2011 GSA Annual Meeting in Minneapolis

Geoscience Education I: Field and Place Based Approaches to Geoscience Education
Minneapolis Convention Center: Room 208AB
11-11:15 am, Sunday, 9 October 2011

KEWEENAW BOULDER GARDEN

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

ROSE, William I., Geological Engineering & Sciences, Michigan Technological Univ, 1400 Townsend Dr, Houghton, MI 49931, raman@mtu.edu

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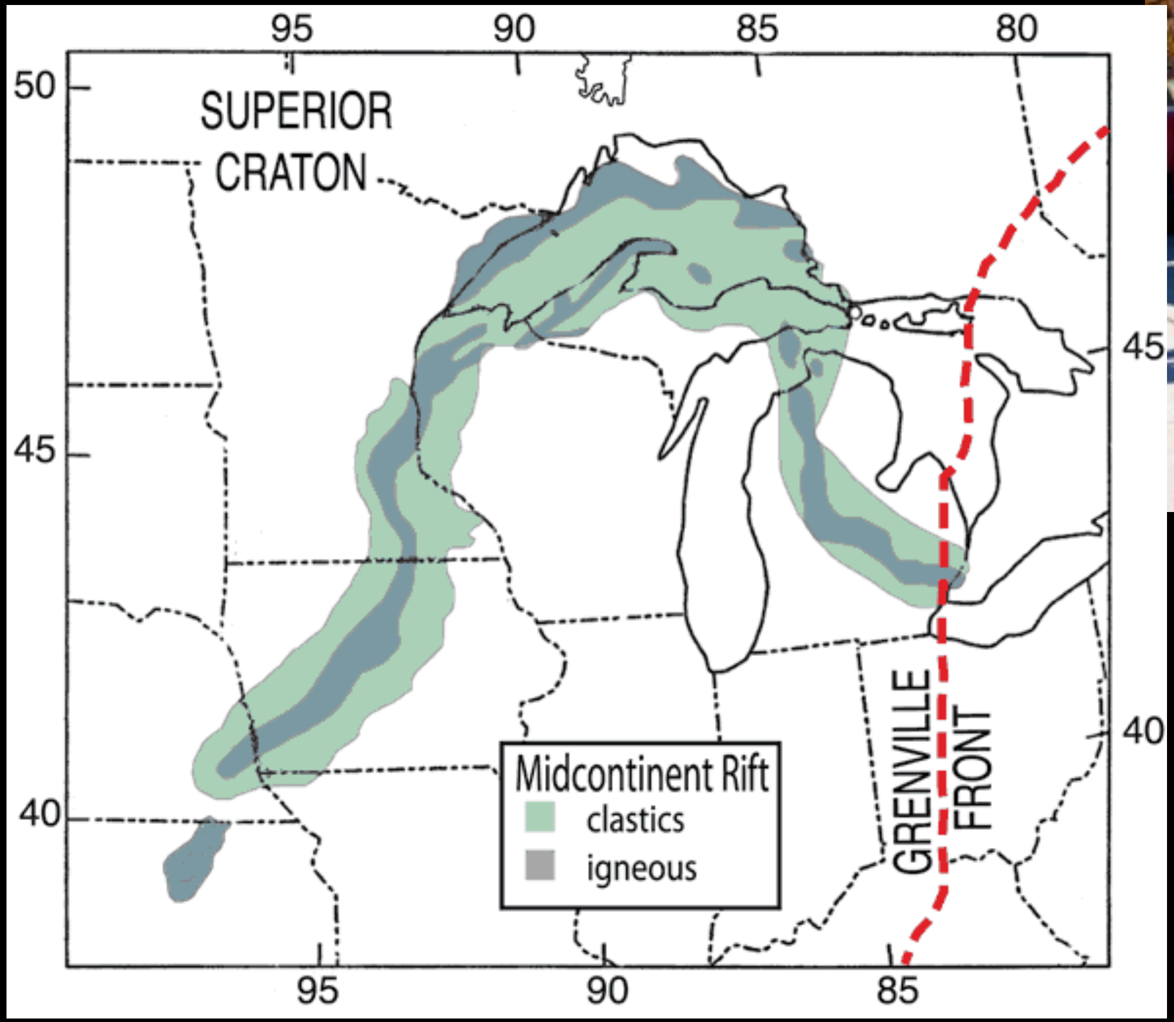
THEME OF THE BOULDER GARDEN: GEOLOGICAL STORY OF THE KEWEENAW RIFT

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.



