LUNAR SAMPLE ACQUISITION & CURATION REVIEW: HUMAN SKILLS & REQUIREMENTS

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INTRODUCTION

- Lunar Sample Acquisition and Curation Review (LSACR)
  - End-to-end review of sample acquisition and curation during next stage of human exploration
  - Consider “Sortie” and “Outpost” scenarios
  - Requested by Science Mission Directorate (SMD) and Optimizing Science and Exploration Working Group (OSEWG) at NASA HQ
  - Jointly conducted by LEAG and CAPTEM
- NAC Recommends:
  - Establish well-defined protocols for collection, documentation, containment, return, and curation of samples
  - Collect samples of various types and purposes with maximum diversity of location and required *in situ* documentation
  - Optimize science return & protect sample integrity

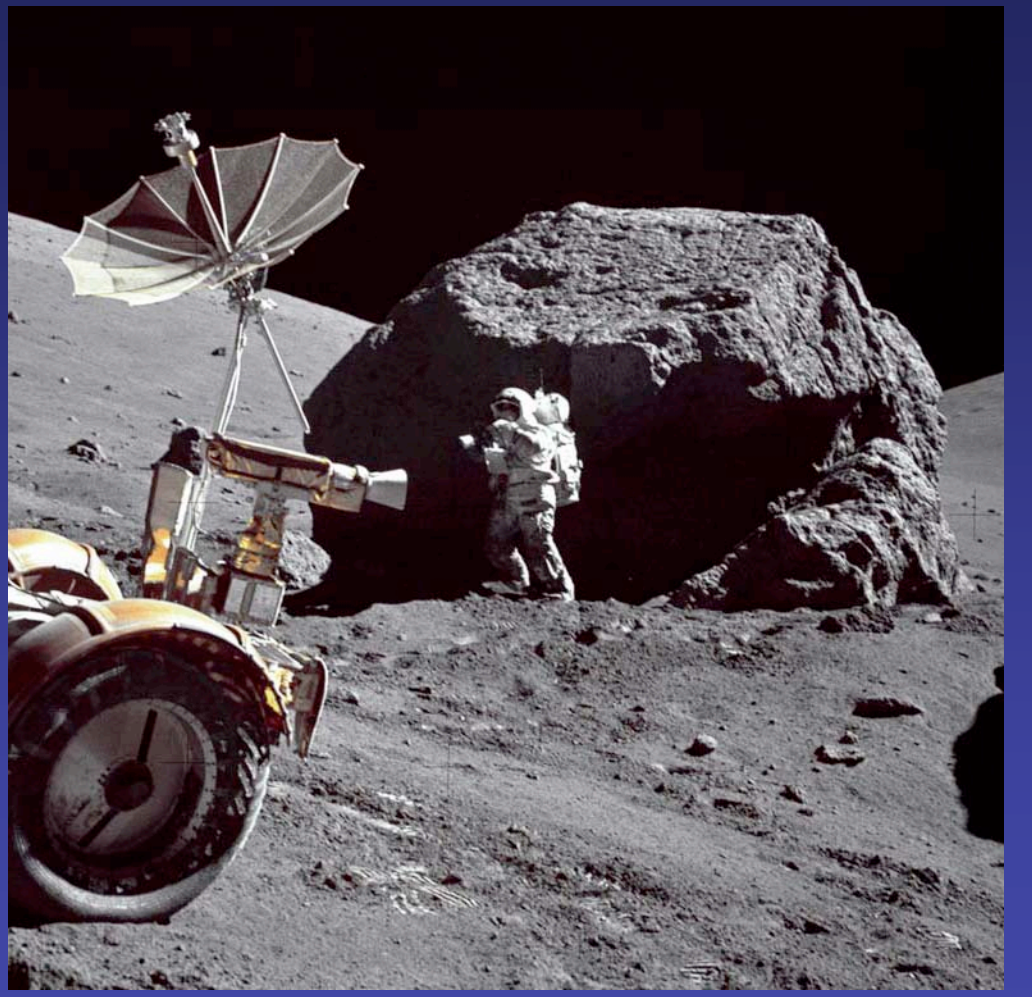
INTRODUCTION

- Lunar Sample Acquisition and Curation Review (LSACR)
  - Tool requirements
  - Instrumentation requirements
  - Sample packaging and preservation
  - Sample contamination control
  - Sample mass & volume requirements
  - Power requirements
  - Crew skills and requirements
  - Communication requirements
  - Flight control requirements
- Crew Skills & Requirements:
  - Focused on training and organization of training team

