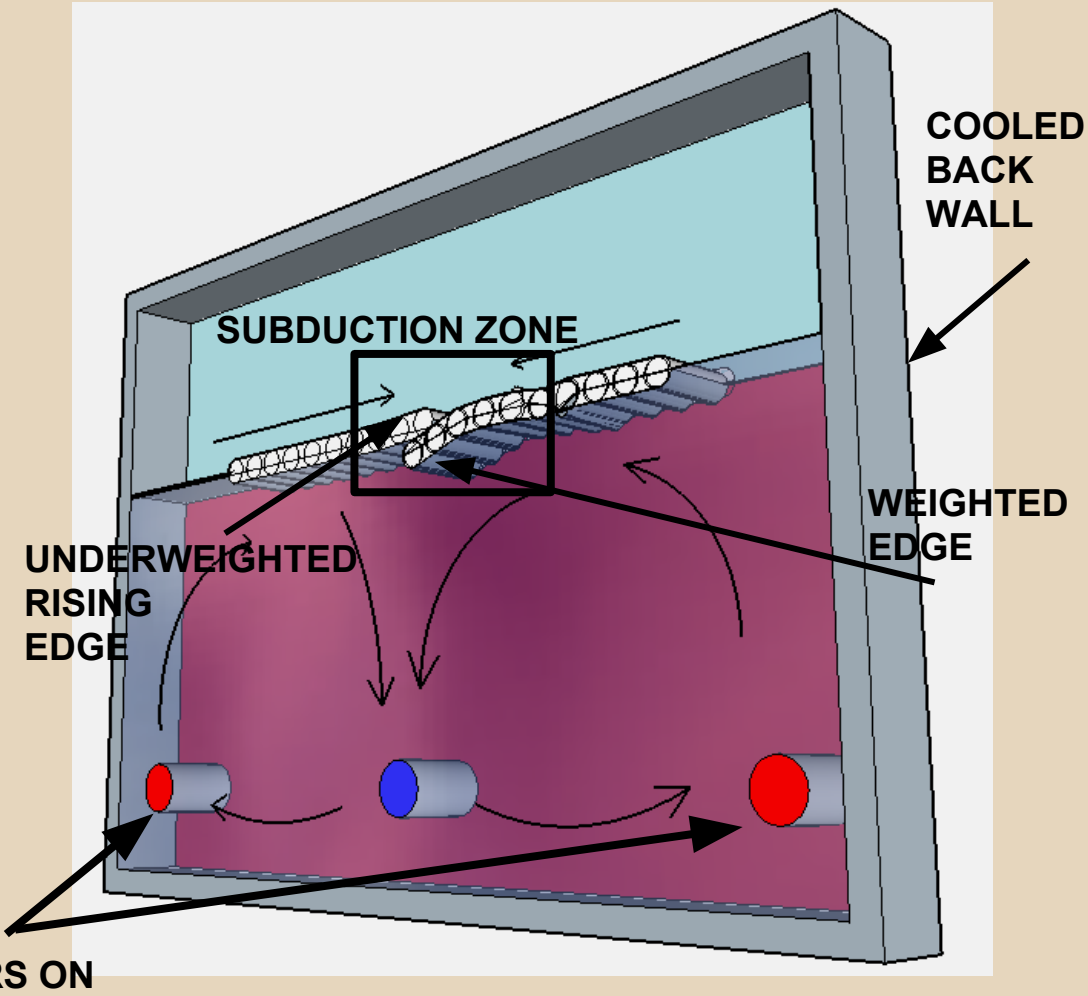
1. Precambrian: Rock texture on walls; heat lamps to convey environment
2. Cambrian Rise: Miniature beach environment
3. Ordovician Deep: Movement of deep ocean water projected on walls; wheel to show settling of clay
4. Silurian Drainage: Rough texture on walls; wheel to show how pebbles settle
5. Devonian Seas: Beach environment projected on walls; sound of waves; Wheel to show how sand settles
5. Devonian Delta: Forest-like environment; excavating activity to show difference between fish and tetrapods
6. Carboniferous Forests: Draw fossils of ferns on a blackboard surface to mimic the appearance of actual fossils from this time
7. Triassic Split: Provide some surface (perhaps gel) that will leave imprints of visitors feet. These can be compared with phytosaur tracks

