Student Briefing:

Lunar Electric Rover (LER) and Crew Activities, Black Point Lava Flow

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LER in a basin within the Black Point Lava Flow test site (2009). This basin was used for station activities during the N2 Traverse (Crew B) and Day 3 Traverse (Crew A). The basin exposed a cross-section of the lava flow (in background) and two overlying sedimentary units.

Photo credit: NASA Desert RATS

**LER as a Geologic Tool**

- Mobility
- Visibility
- Accessibility
- Surface documentation
- Surface sampling
LER crossing outwash channels or channeled terrain on Traverse Day 5 at the Black Point Lava Flow test site (2009). The channels cross-cut the red layered terrain (right background) and the overlying Black Point Lava Flow (left background).

The cabana is closed during drives between stations to keep dust off of the suits and suit ports.

Photo credit: NASA Desert RATS

LER as a Geologic Tool

- Descriptions and photo-documentation of distant features are possible from within the LER during drives between stations.

- Likewise, descriptions and photo-documentation of features in the near-field (directly in front of the LER) are possible from within the LER between stations.
LER as a Geologic Tool

- The vehicle can rotate 360° without any lateral movement.

LER crossing the top of the Black Point Lava Flow test site (2009). The San Francisco peaks are in the distant background.

Photo credit: NASA Desert RATS
LER approaches an outcrop of siltstone on Traverse Day 4 at the Black Point Lava Flow test site (2009). The overlying Black Point Lava Flow is visible in the background. Pebbles and Cobbles of lava are also visible on the upper surface of the siltstone outcrop.

Photo credit: NASA Desert RATS

LER as a Geologic Tool

- The LER can function like a geologist
  - Approaching outcrops
  - Photo-documentation
The lunar surface systems tests are helping the team identify which operations are most efficiently done from within the LER and which require EVA. The goal is to integrate the capabilities to make surface operations as efficient, productive, and safe as possible.

IVA Capabilities

- High-visibility windows
- ForeCam
- AftCam
- Port & starboard cameras
- Docking cameras
- GigaPan

EVA Capabilities

- SuitCam
- Mobile observations
- Sampling
Suit Ports

- On aft deck
  - SPR
  - LER
- Faster egress/ingress
- Canopy added to reduce dust on suits and ports
- Crew can also drive the LER from the suit ports using the aft steering controls

For purposes of the tests, pressurized suits were replaced by light-weight suits. Thus, helmets are open to air.

Photo credit: NASA Desert RATS
Sample Documentation

- Each suit has a camera that streams images
- To be recorded on the LER
- Or captured in the Science Operations Room

EV1 documenting a basalt sample collected on Traverse Day 3 at the Black Point Lava Flow test site (2009). While a sample image is collected, EV1 is vocalizing a description of the sample.
Sample Documentation

• Each suit has a camera that streams images

• To be recorded on the LER

• Or captured in the Science Operations Room

EV2 of Crew B documenting a basalt sample collected on the N1 Traverse at the Black Point Lava Flow test site (2009). While a sample image is collected, EV2 is vocalizing a description of the sample.

A single station within the Science Operations Room was assigned to capture images and record sample descriptions from both EV1 and EV2.

The 2009 simulation suggests two stations with the Science Operations Room may be needed for this activity, with each one be assigned to a specific crew member.

Photo credit: NASA Desert RATS
Geologic Tool Rack

- Hammers
- Tongs
- Scoop
- Sample bags
- Sample storage compartment
- Augmented with LER tools (e.g., for cleaning windows)

EV2 of Crew B removing tool and sample carriage or stand from geologic tool rack on the W2 Traverse at the Black Point Lava Flow test site (2009).

EV2 is conducting a single person EVA; EV1 is conducting IVA from within the LER. This could involve a gigapan image, a description of the distant geological features, or planning for the next portion of the traverse.

Photo credit: NASA Desert RATS
EV2 with tool and sample carrier (right hand) and hammer and tongs (left hand) on Traverse Day 3 at the Black Point Lava Flow test site (2009).

EV2 is conducting a single person EVA; EV1 is conducting IVA from within the LER. This could involve a gigapan image, a description of the distant geological features, or planning for the next portion of the traverse.

Photo credit: NASA Desert RATS
Sample Collection

• Lunar soil samples can be collected with a scoop
  • illustrated here with a scoop of silt

• During Apollo, this type of sampling activity always involved two astronauts

• Single astronaut sampling is being investigated during mission simulations

Photo credit: NASA Desert RATS
Backpack Suits

- An alternative to
  - pressurized suits
  - light-weight suits

- Has integrated communications system

- Has integrated camera system

EV1 describing sample on surface on Traverse Day 5 at the Black Point Lava Flow test site (2009). The sample is photo-documented using the EV1 camera (down-sun twice to produce stereo pair and then at an orthogonal position) before being collected.

Photo credit: NASA Desert RATS
The Lunar Electric Rover (LER) is an electric vehicle. Its tremendous trafficability is due, in part, to six independent suspension wheel units.

Chassis B has a faster-reacting suspension than Chassis A, which may further enhance trafficability.

Photo credit: NASA Desert RATS

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Mobility Solutions

- The 2009 lunar mission simulation used the Chariot chassis A and Cabin B (middle right).

- Chassis B (left) was tested extensively over diverse terrain conditions during 2009 and may be used with a new cabin during the 2010 lunar mission simulation.
For student follow-up:

NASA Desert RATS Overview
(http://www.nasa.gov/exploration/analogs/desert_rats.html)
Includes RATS YouTube
   RATS Blog
   RATS Twitter
   RATS flickr Photo Gallery
   RATS Facebook

NASA Featured 2009 Field Tests
(http://www.nasa.gov/exploration/analogs/)
Acronyms:

ATHLETE = All-Terrain Hex-Legged Extra-Terrestrial Explorer: This is a mobility option that has significant lift capacity and may be used to transport habitat modules and other equipment.

DIO = Directorate Integration Office: The NASA office that is responsible for the integration of science with hardware and operations development during DRATS simulations of lunar missions.

DRATS = Desert Research and Technology Studies: Desert RATS integrates and tests people, hardware, and operational scenarios in analogue terrains.

EV1 = The commander of the crew.

EV2 = The geologist on the crew.
Acronyms (continued):

EVA = Extravehicular Activity: This term refers to activity that involves crew outside their vehicle and, on the Moon, will require a space suit.

ISRU = In Situ Resource Utilization: A term used to describe potential options that will allow explorers to extract their needs from their environment, such as oxygen and hydrogen from the regolith or titanium from basalt, rather than relying on Earth for all of their resources.

IVA = Intervehicular Activity: This term refers to crew activity within their vehicle. For example, if they are describing the terrain, taking a gigapan, or collecting ground-penetrating radar data from within the vehicle, those will be classified as IVA.
Acronyms (continued):

LER = Lunar Electric Rover: The Generation I prototype of the pressurized lunar rover being designed for Lunar Surface Systems and the Constellation Program. A Generation II prototype (which will probably be the immediate predecessor to the flight vehicle) is in the design phase and will be available in 2011.

LSS = Lunar Surface Systems: This is the organization within the Constellation Program that is designing the equipment and developing operational scenarios that are needed for lunar exploration.

SPR = Small Pressurized Rover: The concept vehicle that was used in a trade study to compare crew productivity and safety in a small pressurized rover to that in an unpressurized rover (UPR).

UPR = Unpressurized Rover: The UPR is similar to the Apollo Lunar Roving Vehicle (LRV), but with the Chariot chassis.