Conrad & Bean

RECOMMENDATIONS

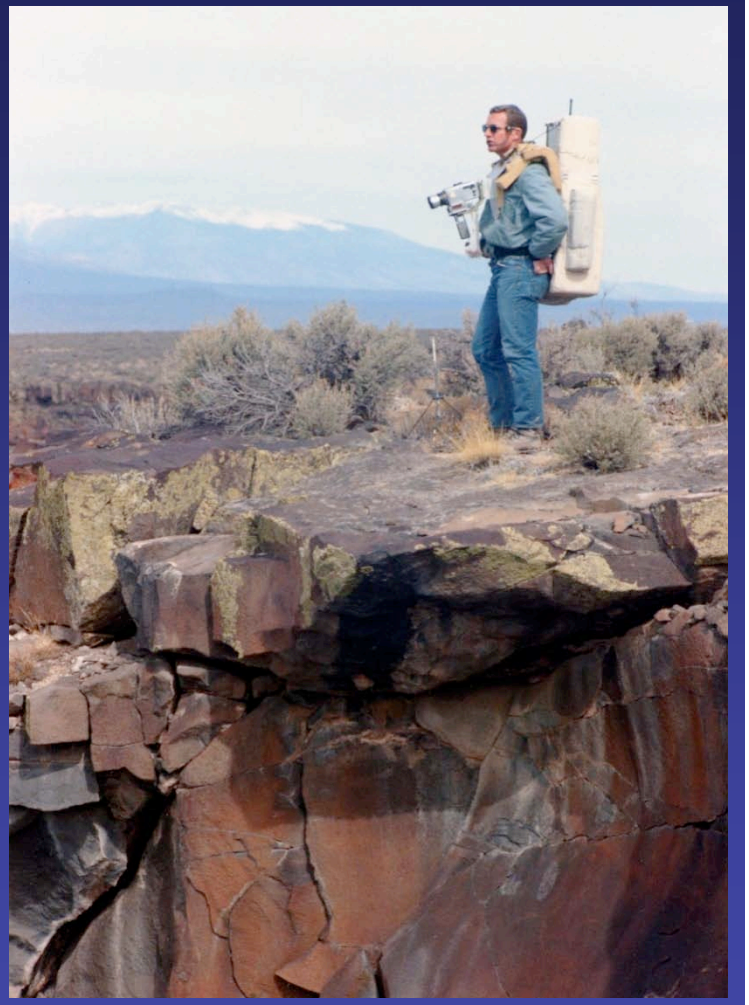
- Surface Geology Principal Investigator (PI)
  - Success of Apollo surface science operations was in large part due to role and leadership of the PI
- PI is responsible for (final decision authority):
  - Field training campaign
  - Traverse design
  - Real-time field operations decisions
- Once a mission is identified the PI position should be established and filled immediately