Education Station on Tectonic Plates

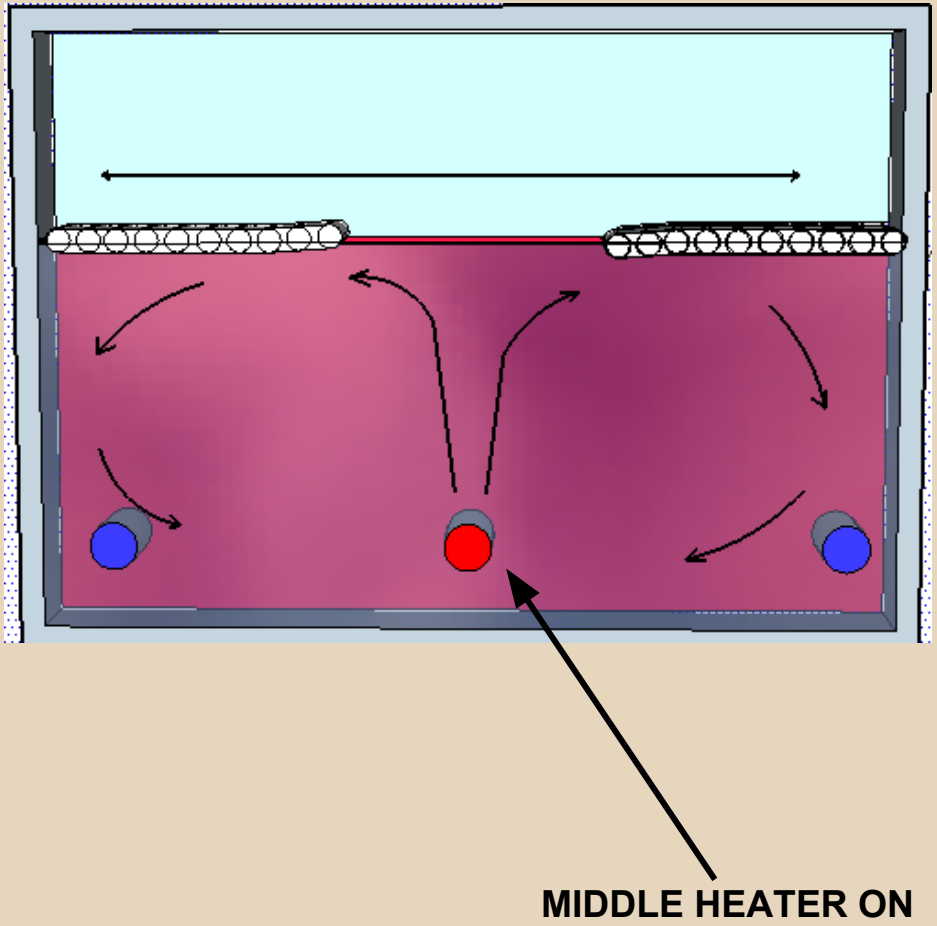
- Display mounted on playhouse
- Illustrates the motion of tectonic plates at convergent and divergent boundaries
- Allows patrons to visualize the process of subduction
- Allows patrons to interact with the display and control what happens by turning either the outer or the middle heaters on



- Three diesel block heaters that can be turned on and off by the visitor
- Filled ⅔ with red radiator coolant
- Two “tectonic plates” made of styrofoam and weights
- Right plate has a weighted left end, left plate has a right end that is lighter than other segments
- When outside heaters are on, convection currents pull plates together, illustrating the subduction that occurs at a convergent boundary



- When the outer heaters are off and the middle heater is on, convection currents will pull the plates apart, illustrating plate motion at a divergent boundary
- The principle of convection is partially responsible for the movement of tectonic plates. It is true that there are other processes at work, but these processes cannot be easily demonstrated or made into an interactive display.
- This display could be constructed fairly easily from materials that already exist.