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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.

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THE SITE

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.

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TEACHING WITH BOULDERS

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 BEEN ABLE 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

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MINERALS IN AMYGDULES, MICHIGAN'S KEWEENAW

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 focussed hobby for collecting in the Keweenaw.

Name *abundance*	Moh's hardness	Color
Analcime *r*	5-5.5	Colorless, white
Barite *c*	3-3.5	white
Calcite *a*	3	Colorless, white, pink
Chlorite *a*	2-2.5	Olive-dark gr, black
Chrysocolla *c*	2.5-3.5	Blue-Green
Copper *r*	2.5-3	Copper, gr-black coatings
Corrensite *a*	1-2	Dk-green to black
Datolite *r*	5.5	White, pink, yellow
Epidote *c*	7	Pistachio green
Laumontite *c*	3.5-4	White-brown, yellow, pink
Microcline *r*	6	Flesh pink
Mohawkite r	3-3.5	Metallic brassy to gray
Natrolite *r*	5.5-6	Colorless-white
Prehnite *r*	6-6.5	Light green-pink
Pumpellyite *c*	5.5	Green
Quartz *c*	7	Colorless, varied
Saponite *r*	1.5-2	Light green, yellow green
Thompsonite *r*	5-5.5	Pink, white

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

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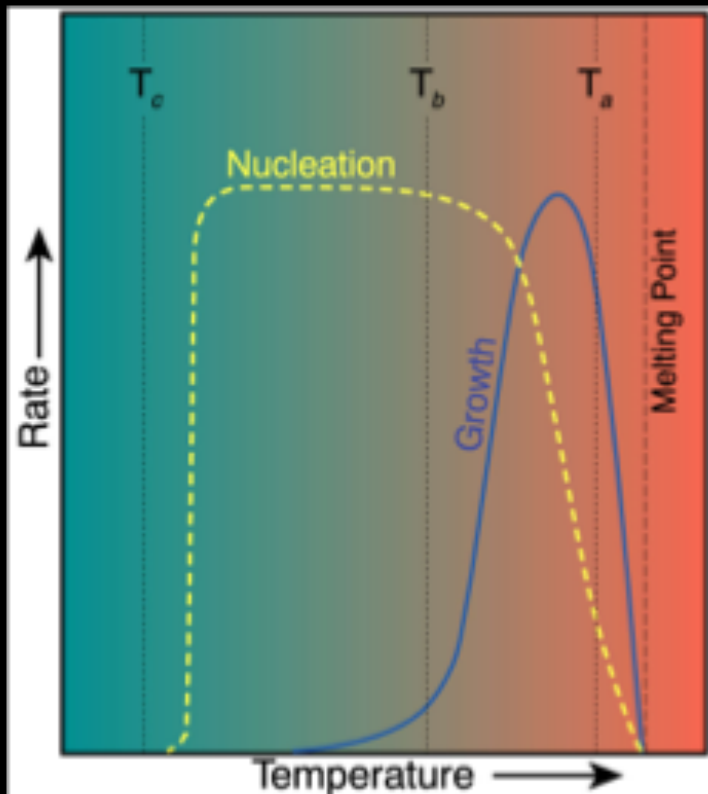
UNDERSTANDING SOLIDIFICATION OF LAVA

