WALK ON MARS: PROGRAM OVERVIEW AND INITIAL LESSONS LEARNED

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Abstract #1615

INTRODUCTION

The Thermal Emission Imaging System (THEMIS)[1] onboard the 2001 Mars Odyssey spacecraft has acquired over 230,000 infrared images of the Martian surface at a resolution of 100 m/pixel since the start of science operations in February 2002. A global map was previously developed by mosaicking together over 24,000 high-quality full-resolution THEMIS daytime infrared images[2] and colorizing it using MOLA[3] elevation data. Although the resulting map has been extremely valuable for scientific and mission operations applications, it has been difficult to communicate this value to students, citizen scientists and the general public, since their interactions with the map have been limited to computer-based geographic information system (GIS) interfaces.

We determined that in order to better communicate the value and importance of mapping the entire Martian surface at 100 m/pixel resolution, people need to be able to physically interact with the map and experience its full scale. Therefore, the THEMIS Day IR with Colorized MOLA Elevation Global Map has been printed on a 95ft x 47.5ft vinyl mat, which allows observers to walk across the map and experience it at approximately full resolution (printed at ~200 pixels per inch).

MAP DETAILS

The size of the map (95ft x 47.5ft) was chosen to fit on a standard high school basketball court (Figure 1), so that a large number of schools will have a sufficiently large indoor surface on which to display the map for education and public outreach events. Due to the vinyl material used, the map must be displayed on smooth or carpeted hard surfaces in order to avoid damage. Displaying the map on uneven or rough surfaces (ex: concrete) could cause damage to the vinyl mat and/or the printed surface.

A simple cylindrical projection centered on the prime meridian was chosen for the map because it maximizes use of the printed surface, which is inherently rectangular, while avoiding the division of any major surface regions between the two ends of the map.

In addition to the simple cylindrical map, there are two smaller (15ft x 15ft) polar stereographic maps centered at each pole, which will be displayed along with the simple cylindrical map when sufficient additional space is available (Figure 2). These smaller maps are designed to give participants a better understanding of the Martian poles, which are significantly distorted in the simple cylindrical map. Both polar maps use custom MOLA elevation color scales in order to better emphasize the topography of the polar deposits.

The vinyl base material and large-format printing process selected for the map have been proven to be wear-resistant in similar applications by the National Geographic Society's Giant Maps program[4] and the Arizona Geographic Alliance's Giant Arizona Floor Map program[5]. For events where viewers are able to walk across the map, they will be required to wear only socks or similarly soft foot coverings, to prevent scratches on the printed surface.

ACTIVITY #1: Walk on Mars

The "Walk on Mars" activity will be primarily used for public outreach events where relatively large numbers of participants are expected and multiple Mars experts are available to explain the map. The Mars experts will be stationed on the map at major topographic features (Olympus Mons, Valles Marineris, etc) and important landmarks (Gale Crater, Gusev Crater, etc) and will answer questions as participants walk between the stations. This will give participants the opportunity to freely walk across the map and stop at the locations they find interesting.

This activity was used at the Arizona State University Open House on February 24th, 2018. Approximately 300 open house participants walked on the map, ranging in age from toddlers to senior citizens. (Figure 3)

Lessons Learned:

- Four to six people are needed to unroll and re-roll the map
- Children would benefit from a more structured activity
- Adults should be required to accompany children at all times
- Bright gym lights can cause glare on the map
- Polarized sunglasses significantly cut down on the glare

Figure 3: Picture from the "Walk on Mars" Test Event at the ASU Open House (February 2018)

