



Center for Lunar Science and Exploration

Education and Public Outreach

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Lunar and Planetary Institute

Exploration Science Forum
22 July 2014



CLSE E/PO

ExMASS High School Research
Educate Students in Scientific Research

Public Night Sky Viewing Events
Engage & Educate the Public

CosmoQuest Google Hangouts
Engage the Public

Traveling Library Exhibits
Engage the Public

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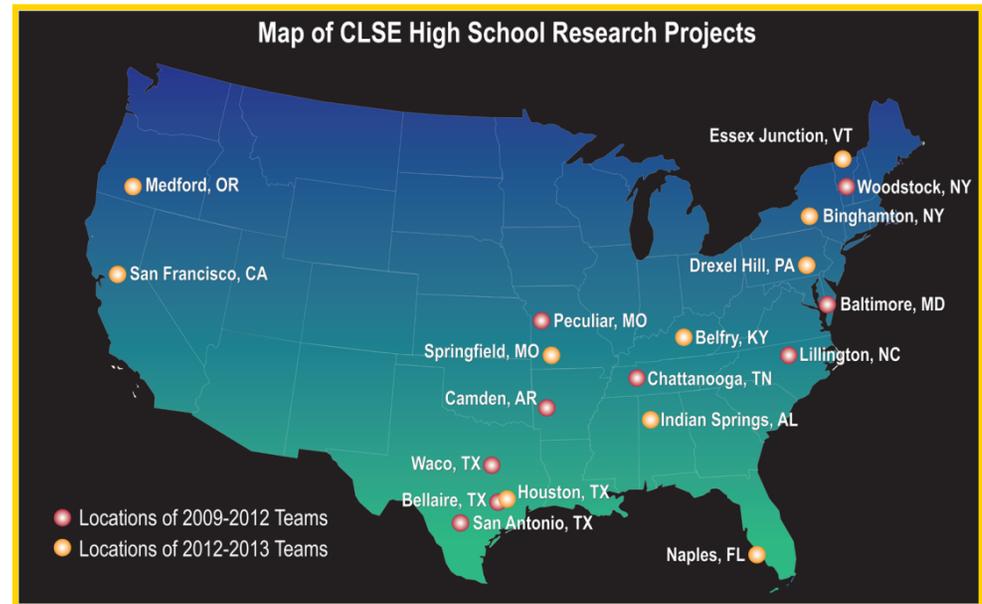
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CLSE E/PO



High School Lunar Research Projects, 2009-2013

- 218 students, 21 teachers, 19 schools across the U.S.
- Of these 19 schools, 12 serve underserved, rural or underrepresented, minority populations
- 17 student posters presented at the annual Lunar Science Forum (2nd place, 2011; 3rd place & HM, 2012; 2nd & 5th place, 2013)
- Upper Darby HS (PA) - “failing school”
- Kickapoo Lunar Research Team (A. Delawder, A. Beason, V. Wilson) & G. Kramer (2013). Stratified Ejecta Boulders as Indicators of Layered Plutons on the Moon, *Icarus*, 228, p. 141-148.



Locations of high schools that participated in the 2009-2013 High School Lunar Research Projects.

CLSE E/PO



Exploration of the Moon and Asteroids by Secondary Students (ExMASS)

Educating students in the process of science through authentic research projects, and exposing them to science and engineering career pathways

- Part 1: Moon/Asteroid 101. Guided inquiry activity to become familiar with lunar/asteroid science and exploration by reading articles and examining imagery. Students apply this knowledge by characterizing the geology seen in lunar/asteroid images.
- Part 2: Students apply their understanding and skills to open-ended research projects, guided by a “virtual” mentor. At the close of the program, students present their research findings as a conference-style poster to a panel of scientists.
- Top four posters will be displayed at the SSERVI Forum; the highest scoring team each year will attend the SSERVI Forum to present in person.
- All student presentations (and other communications when appropriate) will utilize Adobe Connect.





CLSE E/PO

Exploration of the Moon and Asteroids by Secondary Students (ExMASS)

Educating students in the process of science through authentic research projects, and exposing them to science and engineering career pathways

- Up to 10 student teams per year
- Added emphasis on nature and process of science; making explicit connections to student work
- Advisory Group
 - 4 teachers & 2 mentors, will assist in continual improvement of the program
 - Evaluation
 - Teacher application/selection process
 - Communication between groups (CLSE, teams, mentors)
- Evaluation
 - NOS, content, attitudes, general feedback
 - IRB exemption



Locations of 2014-2015 ExMASS participating schools.



CLSE E/PO



Exploration of the Moon and Asteroids by Secondary Students (ExMASS)

Educating students in the process of science through authentic research projects, and exposing them to science and engineering career pathways

- Advisory Group
 - Meet at LPI in July to discuss all aspects of the program including:
 - SSERVI in general and CLSE specifically
 - Strategies for Nature & Process discussions
 - Defining mentor/teacher roles
 - Moon/Asteroid 101
 - Asteroid research appropriate at the HS level
 - Then meet once a semester (or as needed) to discuss the implementation of the program

CLSE E/PO

Traveling Library Exhibits, 2009-2013

Engaging the public in lunar science and exploration through library exhibits

- 7 Available Exhibits
 - A Storm of Asteroids
 - Earth's Daughter
 - The Moon: Cosmic Decoder Ring
 - Treasure Hunt in Earth's Attic
 - Impacts: Delivering Death, Fostering Life
 - Our Molten Moon: The Story of the First Moon Rocks
 - Moon Views: Rabbits in the Rocks



A Storm of Asteroids
Long ago, enormous asteroids pelted our Moon—and Earth!