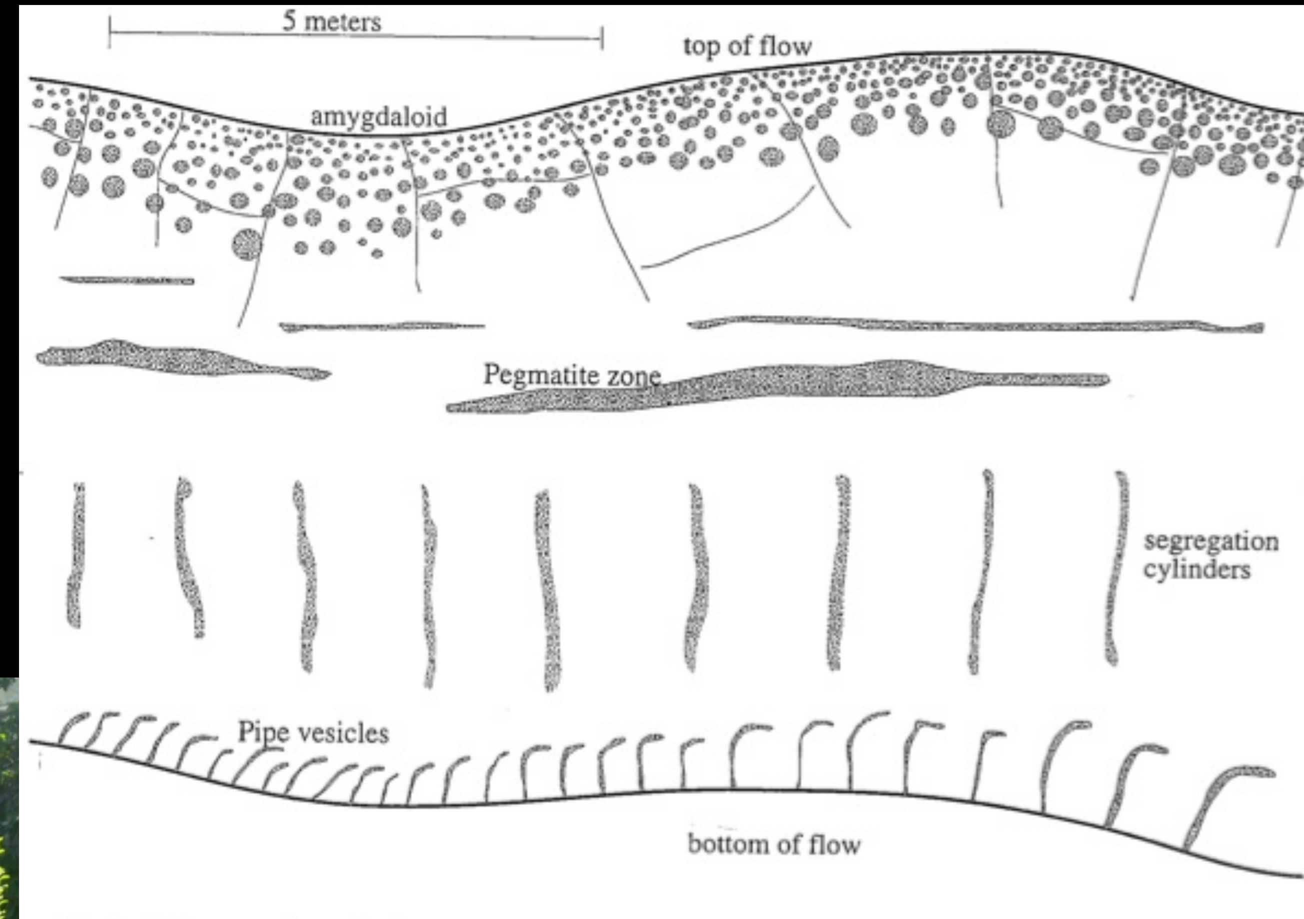


THERE IS A HUGE VARIETY OF TEXTURES SHOWN BY THE BASALT BOULDERS WHICH MAKE UP ABOUT 3/4 OF THE WHOLE GARDEN (BY DESIGN). THE KEWEENAW LAVAS PONDED INSIDE THE RIFT VALLEY AND MANY OF THEM WERE VERY THICK, SO THAT THEY TOOK AS LONG AS 1000 YEARS TO SOLIDIFY. BECAUSE OF THIS THEY DEVELOPED A VARIETY OF 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. KEWEENAWAN 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.