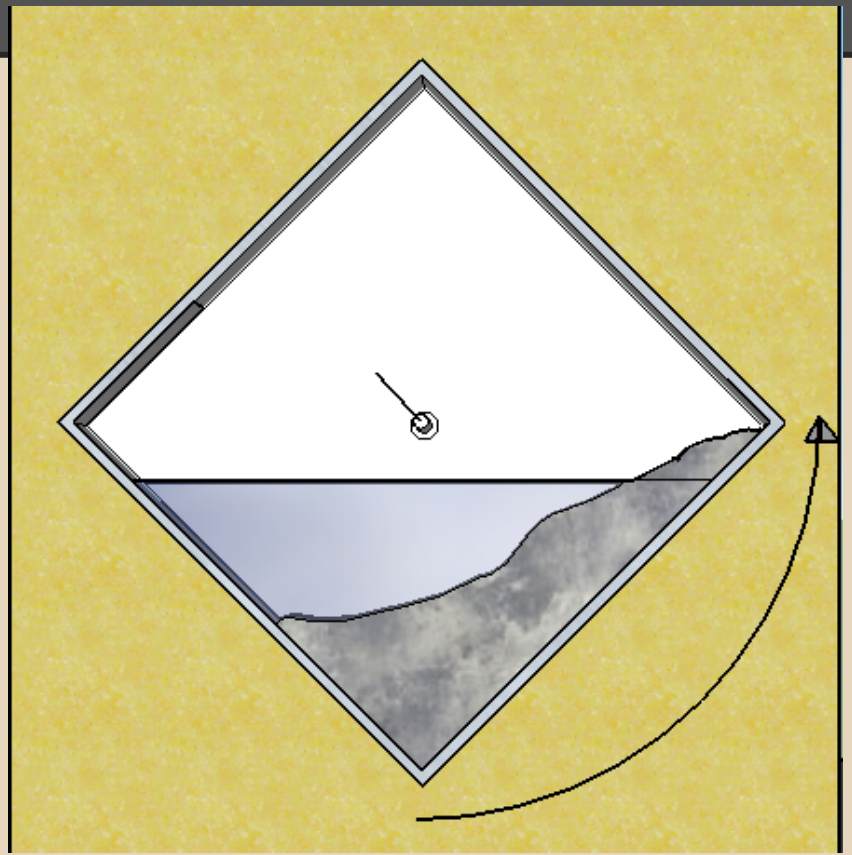
3D Fossil Printing

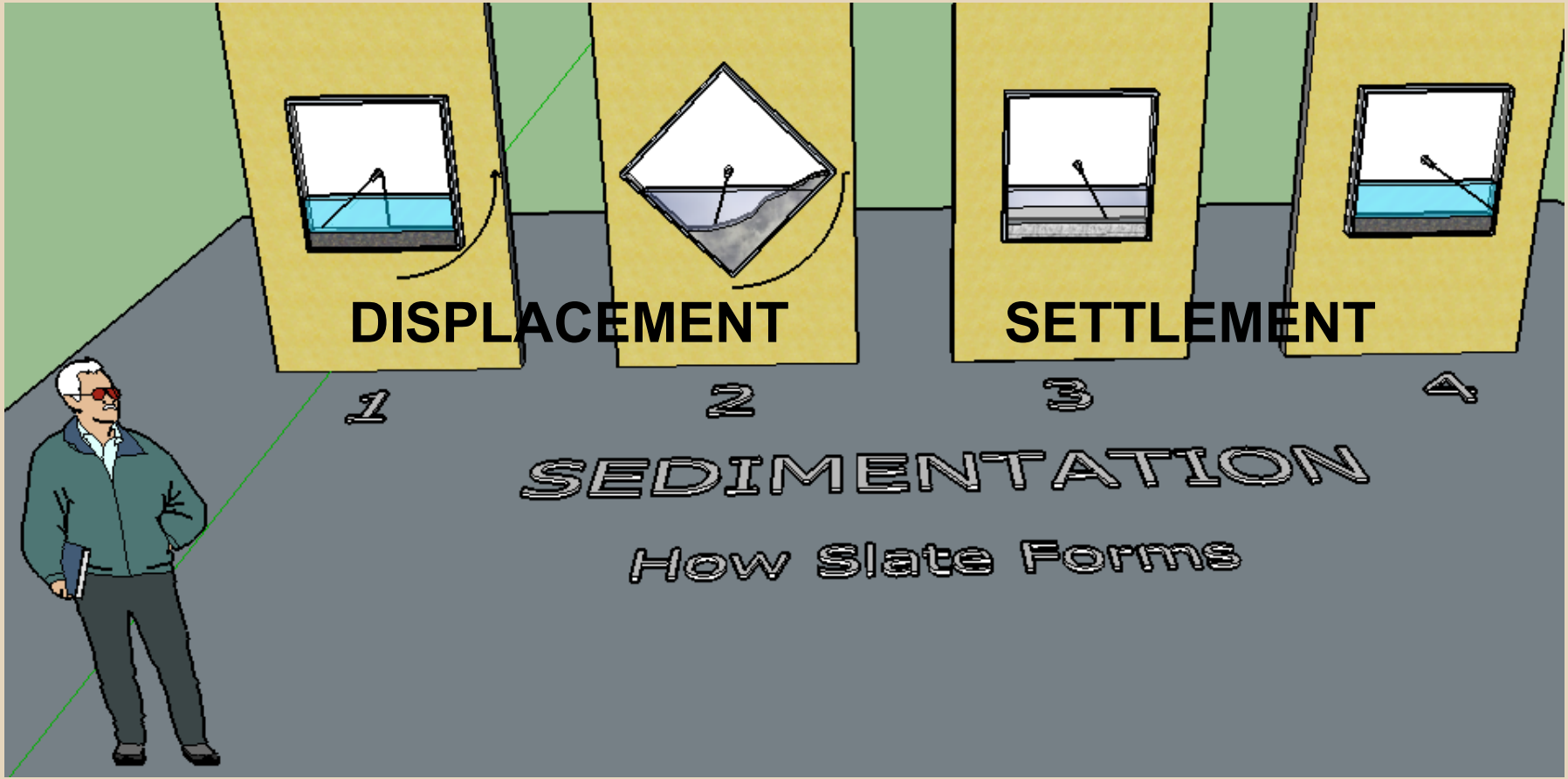
- Using online databases we can download the 3D data of scanned fossils similar to what we find in the formations of eastern PA and western NJ.
- Fossils can be printed using the plastic 3D printer in the Lafayette College Mechanical Engineering Department.
  - Price $5-10 per fossil depending on size
  - Resolution - 1/100 of an inch
  - Printed in durable plastic
- Fossils can be using the the exhibit for patrons to play with and make crayon “rubbings” to take home.

Fossil ammonite printed in plastic (1/100 mm resolution) (http://www.3ders.org/articles/20120327-innovative-digital-and-3d-printed-fossils-for-engaging-the-public-with-science.html)

Education Station Sediment Spinners

- Displays meant to show how sediments of different particle size settle differently, and to illustrate how sediment deposition occurs
- Different sediments to match different phases: clay for the Ordovician Deep phase, pebbles for the Silurian Drainage phase, and sand for the Devonian Seas phase
- Displays mounted in corresponding Education Stations in niches along outer wall of Playhouse
- Alternatively, could flip around a horizontal axis rather than rotating on the wall





Patrons can spin displays and watch as sediment settles upon displacement (illustration above shows one display at various stages in the process).