The Moon's surface is covered by impact craters. The largest crater collected by an asteroid appears to have formed at the same time, 3.9 to 4.0 billion years ago.

This suggests that many have been in a rain of asteroids after the formation of the Moon and other planets.

Scientists are debating the why behind it.

When the basins formed by a showering rain of debris fell by an asteroid bombardment.

The date suggests a model in which the basins were created in a sudden and intense asteroid bombardment 3.9 to 4.0 billion years ago. According to this hypothesis—the "lunar cataclysm hypothesis"—the basin rocks should all be the same age because they formed at the same time.

However, other ancient basins on the Moon may have formed earlier. 4.0 billion years ago, basins in the southern part of the Moon had been formed by the impact of one of the same size objects they were produced by the last of these large impacts.

These same bombardments of giant asteroids pelted Earth. The Earth's surface would be completely reshaped, destroyed by fire from that early period. Scientists need to go back to the Moon to collect the evidence needed to answer the questions of Earth and Moon.

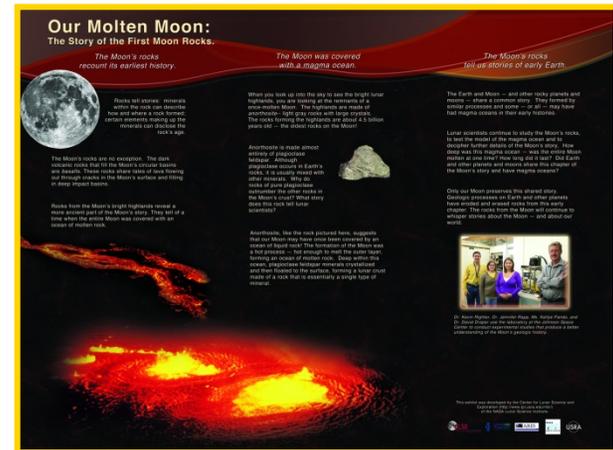
The timing of this rain of planetary debris is a mystery.

Moon rocks produced by the impacts record the age of craters and basins. However, the ages of rocks collected by an asteroid impact appear to have formed at the same time, 3.9 to 4.0 billion years ago.

What caused this asteroid storm? Was it gradual or catastrophic? How long did it last? Where did these asteroids originate? More information about this storm of asteroids will help us understand how our solar system—and Earth—formed and changed.

Dr. David King of the Center for Lunar Science and Exploration is analyzing rocks and impact basins for more information about this rain of asteroids. He also is helping NASA prepare for future exploration of the lunar surface as that raises questions about the Moon's and Earth's origins can be answered.

These answers will also help scientists address questions about the origin and early evolution of life on Earth. The first evidence of life on planet appears in the average record immediately after the proposed bombardment. What role did bombardment have in holding back or promoting the development of life? The answers to these mysteries are waiting on the Moon.



Our Molten Moon: The Story of the First Moon Rocks.

The Moon's rocks recount its earliest history.

The Moon was covered with a magma ocean.

The Moon's rocks tell us stories of early Earth.

When you look up into the sky to see the bright lunar orb, you are looking at the most distant of our neighbors. The light you see is made of particles that were once part of our planet. The rocks falling from the sky are about 4.5 billion years old—the oldest rocks on the Moon.

Scientists made great progress in understanding the early history of our planet. However, the Moon's rocks are a different story. The light you see is made of particles that were once part of our planet. The rocks falling from the sky are about 4.5 billion years old—the oldest rocks on the Moon.

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Available for loan: <http://www.lpi.usra.edu/nlsi/education/exhibits/>

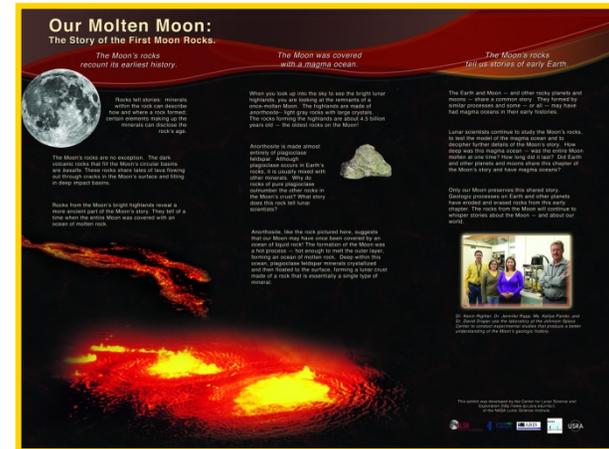
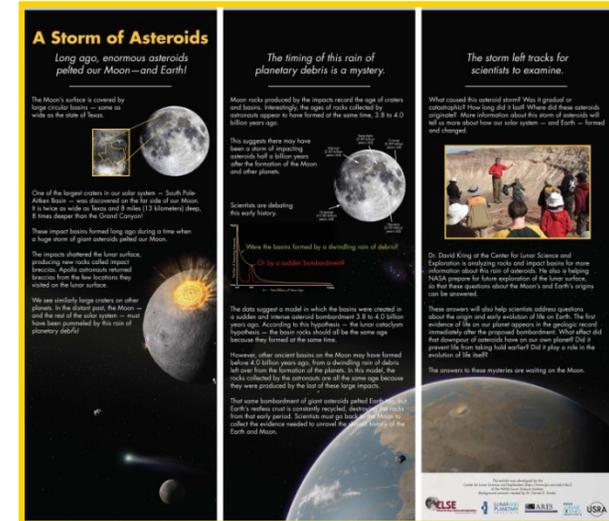