WHICH WAY IS UP?

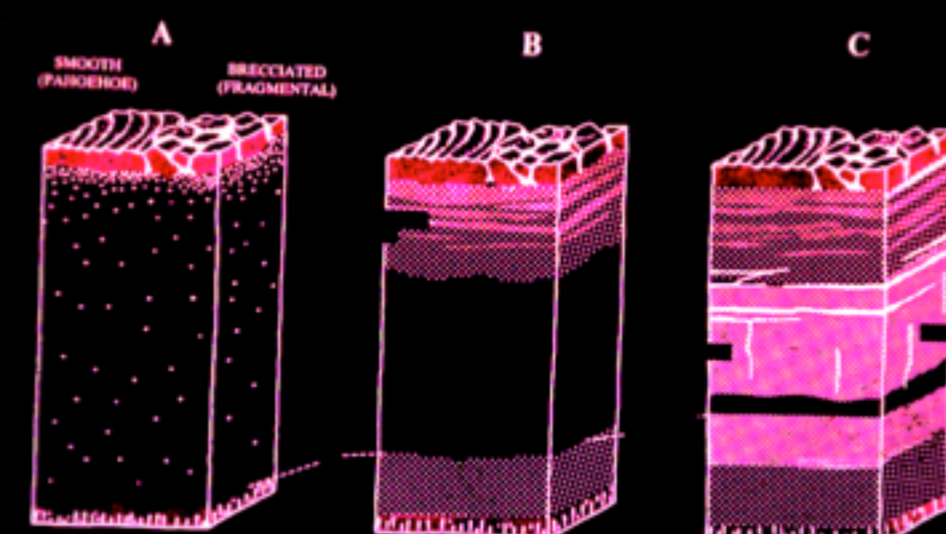
- ALTHOUGH THE BOULDERS NO LONGER REFLECT UP AND DOWN WITH RESPECT TO THE EARTH'S SURFACE, FOR WHICH OF THE BOULDERS IN THE GARDEN, CAN YOU INFER THE DIRECTION OF UP AND DOWN BEFORE THEIR MOVEMENT? EXPLAIN HOW FOR EACH.

- CONSIDERING THE VARIOUS BASALT BOULDERS, WHERE WOULD YOU PLACE THEM WITHIN THE EXPECTED STRUCTURAL ELEMENTS OF A SOLIDIFIED LAVA FLOW?



Idealized Cross section of a Keweenawan Basalt flow, showing sites for secondary minerals.

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.



