3.6 Friedrich Horz

Dr. Friedrich Horz is a planetary scientist interested in impact processes.

Dr. Horz was hired by NASA in 1970 to assist in the geologic training of the Apollo 15, 16, and 17 astronauts. He participated in numerous field trips and classroom activities; specifically, he was to introduce the topic and concepts of impact processes to the crews, a subject that was in its infancy at the time and of interest to only a few prior to the Apollo Program. His familiarity with Apollo and associated science operations led to his current assignment as Deputy Scientist for analog field-tests for the Constellation Program.

Dr. Horz received his B.S. (in 1961) and Ph.D. (in 1965) from the University of Tubingen, Germany, with a thesis that included detailed field work and mineralogical-petrographic characterization of the impact melts at the Ries Crater, Germany. His postdoctoral work at the NASA Ames Research Center, California Institute Technology, and the Lunar Science Institute, Houston, focused on the experimental reproduction of diagnostic deformation and melt phenomena in minerals and rocks that were subjected to impact-triggered shock waves; the experiments produced shock waves of known amplitudes, providing pressure calibrations for equivalent features in naturally shocked rocks. Dr. Horz joined NASA JSC in 1970 and founded the "Experimental Impact Laboratory," which he also managed for 35 years, ultimately including three unique high-velocity guns to simulate shock waves and the cratering process. He published extensively on the shock metamorphism of minerals, rock, and lunar soils, conducted collisional fragmentation experiments and cratering studies, and modeled the evolution of planetary regoliths. He also simulated micro-craters generated by sub-millimeter-sized cosmic dust particles and developed/exposed/analyzed cosmic dust detectors on board Shuttle, MIR, and the Stardust Mission to comet Wild 2.

Dr. Horz received the Barringer Award of The Meteoritical Society in 1996 for his lifetime accomplishments in impact studies. In addition, Dr. Horz has a commendation from the American Geologic Society, and has received, at JSC, NASA Outstanding Performance awards, Certificates of Commendations, and Sustained Superior Performance awards.

A6 – Presentation of Friedrich Horz

Desert Research and Technology Studies (DRATS) Traverse Planning

[Slide 1] The Desert Research and Technology Studies (DRATS) include large scale field tests of manned lunar surface exploration systems; these tests are sponsored by the Director's Office of Integration (DOI) [sic, Directorate Integration Office (DIO)] within the Constellation Program and they include geological exploration objectives along well designed traverses. These traverses are designed by the Traverse Team, an ad hoc group of some 10 geologists form NASA and academia, as well as experts in mission operation who define the operational constraints applicable to specific simulation scenarios.

[Slide 2] These DRATS/DOI tests focus on 1) the performance of major surface systems, such as rovers, mobile habitats, communication architecture, navigation tools, earth-moving equipment, unmanned reconnaissance robots etc. under realistic field conditions and 2) the development of operational concepts that integrate all of these systems into a single, optimized operation. The participation of "science" is currently concentrating on geological sciences, with the objective of developing suitable tools and documentation protocols to sample representative rocks for Earth return, and to generate some conceptual understanding of the ground support structure that will be needed for the real time science-support of a lunar surface crew.

[Slide 3] Major surface systems exercised in the June 2008 analog tests at the Moses Lake site, WA. [Upper left] The Chariot Rover (developed at Johnson Space Center) is an unpressurized vehicle driven by fully suited crews. [Upper right] Mobile Habitat provided by the Jet Propulsion Laboratory. Chariot is the more nimble and mobile vehicle and the idea is to drive the habitat remotely to some rendezvous place where Chariot would catch up – after a lengthy traverse – at the end of the day. [Lower left] The K-10 remotely operated robot (provided by NASA Ames Research Center) conducting scientific/geologic reconnaissance of the prospective traverse region, locating specific sites for more detailed exploration by Chariot and its crew. [Lower right] This earth-moving equipment (provided by NASA KSC) can be attached to Chariot and is envisioned to, for example, level an outpost site or to mine lunar soil.