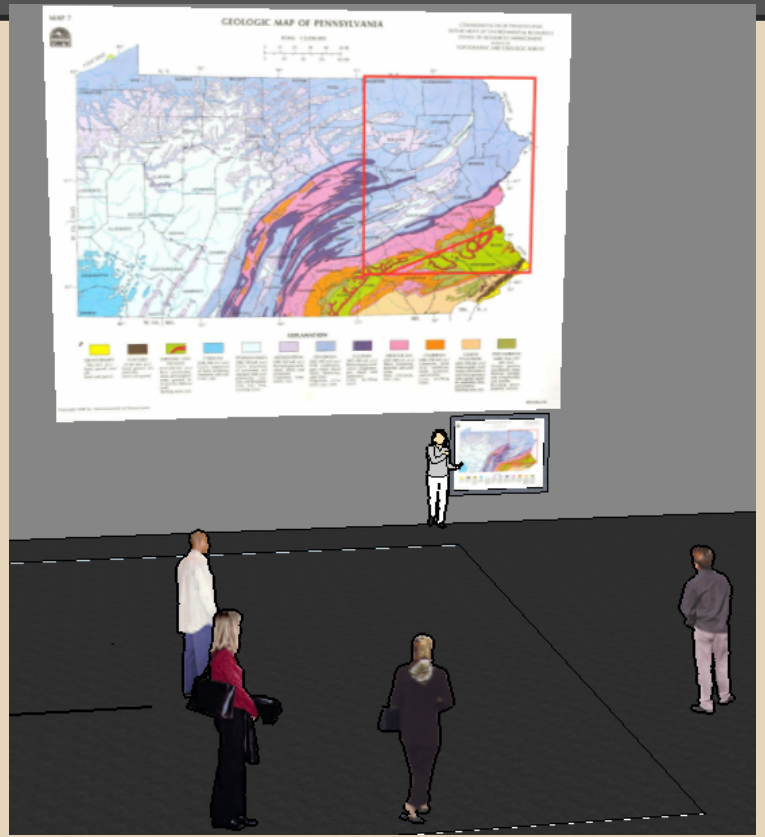
Anthropocene Component

- Panels on the wall of the structure will provide information about human impact on climate change and local and global biodiversity, as well as the the effect certain practices such as unsustainable waste removal and the use of fertilizers can affect our water systems.
- Mining in the Lehigh Valley
    - Exhibit how humans have used raw materials found in the rocks of the local area for materials and buildings.

The Anthropocene Component will be found on the wall just as patrons exit the Playhouse (http://anythingbutlogs.tumblr.com/page/4)

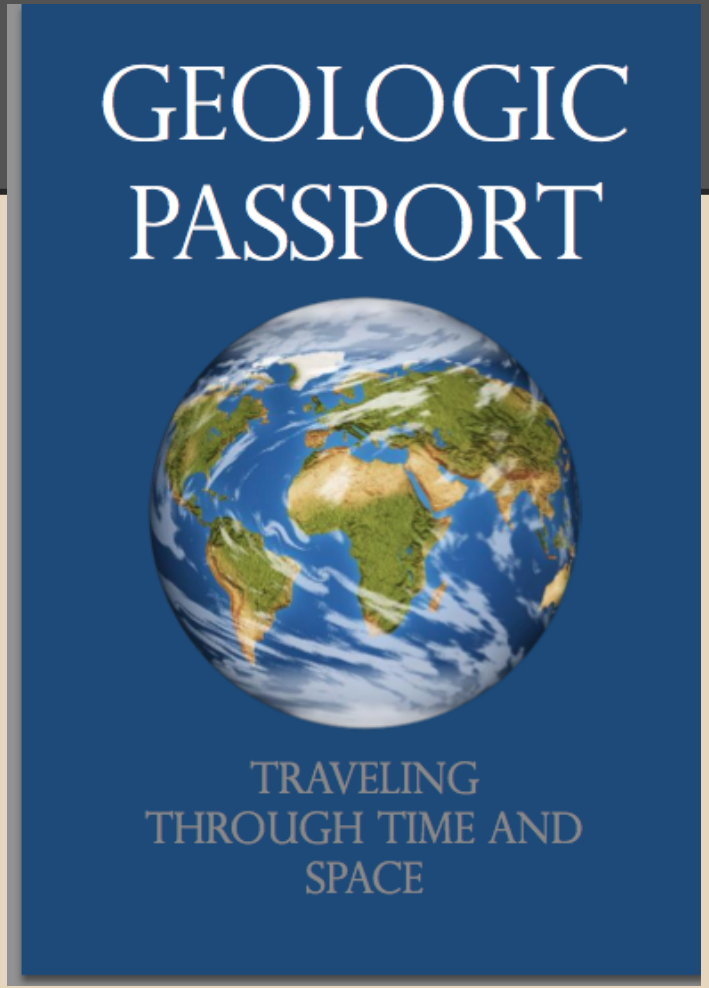
Geology Touch Screen and Projector

- Small touch screen display at “kid level” controls large projected display on wall (or side of playhouse)
- Patrons can manipulate and zoom in on areas of a geologic map of PA, find out what geologic phase their house, school, grandmother’s house, etc is in.
- Could create points of interest that show rock or fossil types from specific areas
- Possibility for tie-in with app