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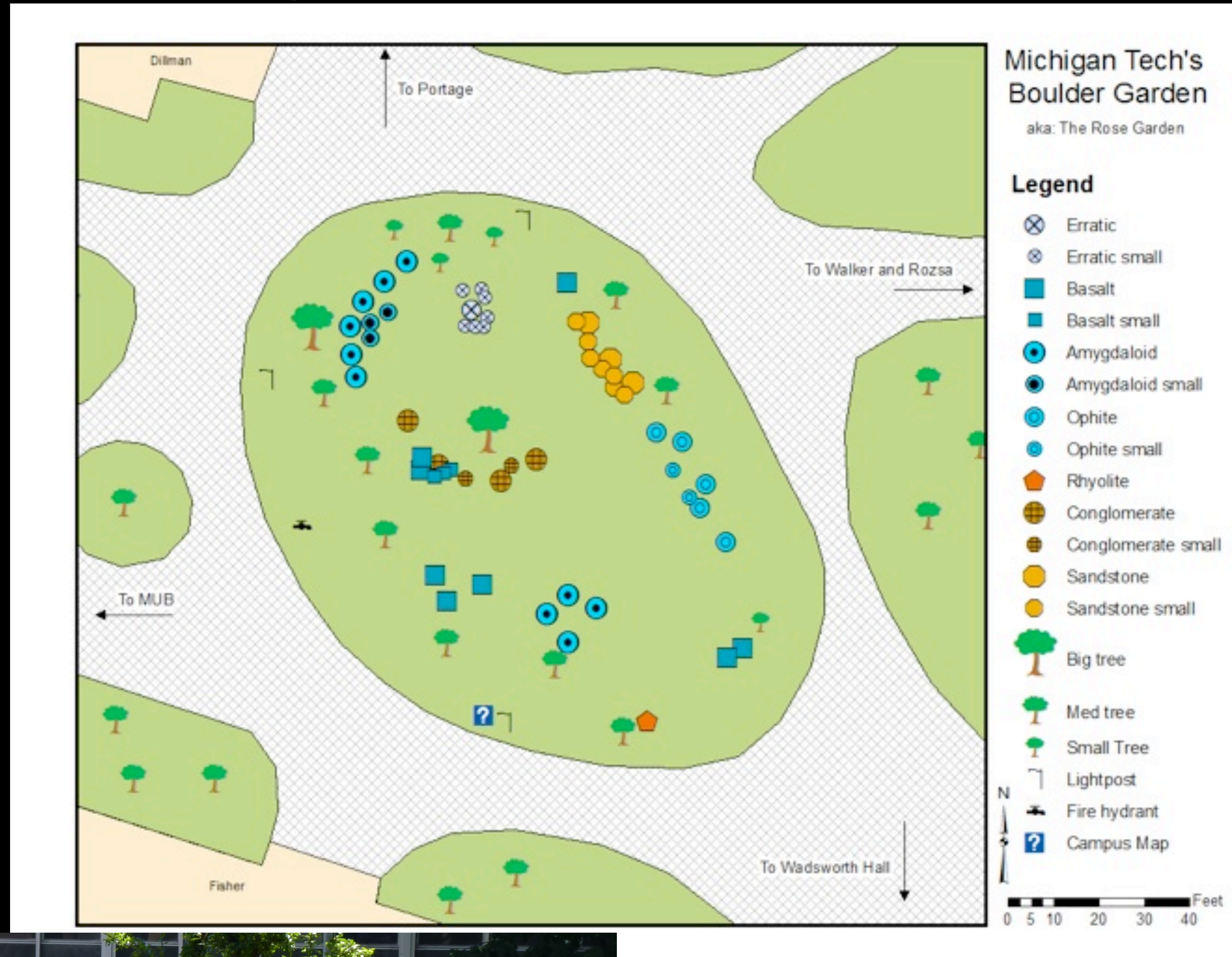
Arrangement of Boulders

Ashok
Geophysics MS,
Artist
Engineer

Lynn
Landscape
Architect

Important helpers



The boulders stand up proudly...

Families
Aesthetics
Art

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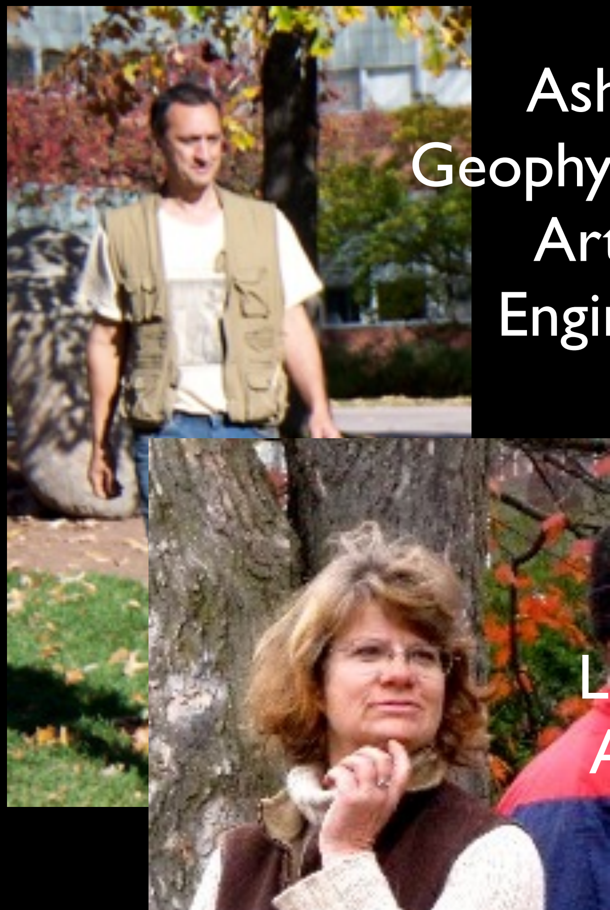