[Slide 4] DRATS tests at Black Point Lava Flow (BPLF), Flagstaff, AZ, in Oct. 2008; featuring the Small Pressurized Rover (SPR). The latter allows the crews to drive in short-sleeve comfort and carries sufficient consumables to support the crews for a few days and nights The astronauts egress and ingress the rover cabin via novel "suit ports" that allow them to step into their EVA-suits from inside – and after closing some seals, to step onto the lunar surface within approximately 10 minutes.

[Slide 5] Fully suited crews conducting field work at BPLF in Oct. 2008. [Upper left] Note the suit port "opening" on the rover and the fixed plates on the astronauts' back packs that interface with/seal against this opening. [Lower left and Right] The geology field tools very much resemble those used by Apollo; however, the Hasselblad film cameras were replaced by modern video cameras mounted onto the back packs (above the astronauts' right shoulder). As a consequence, the present science "back room" will receive in real time continuous, multiple video streams, including those from rover-mounted video cameras, as opposed to Apollo when all surface photography could only be seen after the films were developed following return to Earth.

[Slide 6] The traverse planning process starts with photogeologic mapping of an area and the definition and prioritization of the scientific objectives; no ground observations are allowed in this process, unless acquired via remotely operated robot; typically some 10 geologists are involved in these activities. A set of preliminary traverses is then repeatedly iterated between science and operational interests, until a final traverse emerges that complies with the capabilities and constraints of all surface systems being exercised.

[Slide 7] Major operational constraints that applied for the DRATS 2008 traverse planning.

[Slide 8] Location of Black Point Lava Flow in Northern Arizona, some 40 miles NE of Flagstaff, and part of the San Franciscan Volcanic Field. The relatively young flow is scarcely vegetated, a prerequisite for good rover mobility as well as good rock exposures, thus approximating lunar surface conditions.

[Slide 9] Photogeologic units and maps of the general region as determined by the Traverse Planning Team.

[Slide 10] More detailed photogeologic map of the actual DRATS 2008 test area.

[Slide 11] Example of a typical traverse plan originating and ending at Base Camp (red dot), indicating the specific route to be taken to reach individual stations (numbers), with each station serving specific geologic objectives. This Google Earth-based traverse plan is being displayed on board the rover and used by the crew to navigate.

[Slide 12] Excerpt from a typical traverse plan describing what the crew has to do and observe at a given station, such as Station 1a of traverse SPR. Again: these instructions are available to the crew as text-boxes at any marked location in the Google Earth-based traverse map. The purpose of this slide is to illustrate the detail of planning that goes into the DRATS traverses. Not shown is the detailed time line that is part of this plan; it is generally Mission Control that controls this time line during the actual traverses and that implements any deviations from the nominal plan.

[Slide 13] Traverse plans for the DRATS 2009 campaign. The latter demonstrated the capabilities of current systems to support a continuous, 14-day lunar mission; significantly, the crew worked, ate, and slept inside the rover cabin for a solid 2 weeks and exited only in fully suited configuration to do geological exploration and vehicle maintenance. Total traverse distance was some 135 km. The tent symbols indicate overnight camps, the tear shaped symbols individual geology stations; Base Camp is again marked by a red dot.

[Slide 14] Examples of real-time video images displayed in the DRATS 2009 Science Support Room (SSR), which was located at Base Camp and manned by 7 scientists. Up to 6 separate cameras could be accessed simultaneously by the SSR; the real-time management, analysis and interpretation of these multiple video streams represents a major challenge for efficient back room operations, and constitutes a dramatic departure from Apollo.

[Slide 15] Example of a typical field scene obtained from a suit-mounted video camera (note field of view is partly blocked by astronaut’s helmet; the blue pants belong to a geologic field observer, who silently monitors the activities for subsequent constructive critique at the end of the day). Note the textural and structural detail of diverse basalt boulders that are being revealed by modern, suit-mounted video cameras.

