INTRODUCTION

• Recent Astronaut selection classes do not receive Shuttle training
  – 2009: 14 candidates
  – 2013: 8 candidates

• Job description includes:
  – Maintaining ISS
  – Testing new flight hardware
  – Running science facilities

• NASA long range vision is humans at Mars
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• NASA long range vision is humans at Mars

• Training the operational mindset
  – Not about “making boot prints”
APOLLO SCIENCE TRAINING

- Apollo had known target and defined Mission objectives
- 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 field training*
- Each astronaut received
  ~1030 - 1040 hours of science training
  - Also received additional training in deployment and use of instruments

* Approximate numbers.
# Apollo Training

## Apollo Geologic Training Trip Participation

### Apollo 15 - Launch 26 July 1971
- 5/70 - Oroopia Mts, CA
- 6/70 - Mojave Desert, CA
- 6/70 - Flagstaff, AZ
- 7/70 - Flagstaff, AZ
- 7/70 - Medicine Hat, Alberta, Can.
- 7/70 - Medicine Hat, Alberta, Can.
- 8/70 - San Juan Mts, CO
- 9/70 - Buell Park, AZ
- 10/70 - N. Minnesota
- 11/70 - Flagstaff, AZ
- 11/70 - San Gabriel Mts., CA
- 12/70 - Hawaii
- 1/71 - Kilbourne Hole, NM
- 2/71 - Ubehebe Craters, CA
- 3/71 - Taos, NM
- 4/71 - Coso Hills, CA
- 5/71 - Nevada Test Site, NV
- 6/71 - Flagstaff, AZ

### Number of Trips

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<th>6</th>
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### Apollo 16 - Launch 16 April 1972
- 7/70 - San Juan Mts., CO
- 7/70 - Medicine Hat, Alberta, Can.
- 9/70 - Colorado Plateau, AZ
- 10/70 - N. Minnesota
- 11/70 - Nevada Test Site, NV
- 11/70 - San Gabriel Mts., CA
- 1/71 - Kilbourne Hole, NM
- 1/71 - Kilbourne Hole, NM
- 2/71 - Meteor Crater, AZ
- 3/71 - Flagstaff, AZ
- 4/71 - Camp Verde, AZ
- 5/71 - Capulin Mts, NM
- 6/71 - Mono Lake, CA
- 7/71 - Sudbury, Ontario, Can.
- 9/71 - Taos, NM
- 10/71 - Nevada Test Site, NV
- 11/71 - Coso Hills, CA
- 12/71 - Hawaii
- 2/72 - Boulder City, NV

### Number of Trips

| 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

### Apollo 17 - Launch 6 December 1972
- 10/71 - Big Bend Region, TX
- 11/71 - Flagstaff, AZ
- 11/71 - Coso Hills, CA
- 12/71 - Kilbourne Hole, NM
- 1/72 - Boulder City, NV
- 2/72 - Chocolate Mts., CA
- 2/72 - Flagstaff, AZ
- 3/72 - Sierra Madera, TX
- 4/72 - San Gabriel Mts., CA
- 6/72 - Hawaii
- 7/72 - Stillwater Complex, MT
- 8/72 - Nevada Test Site, NV
- 9/72 - Tenopah, NV
- 10/72 - Blackhawk Slide, CA
- 11/72 - Flagstaff, AZ

### Number of Trips

| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

## All-Time Number of Trips

| 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 |
|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 28 | 23 | 22 | 21 | 19 | 17 | 16 | 15 | 13 | 12 | 10 | 9 | 7 | 6 | 6 | 6 | 6 | 5 | 4 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## Notes

- The table includes participation in Apollo training trips from Apollo 15 to Apollo 17.
- Each trip is listed with its corresponding date and location.
- The number of trips taken by each participant is indicated by an 'X' in the respective row.
- The all-time number of trips is shown at the bottom.
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

• Training ensures cadre of personnel for mission specific directors, trainers, backroom participants and team scientists

Silver & Apollo 16 crew

Schmitt & Cernan
CURRENT FIELD GEOLOGY TRAINING

• Teaching / Field Camps

• Field Assistants

• Integrated Analog Tests

* Includes candidates and senior members of Astronaut Office
TEACHING / CLASSROOM

• Limited discussion of planets or targets
TEACHING / CLASSROOM

- Present basic classroom understanding of major geologic principles
- Focus on what crew can see from orbit linked to what it looks like on surface
  - Outcrop to Orbit
• Look out the window
• Identify volcanoes
• Acquire images of them
• Describe what you see
• What observations can they make
• Why they are important
• How to make them
TEACHING / FIELDCAMPS

• Complete “Outcrop to Orbit”
• Astronaut Office also uses field geology training for:
  – Expeditionary training
  – Team building
• Also used to train senior members
TEACHING / FIELDCAMPS

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Dike Swarm, Sinai Peninsula

Ship Rock, NM
FIELD ASSISTANTS

- Astronauts take part in funded field research projects
- Astronaut Office also uses field assistantships for:
  - Expeditionary training
  - Team building
FIELD ASSISTANTS

- Sample identification, documentation, collection
- Instrument deployment and operation
- Mapping, interpretation of features from orbit vs ground

Sample collection

Data collection

Lava Tubes
FIELD ASSISTANTS

- Participation is mutually beneficial
- Astronauts think outside the geologist’s “box”
- Forces us to critically rethink our hypotheses
- Astronaut gains firsthand experience with in-field hypothesis development
- Exposure to geologically “talking the talk”
INTEGRATED ANALOGS & FIELD TESTS

- Research and Technology Studies (RATS); 1997-2012
- Conducted in analogs settings (hardware, operations, geology)
- To address different questions there are a series of different test teams and opportunities for outside participation
  - RATS, NEEMO, ISTAR, ISRU Hawaii Analog, HiSEAS, PLRP, ESA CAVES

http://www.nasa.gov/exploration/analogs/
or, internet search: nasa & analogs
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INTEGRATED ANALOG TESTS

- Crew conduct field tests with scientists and engineers
- Evaluate best practices for using hardware and operations to achieve science goals

NEEMO 16

DRATS 2010
CONCLUSIONS

• Begin developing the training team now, both inside and outside NASA

• 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, science team and backroom participants might be selected

• Using the time we have now to establish protocols and procedures with next generation technology and personnel