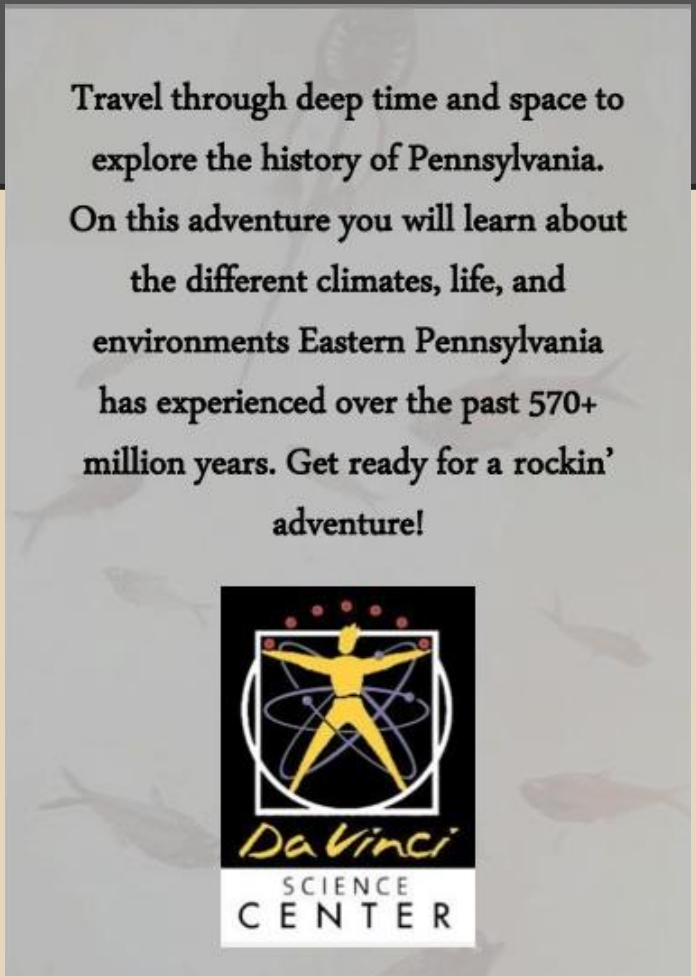


Geologic Passport

The Geologic Passport can be handed out to families with kids when they purchase a ticket. The passport will include a brief overview of the different geology phases of PA so the kids can follow along with the stations.



Geologic Passport (cont.)



The geologic passport will allow younger patrons to explore the museum and find stickers for the different geologic phases. This will be interactive activity for them and also will allow them to take home a keepsake with the Da Vinci logo hopefully encouraging future visits.

Cambrian Rise

570-500 MILLION YEARS AGO

Global sea levels rise in the Cambrian Period. On many ancient continental shelves beaches transgress onto land leaving sandstones and their wake and records of shallow marine conditions atop the sands. Some of the earliest forms of life, stromatolites are all around you. Stromatolites are algal colonies that form in mushroom-like structures. During this phase, you will not see any terrestrial life, only plants and animals in the water.

What happens when sea-level rises? Draw a new line on this cross-section to show the sea-level rising up to the red star.

If you were the red star, what kind of environment would you be in before the sea-level rose (terrestrial or beach)? _____

When the sea-level rose, what kind of environment are you in (terrestrial or beach)? _____

I visited the Cambrian Rise! I was there on _____

I put a point on the DaVinci Center Geology App: _____

Cambrian Rise

This is a sample of what one of the geology phases would like in the passport. There is a spot for the patron to put a sticker when they find that station in the geology exhibit and also a few questions for the patron to fill out!

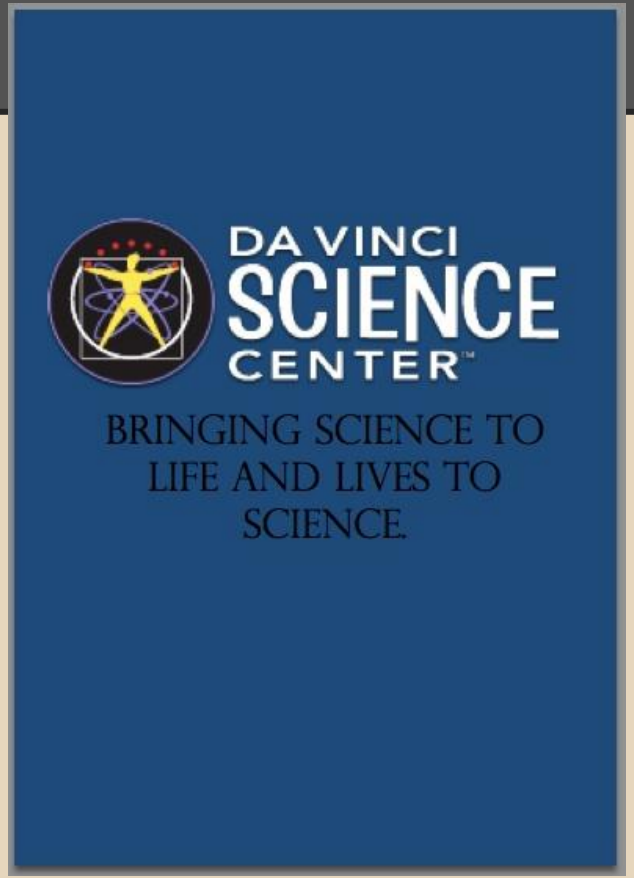
Geologic Passport (cont.)

The objective of the passport is to keep young patrons interested in the geology exhibit by giving them an incentive, to fill their passport with all of the stickers, to visit every station.

The passport ties together the various stations and also helps educate the younger visitors on the processes and differences between the geology phases.

The passport can also be connected to the app- by encouraging them to go to the app to find out more answers.

It’s all just one big scavenger hunt!