CLSE E/PO

Traveling Library Exhibits, 2009-2013

Engaging the public in lunar science and exploration through library exhibits

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***On display this week at ESF**

CLSE E/PO

Traveling Library Exhibits, 2009-2013

Engaging the public in lunar science and exploration through library exhibits

- As of April 1, 2013:
 - 41 unique locations
 - >120,000 visitors
 - Exhibit files downloaded ~500x
 - 93% of institutions used the exhibits to enhance their space science programming including lectures, night sky viewings, and family science nights



Library patrons view Lunar Traveling Exhibits.

Available for loan: <http://www.lpi.usra.edu/nlsi/education/exhibits/>



CLSE E/PO



Traveling Library Exhibits

Engaging the public in lunar and asteroid science and exploration through library exhibits

- We will create one interpretive traveling exhibit in years 1 and 2
- Themes include:
 - *Protecting Our Home*
 - Will discuss the hazards of asteroids impacting Earth,
 - Consequences of such impacts, and
 - Research being done to better predict impacts
 - *Asteroids: Rosetta Stones to the Early Solar System*
 - Will explore how studies of asteroids and meteorites give insight into the formation and early evolution of the solar system
 - Discuss how SSERVI research adds to understanding of the early solar system
- Evaluation
 - Visitor demographics, counts, perceptions; exhibit use





CLSE E/PO

Google Hangouts

Engaging the general public in NASA science and exploration

- Monthly Hangouts featuring SSERVI scientists/engineers
- Partnership with CosmoQuest (Astrosphere New Media Association)
 - CosmoQuest co-hosts and produces Hangouts
 - CLSE co-hosts Hangouts & recruits guests
- Hangouts will be broadcast live on:
 - the CosmoQuest website, YouTube Channel and Google+ page
 - the CLSE Team website
- Evaluation
 - Topic, speaker; ideas for the future



CosmoQuest Hangout shown through their website.

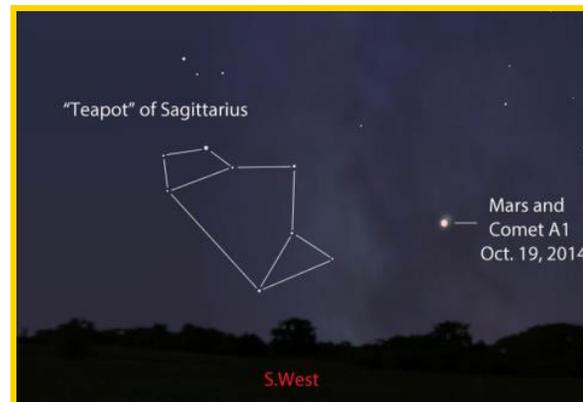
CLSE E/PO



Public Night Sky Viewing Events

Engaging and educating the public about SSERVI, SMD, and NASA science and exploration

- Leverage LPI's ongoing Sky Fest program; LPI-JSCAS partnership
- Thematic events provide opportunities to engage and educate the public on solar system science and exploration:
 - International Observe the Moon Night (InOMN; September 6, 2014)
 - Comet encounters (Siding Spring; October 19, 2014)
 - Launch of the OSIRIS-REx mission (September 2016)
- Evaluation
 - Ongoing Sky Fest evaluation of visitors' demographics, motivations, etc.



Position of Comet Siding Spring on 19 OCT 2014.





CLSE E/PO

Synergistic Activities

CLSE E/PO is committed to collaborating with SSERVI Central and other SSERVI teams

- Assist with educator workshops (June 2014),
- Share SSERVI team science in our programs,
- Collaborate on events such as InOMN and SMD mission outreach (e.g., OSIRIS-REx),
- Participate in the SSERVI E/PO Working Group as well as SSERVI Central E/PO telecons and meetings, and
- Openly share programmatic approaches, evaluation tools, and lessons learned to the entire Institute





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CLSE E/PO

SSERVI Scientist Involvement

CLSE E/PO is committed to including SSERVI science teams in our activities

- CLSE E/PO invites all SSERVI science team members to participate
 - Mentors/Judges for the ExMASS program
 - Traveling Exhibits available for loan in your community
 - Hangout guest
 - Distribute your materials at our public events





Thank You

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