Jack Schmitt

RECOMMENDATIONS

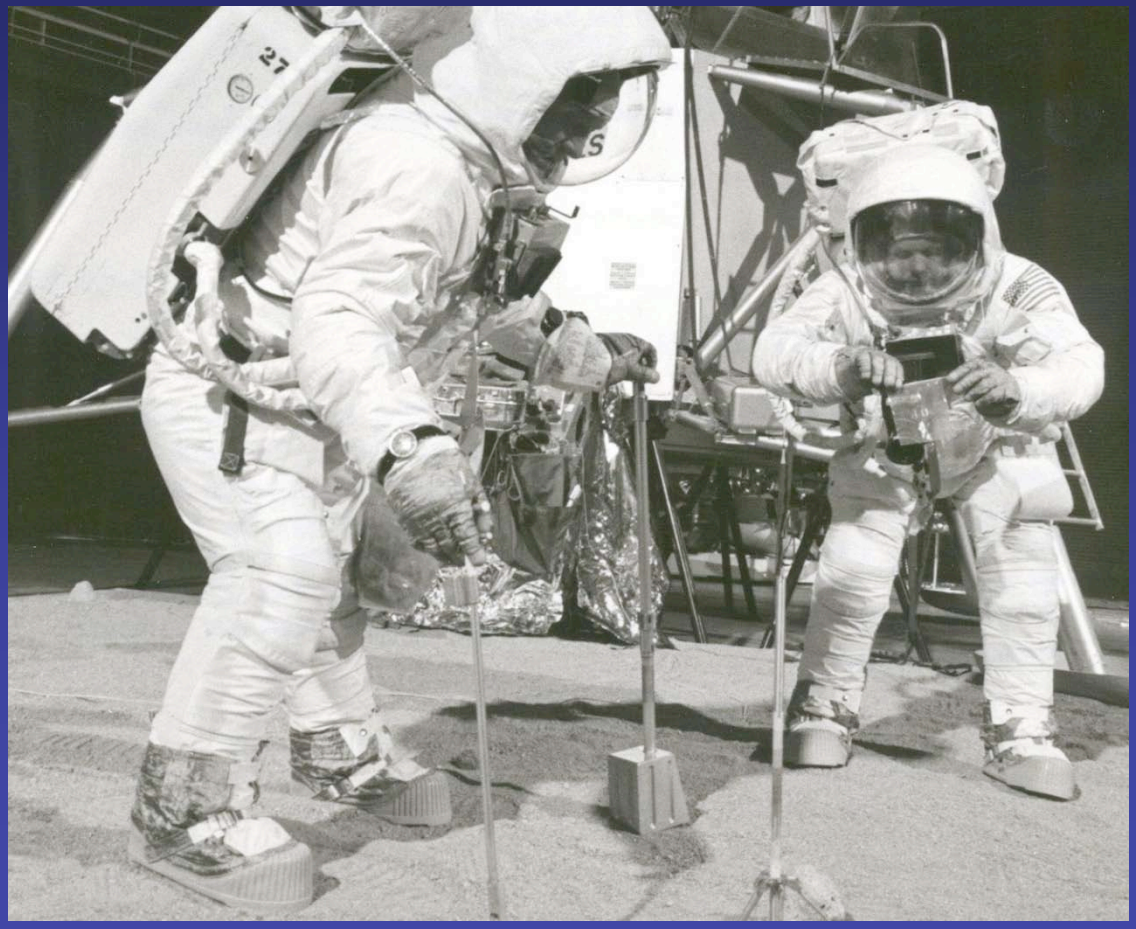
- Under guidance of PI all astronauts should be trained for efficiency in:
  - Fundamental field geology skills
  - Hand specimen petrography
  - Sample collection tool use and protocols
  - Science instrument use
  - Sample collection and documentation protocols
  - Outpost laboratory analytical capabilities
  - Science support room interaction
  - Field and laboratory curation protocols
  - Navigation and rover operation



Dave Scott

RECOMMENDATIONS

- Crew must have level of training at least equal to that of Apollo
- Future crew must be equally trained regardless of background
- Long-duration operations will require both sample collection and curation
  - Each mission should have one “expert” in geology
  - Each non-sortie mission should have one “expert” in curation/collection management
  - Expert = prior expertise in the field