Purpose of the App

- Purpose:
  - to connect patrons to the geology of their local area
  - to further their understanding of geology
  - to promote independent learning
  - to encourage patrons to keep visiting the Center

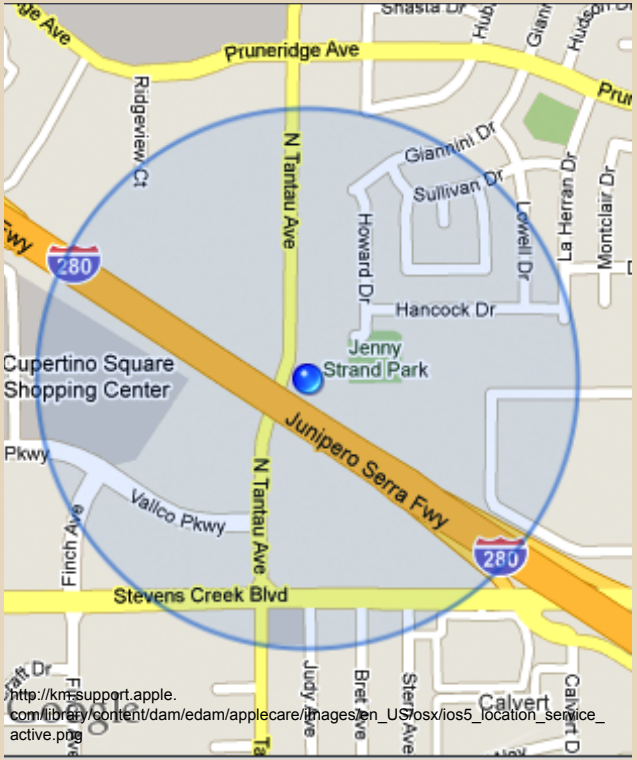
- Could create two versions of the app--one aimed towards teens and adults and one aimed towards school-age children so that entire families could benefit
- Have been using MIT App Inventor 2 which works for Android tablets and phones and PC computers

Possible App Features

- Geology-themed educational mini games
- An interactive map of local geologic points of interest to which users could add their own points of interest as they are discovered and check off which places they have visited
- Virtual badges or stickers that could be earned in minigames and by visiting local geologic POIs
- QR codes on info boards at POIs that would open information in the app

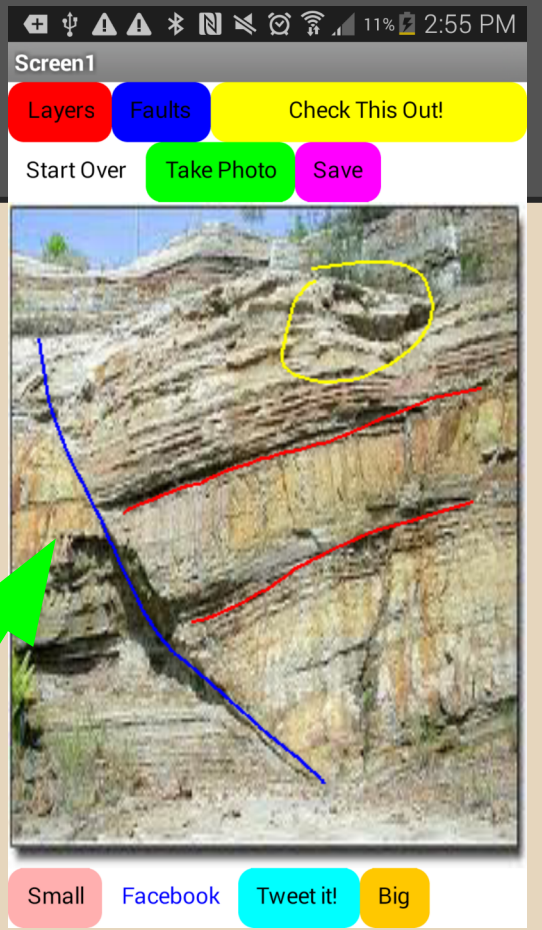
Possible App Features (cont.)

- Mini-quizzes to earn badges based on the information at each POI
- Badge “goals” to be reached that could correspond to a certificate or prize that could be redeemed at the Center to promote repeat visits
- Using location services to alert mobile users when they are near POIs
- Ways to share accomplishments/places visited on social media accounts to gain publicity for the app and the Center