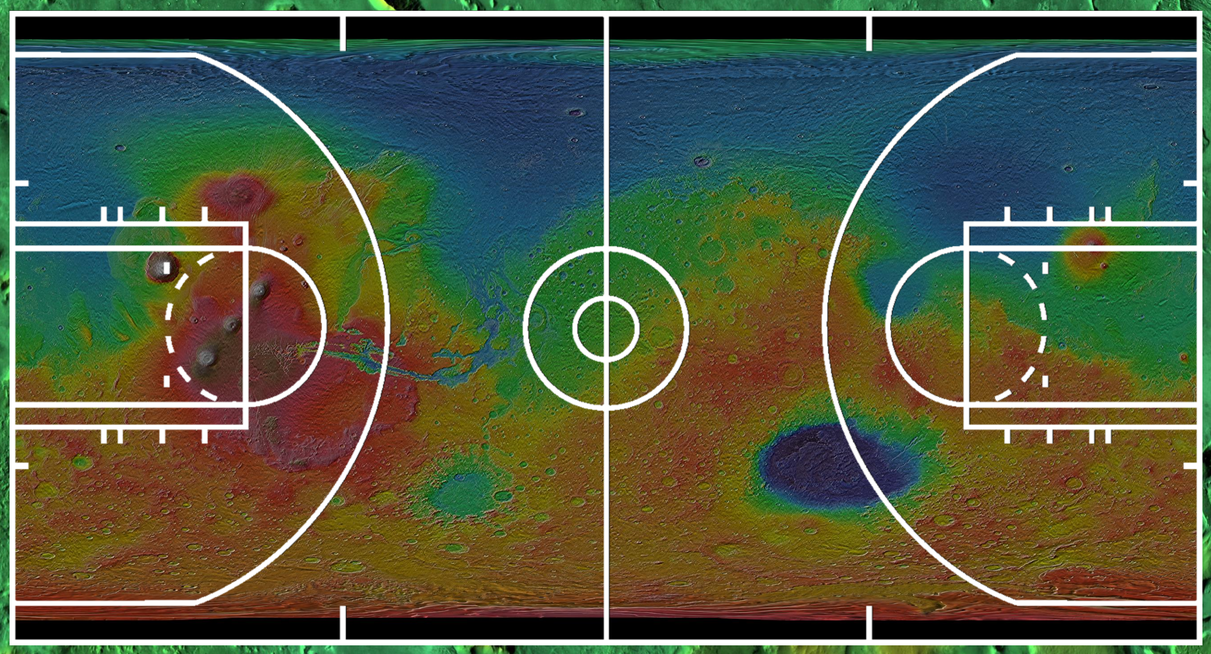

Figure 1: THEMIS Day IR with Colorized MOLA Elevation Global Map (Simple Cylindrical Projection) with Basketball Court Markings for Scale

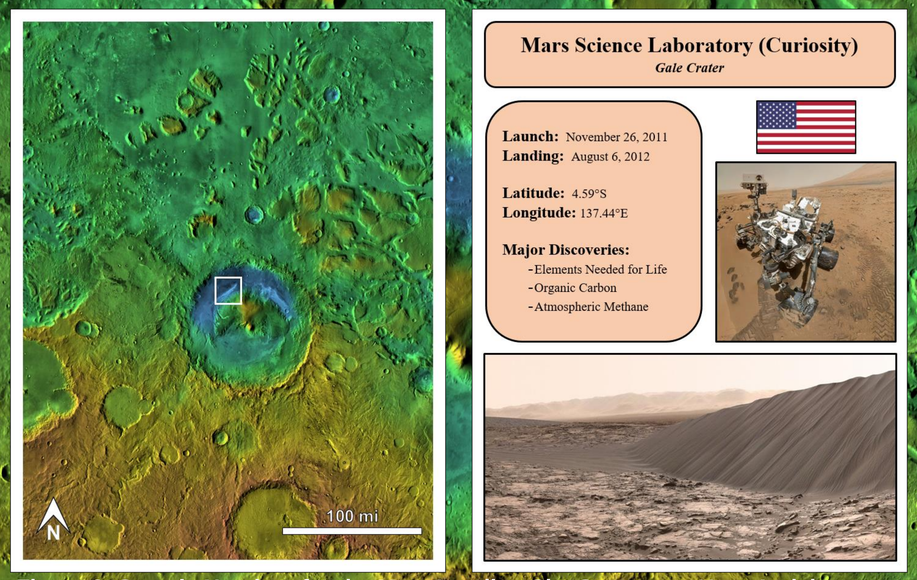

Figure 2: Sample Handout for the Mars Landing Site Scavenger Hunt Activity

Figure 4: Pictures from the "Tour of Mars" and "Mars Landing Site Scavenger Hunt" Test Event at a Local Elementary School (March 2018)