[Slide 16] Close up image of a basalt fragment obtained with a suit-mounted video camera. This image illustrates the richness of detail and information that can be obtained via modern digital cameras and that will have to be processed and interpreted by the SSR in essentially real time.

[Slide 17] Inside the DRATS 2009 SSR illustrating the CoI, PI, and SCICOM "stations".

[Slide 18] Role assignment of the DRATS 2009 Science Support Room; the latter was located in the Mobile Mission Control Center (MMCC), a giant, enclosed trailer that has been developed and installed at NASA JSC and KSC, and that was hauled to the field site/Base camp at Black Point Lava Flow, AZ. The SSR had 7 "operational" functions and seats, all equipped with dedicated PCs and dual monitors. One wall was occupied by the *Field Geology PI*, his *CoI* (who are responsible for all scientific matters) and the science communicator (*SCICOM*; the only person who talked to the crew in the field). The other wall was occupied by "specialists" that kept track of all *rocks* collected, that operated the high-resolution *panoramic still camera* (Giga Pan) on top of the rover's central mast, and that monitored all geologic "structures" visible in the *suit-mounted cameras* and additional cameras on the rover. An *OPSLINK* position communicated with Flight Control next door and informed the SSR about all non-scientific matters, such as time lines, navigation/position data, and/or any anomaly that would override the nominal traverse plan.

Summary: Detailed traverse planning not only supports the integration and simultaneous operation of diverse engineering systems during NASA's analog field tests, but the latter provide significant opportunities also for the conceptual development of future science operations. Simultaneous streams of multiple video and still cameras have to be processed, analyzed and interpreted in essentially real time, a major challenge that needs further development and study. The present activities also develop a cadre of experienced operator-scientists that will eventually design the detailed surface operations of the future.

Desert Research and Technology Studies (DRATS)

TRAVERSE PLANNING

Friedrich Horz
ESCG Group
Houston, TX
Aug. 4, 2009
LPI Workshop

1

Purpose of Analoge Field Studies:

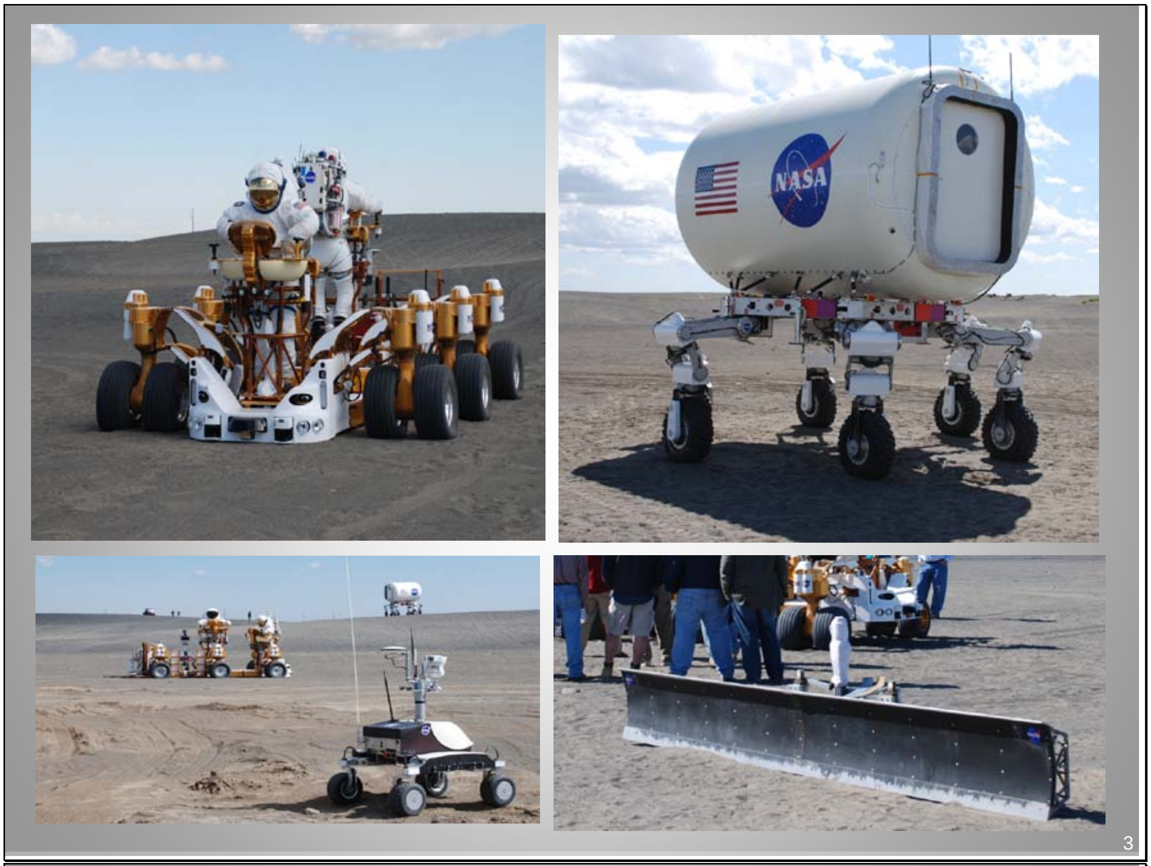
Conceptual Advancement of Technology Systems
e.g. Rover
Communication (voice; video)
Unmanned robots