Armstrong & Aldrin

APOLLO SCIENCE TRAINING

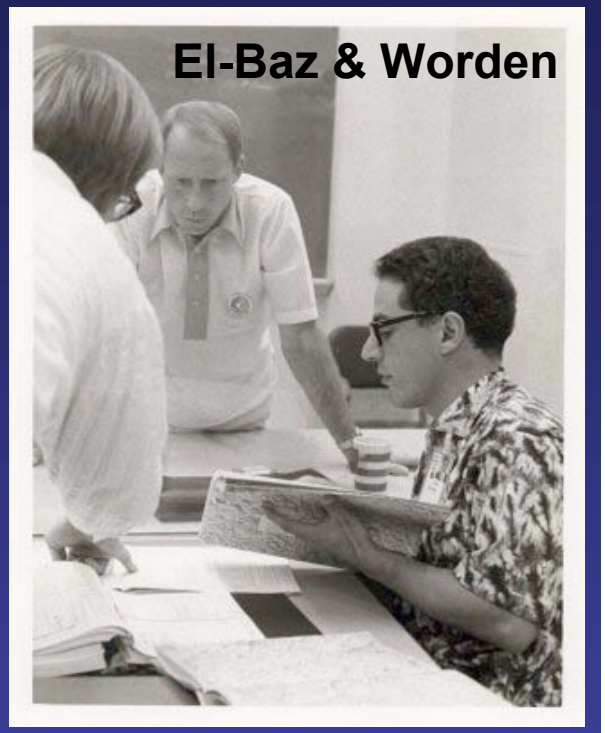
- Each Apollo 15 astronaut experienced:
  - ~375 hours of general geologic training
  - Mission specific training:
  - ~80 hours general science lectures
  - ~20 hours PI-led briefing
  - ~80 hours orbital geology training
  - ~12 hours lunar sample training
  - ~470 hours of geologic field training
- Each astronaut received ~1030 -1040 hours of science training
  - Also received additional training in deployment and use of instruments

El-Baz orbital geology

Irwin & Scott

RECOMMENDATIONS

- Training & Education broken down into:
  - Basic field science (geology)
  - Instrument and tool use
  - Integrated operations simulations
- Training & Education sites include:
  - Classrooms, NASA center field sites, Analog environments
- Astronaut training program must identify locations where personnel will be educated
- All training need not require remote analog settings
- Integrated simulations will require travel to analog sites and must include not only crew <u>but also science support room</u>



El-Baz & Worden

Irwin & Scott

RECOMMENDATIONS

- Advanced training tied to specific mission goals will require unique analog sites
- Early on PI must begin identifying training sites to support curriculum
  - Must address all three categories of training
  - Determine if Apollo training sites remain unmodified and relevant
  - New sites must be identified to cover all “lost” training sites and new science goals
- Each site must be governed by a clearly identified approach to teaching specific principles
  - Cost/Benefit balance for any potential site must be determined and serve a critical basis for choosing sites

RECOMMENDATIONS

- Petrographic training relied on classroom and field training
- Replenish Apollo training samples to include a wider range of crustal lithologies and rock specimens
- Collect new samples relevant to recent discoveries

- Begin identifying NASA (USGS) personnel needs
  - Address these needs through hiring and development of collaborations with academia

APOLLO TRAINING

- Between May 1970 & Nov 1972:
  - 59 field experienced geologists trained Apollo 15-17 crews
  - ~ 10:1 individual field scientist to Apollo Mission crew (2 people) who walked on the Moon
  - Took 375 individual trips
  - Total of 27 field sites

RECOMMENDATIONS

- Begin developing the training team now, both inside and outside NASA
- Continue to develop operations protocols and training team members through operations field tests
- NASA must continue to ensure the role of field science within planetary research
  - Contributes to development of science goals
  - Ensures a cadre of personnel from which crew, trainers, and backroom participants might be selected

Desert Research And Technology Studies (DRATS)

CONCLUSIONS

- Moon is the Rosetta Stone of interpreting planetary processes
  - Same for human exploration
- Must use time we have to establish protocols and procedures with next generation technology and personnel
- Apollo heavily relied upon field scientists within NASA & USGS
  - Must ensure that proper personnel are in place within NASA & USGS
  - Must build and foster proper relationships with academia and international partners
- Now is the time

http://www.nasa.gov/exploration/analogs/