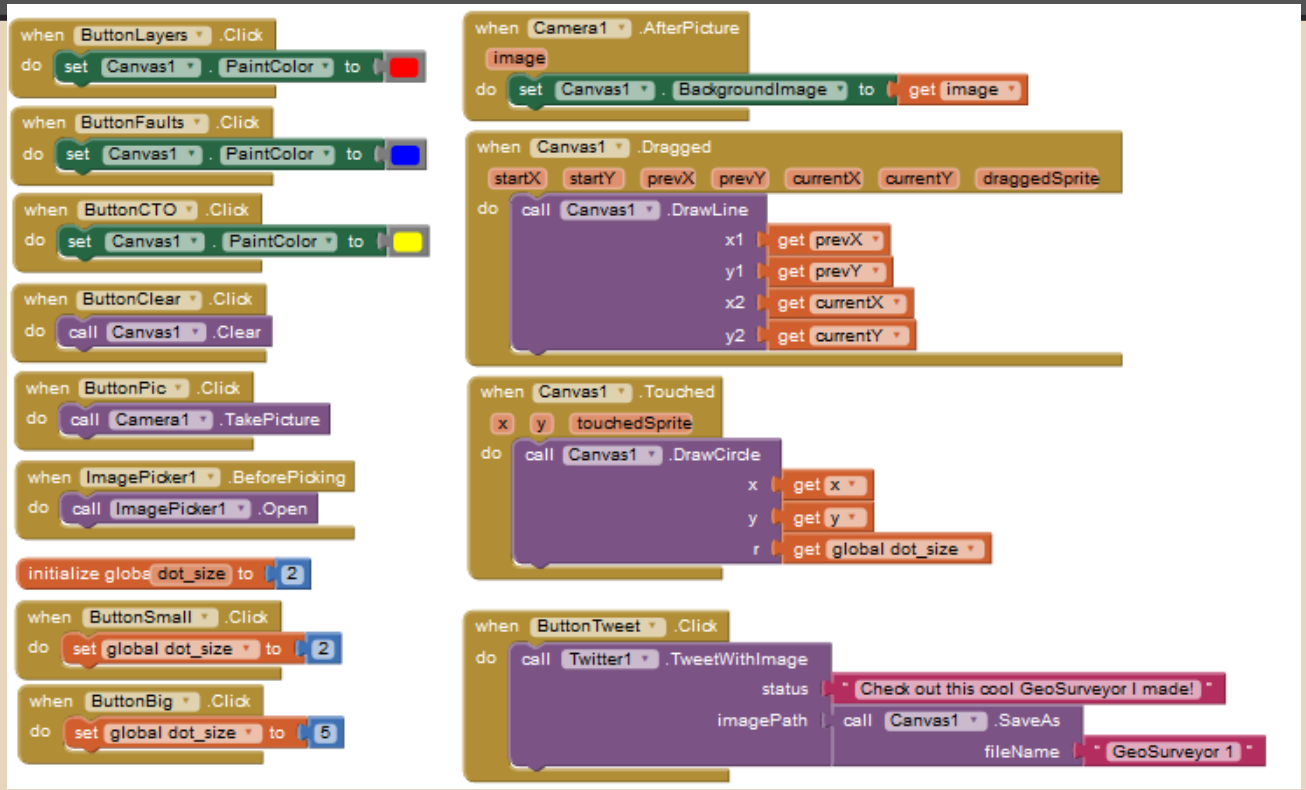
GeoSurveyor App Component (Rough Version)

- Aimed towards teens/adults
- Allows user to take picture (or choose from their device's gallery) of outcrop or other geologic structure and point out layers, faults, and other interesting features
- They can save the photo or share it via Twitter or Facebook
- Meant to teach how to identify basic features of outcrops



Code for GeoSurveyor App

- Used MIT App Inventor 2 block credit
- Could extend code to post to Facebook in order to connect to email, text, Tumblr, and other social media sites
- Could add zoom feature

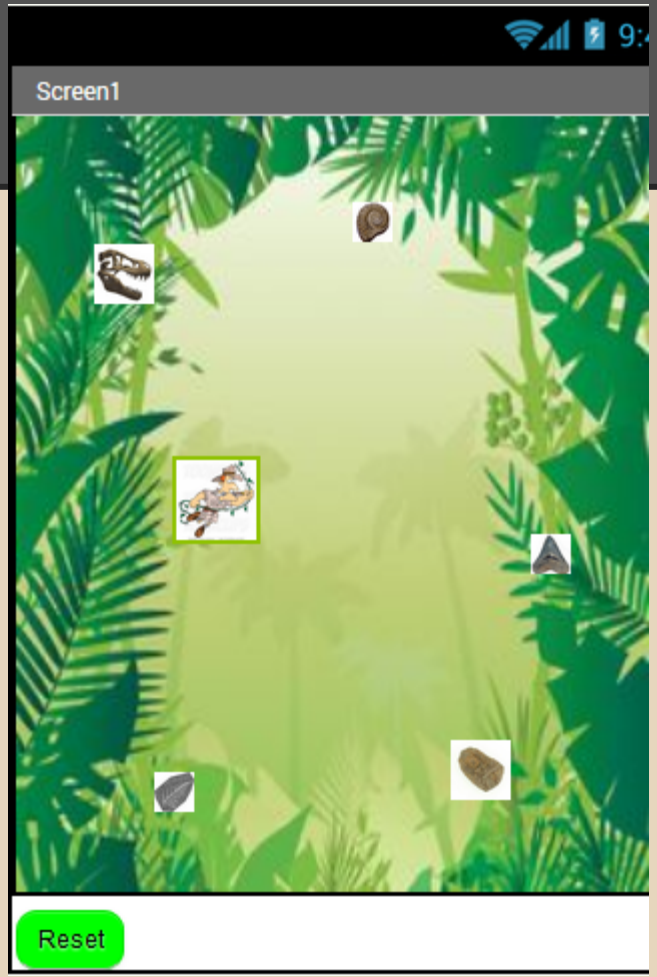


Fossil Hunter App (Rough Version)