Conceptual Development of Mission Operations, including

Science Operations
e.g. Tools
Sampling and Documentation Protocols
Ground Support/Science Backroom

Integration of all Systems and Implications for Constellation Architecture

2


3


4

5

Traverse Planning: Approach

Science Objectives:

Produce Geologic Map from Remote Sensing Data
Interpret Origin of Photo-Geologic Units
Establish Science Objectives and their Priorities
If available: Robotically Acquired Ground Observations

Preliminary Traverses:

Determine Points of Interest
Select those Points most Suitable for "Stations"
String these Stations into some logical Flow
Determine Driving Times
Iterate and Re-arrange until suitable Station Times (typically > 30 min) result that meet the Science Objectives.

Final Traverses:

Repeated Iterations with Diverse Operational Elements to define formal Overhead Times and Navigation Data
Load into Google Earth Based Navigation System on LER

6

Traverse Constraints

Terrain : Accessible by Rover

Mobility: Rover Speed some 4 km/h

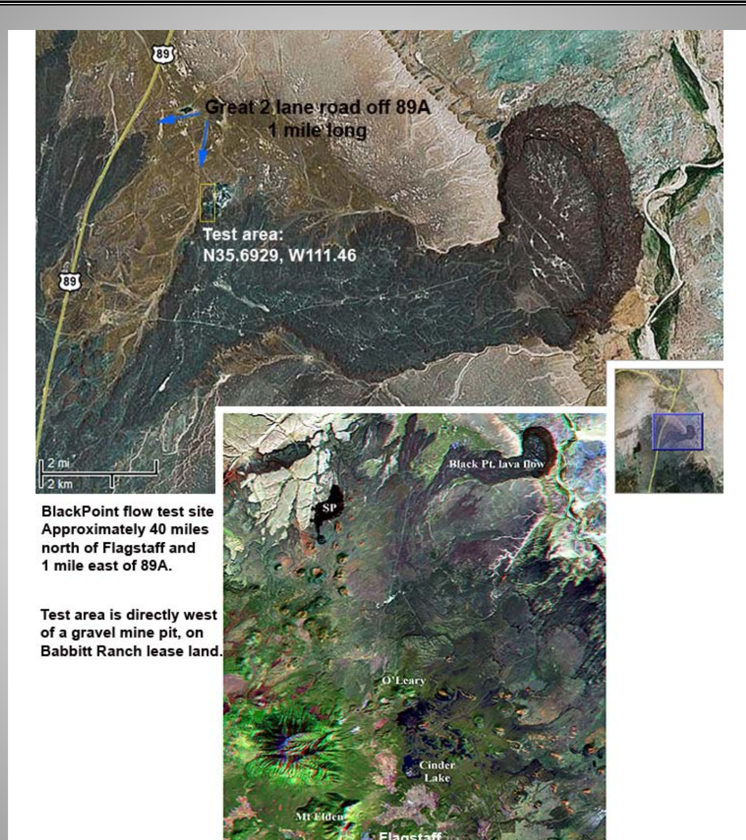
Crew Day: 15 hours

In Suit : 8 hours/day

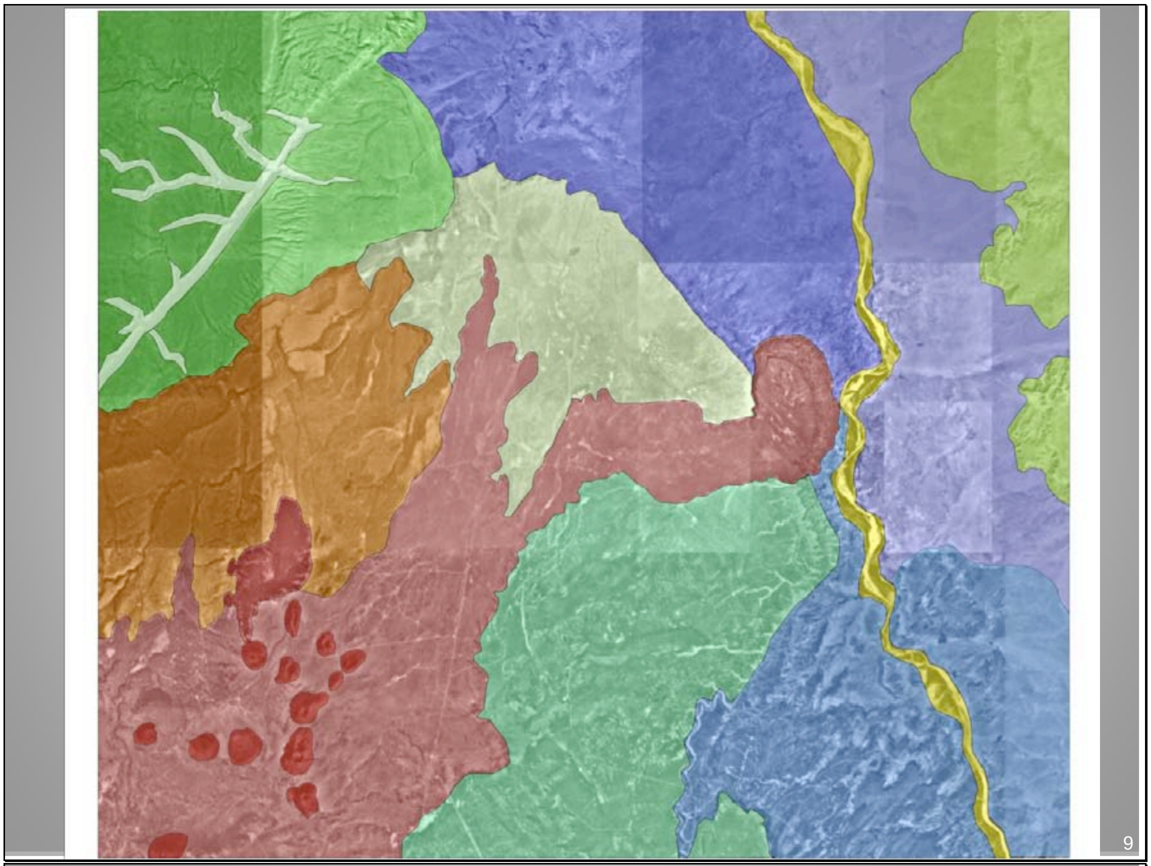
Egress/Ingress: 15/10 min ea

Diverse Technology Demonstrations
e.g. Recharging
Docking with Habitat
Loss of Signal