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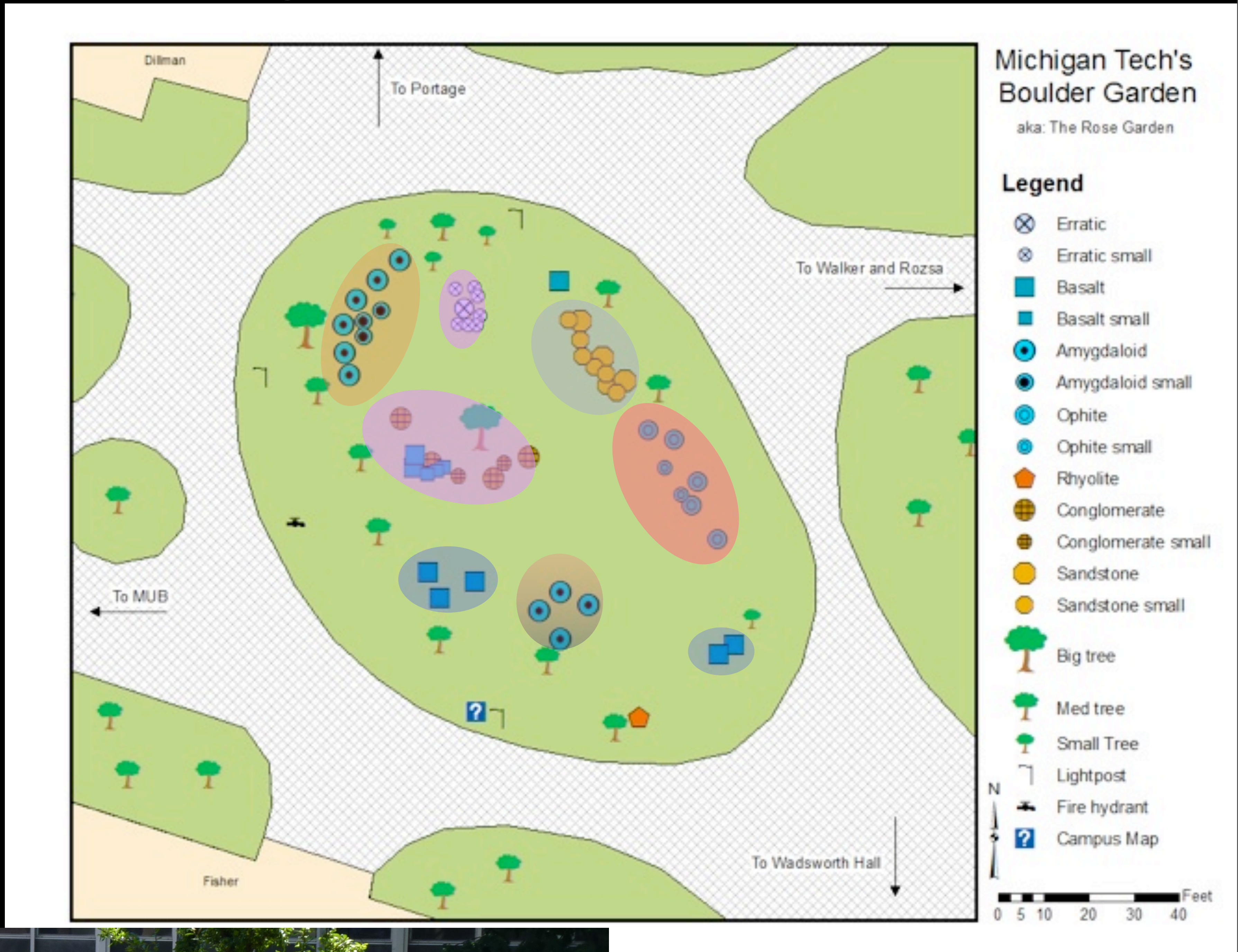