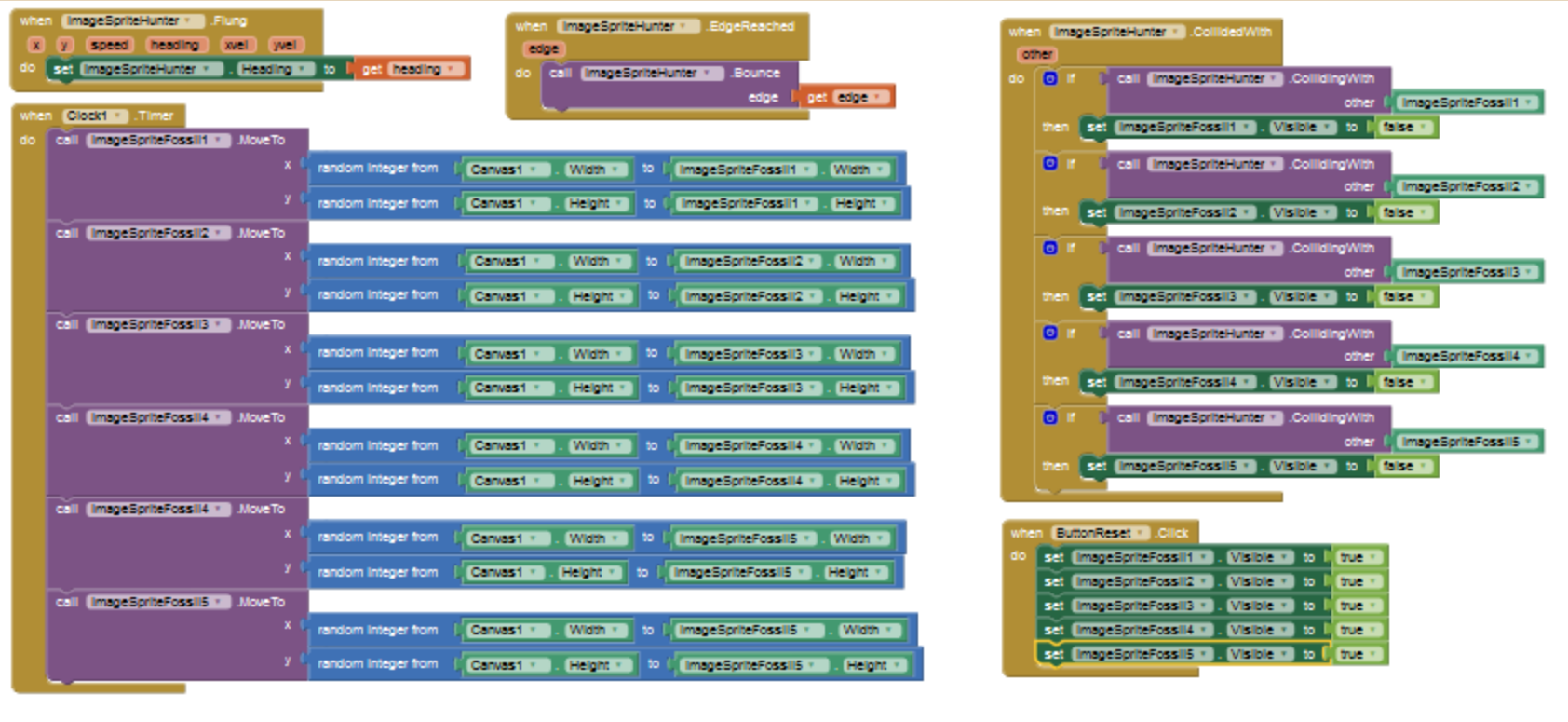
- For all ages but mostly kids
- Fling the “explorer” at the fossils (which are constantly changing location) in order to collect them all!
- Reset to start over
- Fossils could be changed to reflect local fossils of the geologic phase of the person’s location

Things We Could Add:

- Enemy “fossil thieves” to avoid
- Different levels of difficulty: faster fossils, increased number of “thieves”, etc.



Code for Fossil Hunter App



Moving Forward With the App

- We need to be mindful of people being able to add their own POIs if they are on private property or in an area that does not want to be publicized for traffic or other reasons.
- The app will need to be available for free download somewhere.
- May need to find someone to write code or translate existing code to work on iOS.

Future Directions

- After hearing feedback from our community partner we will alter our plans to incorporate suggestions of the Da Vinci Science Center staff.
- We will further develop the various exhibit stations with more detailed specifications (such as dimensions, building materials, where to get the necessary materials, pricing options, etc.).
- We will continue to develop ideas for apps and attempt to create rudimentary versions of those apps for presentation.
- After compiling the various versions of apps, we will either convert the app code into tablet and Apple versions ourselves or go to an external resource to complete this process.
- We will figure out various options to best market and distribute the app to Da Vinci patrons.
- We will assess if outside funding is needed and how to pursue it.
- We will...

Acknowledgments

- Dr. David Smith, Da Vinci Center Senior Director of Science and Strategic Initiatives
- Karen Knecht, Da Vinci Center Director of Education and Exhibits
- Lin Erickson, Da Vinci Center CEO and Executive Director
- The Da Vinci Center for allowing us to come visit their facility and for providing direction and suggestions
- Dr. Lawrence Malinconico, Lafayette Geology Department (consulting and advising)
- Dr. Dan Bauer and Dr. David Sunderlin (faculty facilitators)
- Dr. Jeff Helm of Lafayette Mechanical Engineering (3D printing)
- Dr. Susan Niles for her assistance with our training
- Judy Bauer for her support and assistance with our training