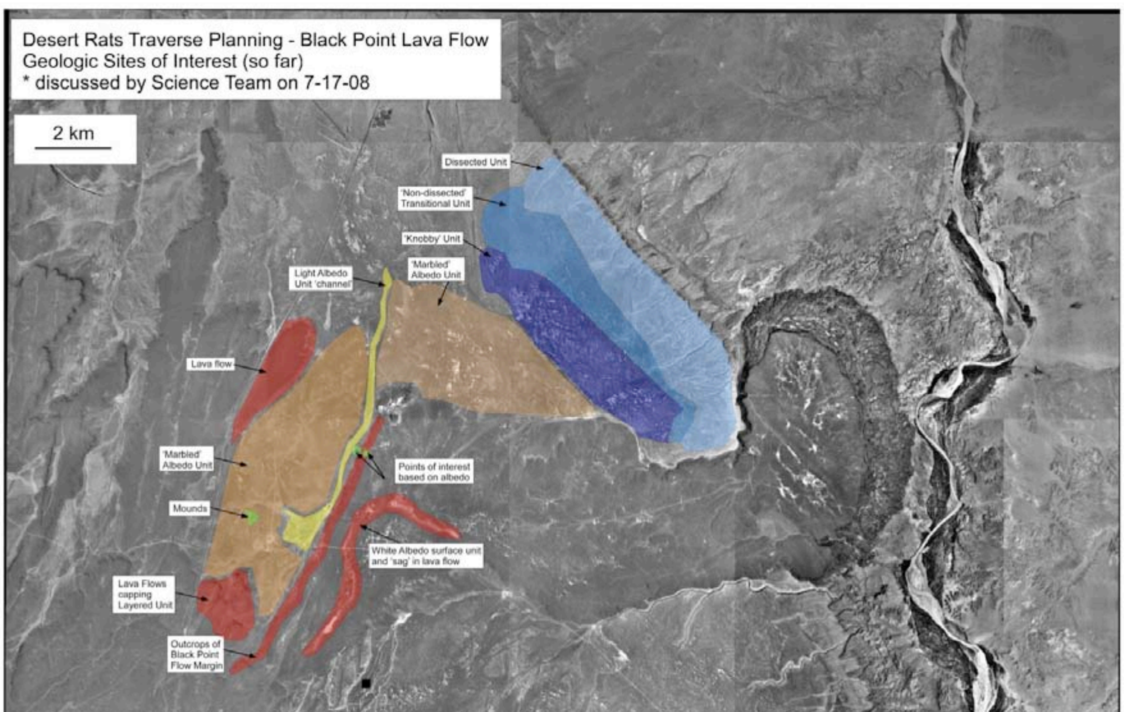
7



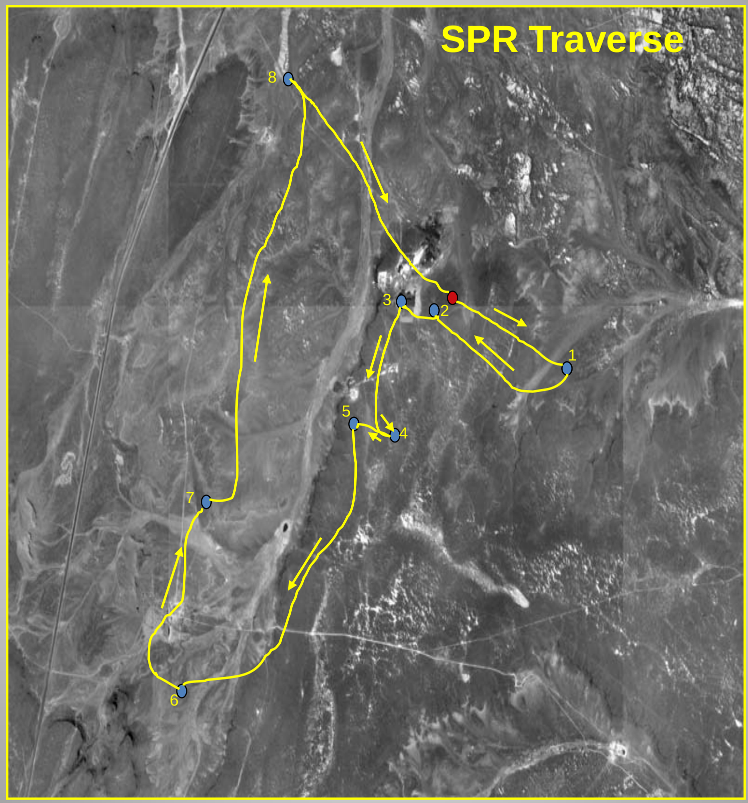
8



9


Desert Rats Traverse Planning - Black Point Lava Flow
Geologic Sites of Interest (so far)
* discussed by Science Team on 7-17-08
2 km
Dissected Unit
'Non-dissected' Transitional Unit
'Knobby' Unit
'Marbled' Albedo Unit
Light Albedo Unit 'channel'
Lava flow
'Marbled' Albedo Unit
Points of interest based on albedo
Mounds
White Albedo surface unit and 'sag' in lava flow
Lava Flows capping Layered Unit
Outcrops of Black Point Flow Margin

10



11

SPR TRAVERSE

9:30 Hours

DETAILED TASKS

RED: Instructs crew to egress and ingress

Blue: Brief comment regarding relation to major science objective(s)

Bold: Major tasks (to be incorporated into cuff check list)

Normal font: specific suggestions and pointers

Drive A (including test drive):

Comment on vehicle performance and trafficability issues (surface relief; boulders, vegetation etc)

Comment on possible lava-flow features

EV 1: Remain inside

EV 2: Egress

Station 1a)

Describe general morphology and geological setting of BPLF and MU

What do you see along the planned traverse and at (what?) distances beyond, including the horizon?

Detailed description of BPLF:

How thick?

How extensive? (how far to the S?)

Any obvious stratification ?

Detailed description of MU:

Is it layered and at what scales?

