KEWEENAW BOULDER GARDEN
—A REVITALIZED KAME TERRACE ON CAMPUS, USED AS A TEACHING LABORATORY

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THEME OF THE BOULDER GARDEN:
GEOLOGICAL STORY OF THE KEWEENAW RIFT

BY SELECTING ABOUT 40 BOULDERS, WE CAN PUT IN ONE PLACE A DETAILED RECORD OF EVENTS THAT HAPPENED BETWEEN ABOUT 1096 AND 1070 MILLION YEARS AGO TO SHAPE THE PENINSULA AND LAKE SUPERIOR.
LOCATION

ON THE MICHIGAN TECH CAMPUS IN HOUGHTON, MICHIGAN IN THE UPPER PENINSULA.

IN THE CENTER OF THE MAIN CAMPUS BETWEEN DILLMAN AND FISHER HALLS. X MARKS THE SPOT.
WHY A BOULDER GARDEN IN THIS PLACE?

--GEOLOGICALLY-- BECAUSE THIS IS EXACTLY WHERE BOULDERS WOULD BE EXPECTED TO OCCUR, AND PROBABLY DID OCCUR BEFORE THE CAMPUS WAS DEVELOPED. THUS WE HAVE RESTORED NATURAL ORDER.

--EDUCATIONALLY-- BECAUSE IT IS IN A PLACE WHERE HUNDREDS OF PEOPLE CAN INTERACT WITH IT EVERY HOUR DURING THE DAY. AND WHERE CLASS CAN BE EASILY HELD.
THESE BOULDERS ARE LIKE OUTCROPS, THEY CONTAIN AS MUCH INFORMATION AS MANY OUTCROPS AND BECAUSE THEY WERE SMOOTHED BY GLACIAL ACTION, IT IS EASY TO “READ” THEM (TO SEE THEIR DETAILS). BY CAREFULLY CHOOSING THEM AND THEN MOVING THEM TOGETHER, WE HAVE BEENABLE TO ASSEMBLE AN AMAZING TEACHING RESOURCE, WHERE STUDENTS MAY SHARPEN THEIR SKILLS AT READING THE ROCKS.

Some ways to use the boulder garden in geological classes:

Rock identification
Mineral identification
Which way is up?
Understanding Solidification
Sedimentary rock structures
Assembling a rift
THE MOST OBVIOUS PROPERTIES OF THE AMYGDULE MINERALS CAN BE USED TO IDENTIFY THEM. As an initial exercise in mineral identification, this is an excellent confidence builder, with earth scientists, and it opens up a field focused hobby for collecting in the Keweenaw.

What’s next? After mastering the mineral identifications in the boulders, students can also look at amygdular minerals to study the order that minerals deposited in those vesicles

<table>
<thead>
<tr>
<th>Name</th>
<th>Moh’s hardness</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analcime r</td>
<td>5-5.5</td>
<td>Colorless, white</td>
</tr>
<tr>
<td>Barite c</td>
<td>3-3.5</td>
<td>white</td>
</tr>
<tr>
<td>Calcite a</td>
<td>3</td>
<td>Colorless, white, pink</td>
</tr>
<tr>
<td>Chlorite a</td>
<td>2-2.5</td>
<td>Olive-dark gr, black</td>
</tr>
<tr>
<td>Chrysocolla c</td>
<td>2.5-3.5</td>
<td>Blue-Green</td>
</tr>
<tr>
<td>Copper r</td>
<td>2.5-3</td>
<td>Copper, gr-black coatings</td>
</tr>
<tr>
<td>Corrensite a</td>
<td>1-2</td>
<td>Dk-green to black</td>
</tr>
<tr>
<td>Datolite r</td>
<td>5.5</td>
<td>White, pink, yellow</td>
</tr>
<tr>
<td>Epidote c</td>
<td>7</td>
<td>Pistachio green</td>
</tr>
<tr>
<td>Laumontite c</td>
<td>3.5-4</td>
<td>White-brown, yellow, pink</td>
</tr>
<tr>
<td>Microcline r</td>
<td>6</td>
<td>Flesh pink</td>
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<tr>
<td>Mohawkite r</td>
<td>3-3.5</td>
<td>Metallic brassy to gray</td>
</tr>
<tr>
<td>Natrolite r</td>
<td>5.5-6</td>
<td>Colorless-white</td>
</tr>
<tr>
<td>Prehnite r</td>
<td>6-6.5</td>
<td>Light green-pink</td>
</tr>
<tr>
<td>Pumpellyite c</td>
<td>5.5</td>
<td>Green</td>
</tr>
<tr>
<td>Quartz c</td>
<td>7</td>
<td>Colorless, varied</td>
</tr>
<tr>
<td>Saponite r</td>
<td>1.5-2</td>
<td>Light green, yellow green</td>
</tr>
<tr>
<td>Thompsonite r</td>
<td>5-5.5</td>
<td>Pink, white</td>
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</table>
UNDERSTANDING SOLIDIFICATION OF LAVA

There is a huge variety of textures shown by the basalt boulders which make up about 3/4 of the whole garden (by design). The Keewenaw lavas ponded inside the rift valley and many of them were very thick, so that they took as long as 1000 years to solidify. Because of this they developed a variety of spectacular solidification features, including vesicles, segregation cylinders, columnar jointing, dolerite or pegmatite horizons, granophyres and others. One family of boulders shows the solidification features in an unusually complete way. Basalt is basically made up of two minerals: pyroxene and feldspar. Keewenawan basalts commonly have obvious ophitic textures where pyroxene is large and feldspar are tiny. This makes for a distinct growth pattern which strongly influences the overall rock properties. It was the long solidification that led to ophitic basalt, by making a moderate, long-lived undercooling which led to accelerated growth rates for pyroxene and accelerated nucleation rates for feldspar.
Lava flows form crusts where heat is lost. They cool from the top and bottom and the middle stays liquid (black layers, below) much longer. They develop structure that allows us to detect what part of the flow each boulder reflects.

**WHICH WAY IS UP?**

- Although the boulders no longer reflect up and down with respect to the Earth's surface, for which of the boulders in the garden, can you infer the direction of up and down before their movement? Explain how for each.

- Considering the various basalt boulders, where would you place them within the expected structural elements of a solidified lava flow?
The boulders stand up proudly...

Important helpers
The boulders stand up proudly...

Important helpers

Families

Aesthetics

Art
The boulders stand up proudly...

Important helpers

Arrangement of Boulders

Aliens

Multiracial family

Orphan

Families Aesthetics Art

Legend

- Erratic
- Erratic small
- Basalt
- Basalt small
- Amygdaloid
- Amygdaloid small
- Ophite
- Ophite small
- Rhyolite
- Conglomerate
- Conglomerate small
- Sandstone
- Sandstone small

- Big tree
- Med tree
- Small Tree
- Lightpost
- Fire hydrant
- Campus Map

Michigan Tech’s Boulder Garden
aka: The Rose Garden

Ashok
Geophysics MS, Artist
Engineer

Lynn
Landscape Architect
PART OF THE GOAL OF A BOULDER GARDEN IS TO CREATE A FAVORABLE EDUCATION ENVIRONMENT BY MAKING AN ATMOSPHERE OF POSITIVE LEARNING. SOME PLACES, INCLUDING MICHIGAN’S KEWEENAW ALREADY HAVE A “SENSE OF PLACE”. BUT IT MAY BE POSSIBLE TO CREATE ONE THROUGH A CONSCIOUS PROCESS, WHICH INVOLVES ART AND DESIGN.

www.geo.mtu.edu/~raman/SilverI/Boulder_Garden/