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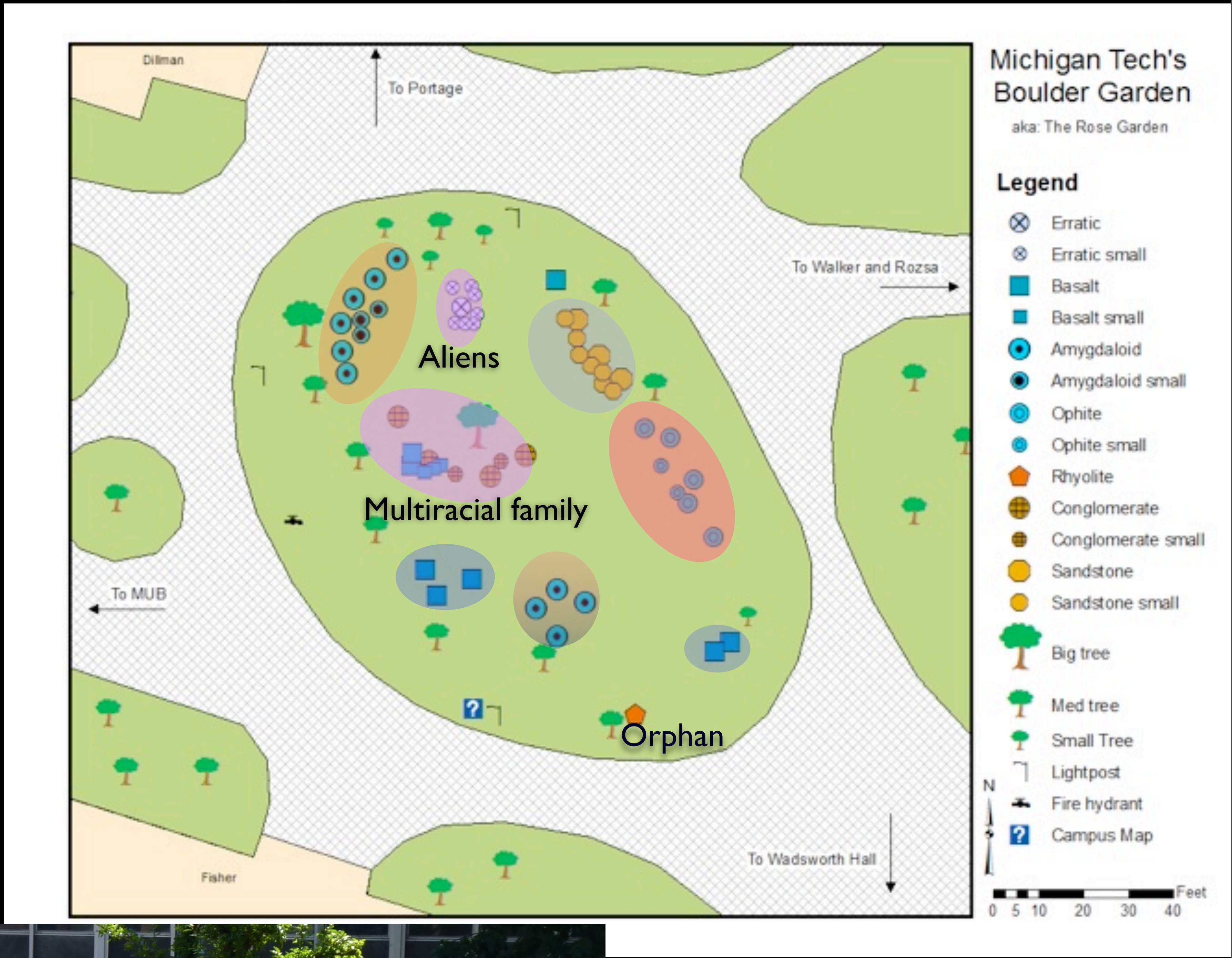

The boulders stand up proudly...

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SENSE OF PLACE

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/

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