ACTIVITY #2: Tour of Mars

The "Tour of Mars" activity will be primarily used for education events where small groups of participants are expected and at least one Mars expert is available to explain the map. The Mars expert will guide the small groups around the map, stopping at major topographic features (Olympus Mons, Valles Marineris, etc) and important landmarks (Gale Crater, Gusev Crater, etc) in order to explain them. This will give participants the opportunity to walk across the entire map in a structured format and learn about important locations during a time-limited tour period.

This activity was used at Ss. Simon and Jude Elementary School in Phoenix, AZ on March 13th, 2018. Approximately 200 students from grades 4-8 walked on the map and participated in the Mars landing site scavenger hunt activity. (Figure 4)

Lessons Learned:

- Students as young as 4th grade showed active interest in the map
  - Lower grades could possibly learn from the map as well
- Crutches do not damage the map, if used very carefully
- Teachers gave the students an "Introduction to Mars" lesson the day before, which aided their understanding of the map
- Teachers required students to take pictures of three interesting locations, which they will write about in a follow-up assignment
- The scavenger hunt activity was a good compliment to the "Tour"

ACTIVITY #3: Landing Site Scavenger Hunt

After the first test event, a Mars landing site scavenger hunt activity was developed to provide children with a more structured way to explore the map. Information sheets (8.5"x11") were created for each of the 13 spacecraft that have landed on Mars, as well as an additional sheet for the InSIGHT mission. The front has a portion of the map with the landing site in the center (Figure 2a) and the backside has information and pictures from the mission (Figure 2b).

During the "Tour of Mars" test event, each class was broken into 14 groups and each group was given one landing site to find, as well as a colored cone corresponding to the outcome of the mission (successful, failed, future). Once all the landing sites had been located, students were told to raise their hands based on the mission's country of origin (USA,ESA, USSR). They were then asked to raise their hands based on the color of their cones, which is when they discovered which missions succeeded and which missions failed. The students were then asked to gather around the "future mission" cone, and they were told about the upcoming InSIGHT mission.

Lessons Learned:

- The activity kept the students very engaged
- The activity is a great lesson about latitude and longitude
- During the "Walk on Mars" events, we should have binders of the entire set of handouts, so people can hunt for all 14 landing sites on their own.

FUTURE WORK

Now that the initial test events have been carried out successfully, we are ready to use the map for future "operational" events. The map will be displayed at the Lunar and Planetary Science Conference on Wednesday, March 21st, 2018. The elementary school we visited has also requested that we return during their annual science fair, so that students can bring their parents to walk on the map.

We will also create a website for the map, which will include basic facts about the map, basic Mars lessons that teachers can use to prepare their students, and a request form for schools interested in having the map displayed at their school.

We have also begun investigating ways to expand the reach of the map beyond the schools in close proximity to Arizona State University.

ACKNOWLEDGEMENTS

This project was partially inspired by the National Geographic Society's Giant Maps program, was completed with the assistance of the Arizona Geographic Alliance, and was largely funded through the Arizona State University School of Earth and Space Exploration (SESE) Summer Exploration Graduate Fellowship program.

References

[1] Christensen et al. (2004) Space Sci Rev 110: 85-130. [2] Hill and Christensen (2017) J. Geophys. Res. Planets, 122, 1276–1299. [3] Smith et al. (2001) J. Geophys. Res. Planets, 106, 23689–23722. [4] https://www.nationalgeographic.org/education/giant-maps/. [5] https://geoalliance.asu.edu/GiantTravelingMap

Figure 5: (Background) Subsection of the THEMIS Day IR with Colorized MOLA Elevation Global Map at the Approximate Printed Resolution of the Floor Map