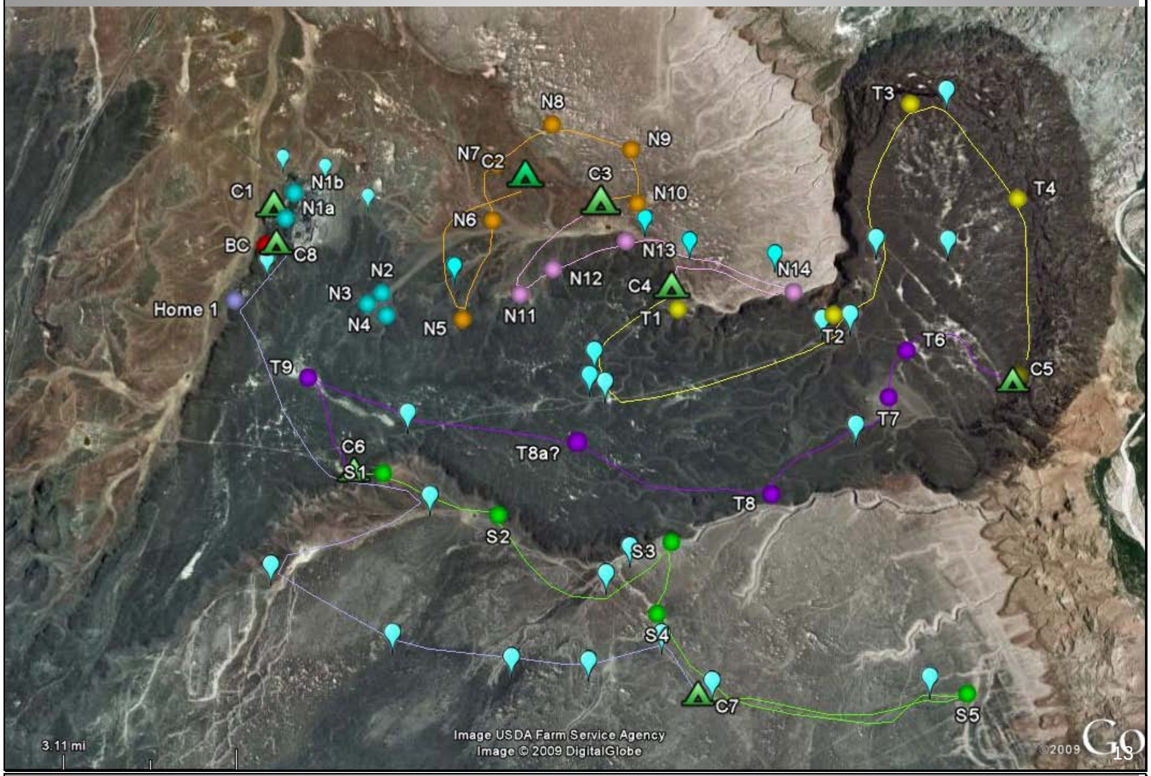
Does it look like a volcanic or sedimentary deposit?

Is the contact of BPLF and MU exposed and accessible anywhere?

EV2: Collect 2-5 representative samples from the top of BPLV

Describe textural diversity of samples, e.g. color, grain size, vesicles, vugs, lineations, identifiable minerals including phenocrysts

12



13

EVA Suit Camera Live Display

Live image displays from

Network Video Recorder (NVR)

Quad or single display

14

15

16

17

		Seat 1 Co I	Seat 2 PI	Seat 3 SCICOM	Seat 4 Giga Pan	Seat 5 Structure	Seat 6 Petrograph	Seat 7 TBD/OBS	Seat 8 OPSLink	Field 1	Field 2	Field 3
Aug.28	Dry Run	Rice	Kring	Lee	Hurtado	Hynek	Evans	K10	Lofgren	Horz		
Aug. 29	N1, B	Rice	Kring	Lee	Hurtado	Hynek	Evans	K10	Lofgren	Horz	Hodges	Cohen
Aug. 30	W2, B	Kring	Rice	Lee	Hodges	Hynek	Evans	Cohen	Horz	Lofgren	Hurtado	Lee
Sept. 2	W1, A	Kring	Rice	Eppler	Hodges	Hurtado	Cohen	K10	Horz	Lofgren	Hynek	Evans
Sept.3	N2, A	Rice	Kring	Eppler	Hodges	Hurtado	Cohen	K10	Lofgren	Horz	Ming	
Sept.4	N, Day 2	Hurtado	Kring	Eppler	Hynek	Evans	Cohen	Ming	Horz	Lofgren	Head	
Sept.5	N. Day 3	Hynek	Kring	Ming	Evans	Hurtado	Cohen	Head	Lofgren	Horz	Bell	Gruener
Sept.6	Top; Day1	Ming	Horz	Hurtado	Hynek	Bell	Gruener	Head	Lofgren	Kring	Cohen	Eppler
Sept.7	Top;Day2	Cohen	Lofgren	Hynek	Hurtado	Evans	Gruener	Head	Horz	Eppler	Ming	
Sept.8	S, Day1	Ming	Rice	Cohen	Hynek	Gruener	Bell	Evans	Eppler	Kring	Horz	
Sept.9	S, Day2	Evans	Rice	Eppler	Ming	Gruener	Bell	TBD	Horz	Kring	Lofgren	

18