

Middle Crescent Crater



Tremors and Tracks: Tracing the Apollo 12 Astronauts Through Time

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EVA-1

50m

General Acronyms

ALSCC = Apollo Lunar Surface Close-up Camera (stereoscopic)
ALSEP = Apollo Lunar Surface Experiment Package
CapCom = Capsule Communications at Mission Control in Houston (Gibson)
CCIG = Cold Cathode Ion Gauge (attached to the SIDE)
CDR = Commander (Charles "Pete" Conrad)
CS# = Core Sample
C/S = Central Station
DAC = Data Acquisition Camera (16mm video camera in LMP window of LM)
EMU = Extravehicular Mobility Unit (the iconic spacesuit)
EVA = Extravehicular Activity
FP-# = Footpad (usually refers to Surveyor III Spacecraft)
GET = Ground Elapsed Time (AKA: Mission Elapsed Time)
HTC = Hand Tool Carrier
LM = Lunar Module
LMP = Lunar Module Pilot (Alan Bean)
LP = long period (oscillations seen by the PSE)
LROC = Lunar Reconnaissance Orbiter Camera
LSM = Lunar Surface Magnetometer
MESA = Modular Equipment Stowage Assembly (tool table attached to the LM)
NAC = Narrow Angle Camera (one of the LROC cameras)
PLSS = Portable Life Support System (the white, rectangular backpack)
PSE = Passive Seismic Experiment
RTG = Radioisotope Thermoelectric Generator
SEQ Bay = Scientific Equipment Bay
SIDE = Suprathermal Ion Detector Experiment (CCIG is attached to this)
SWC = Solar Wind Collector
SWS = Solar Wind Spectrometer

Station Acronyms

Stations are defined here as locations where astronauts stopped to collect samples, and/or take Hasselblad photos, and/or work with equipment. The approximate size of a station is based off of the area they travelled around in while documenting, sampling, or working at a single feature or piece of equipment. Each station is named after the geologic feature of interest; large equipment packages; or a combined name that states first where they were, then where they are going. Numbers indicate the order in which they visited sites around each feature of interest (excluding LM-2 through LM-5, named in counterclockwise order).

BK = Block Crater
BN = Bench Crater
CC = Contrast Chart Site
CO = Contingency Sample Site
HD = Head Crater
HO = Halo Crater
MC = Middle Crescent Crater
NM = North (Small) Mound
SM = South (Large) Mound
SP = Sharp Crater
SV = Surveyor Crater
S3 = Surveyor III Robotic Lander
TR = Triple Craters

Apollo Identification Numbers

AS12-##-### = Apollo 12 Photo ID Number
120## = Sample ID Number

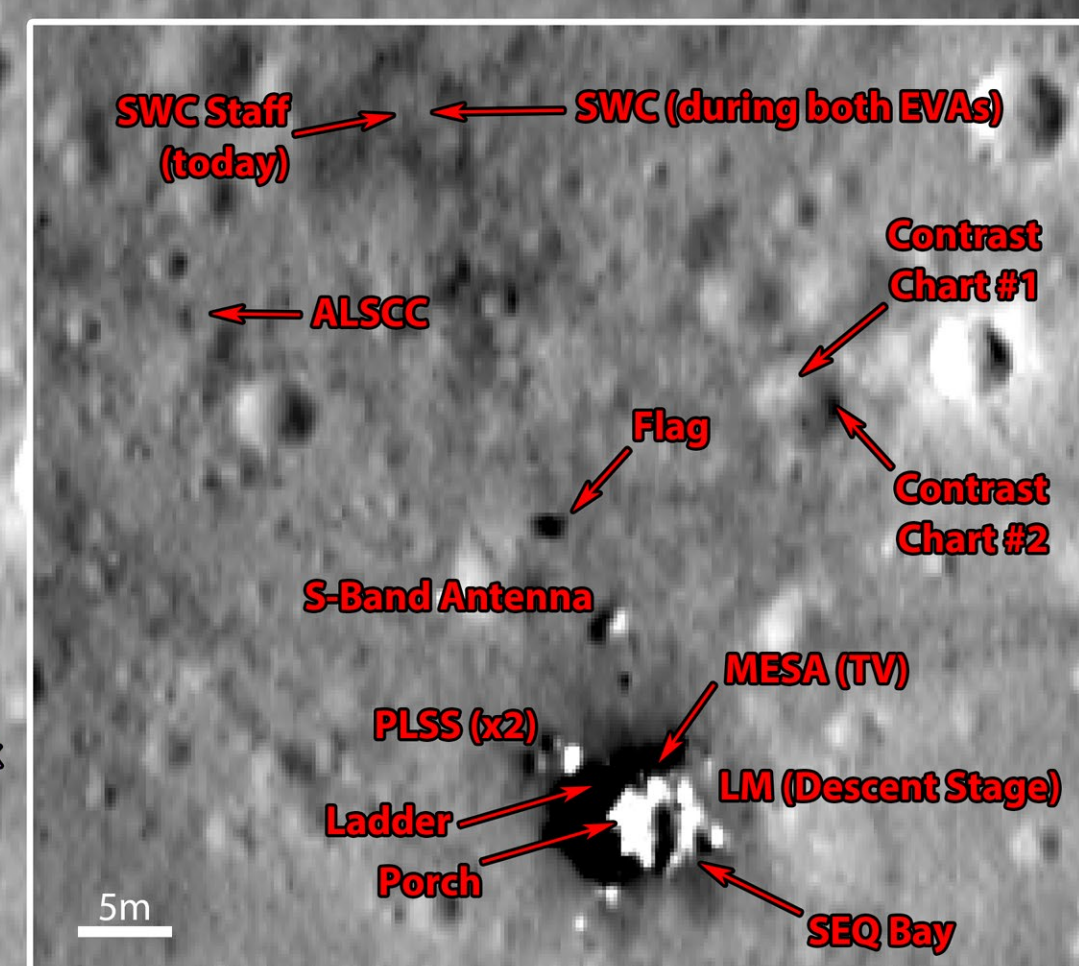


Fig 1-7. Equipment near the LM on LROC NAC M175428601R

LROC NAC M175428601R

EVA-2

50m

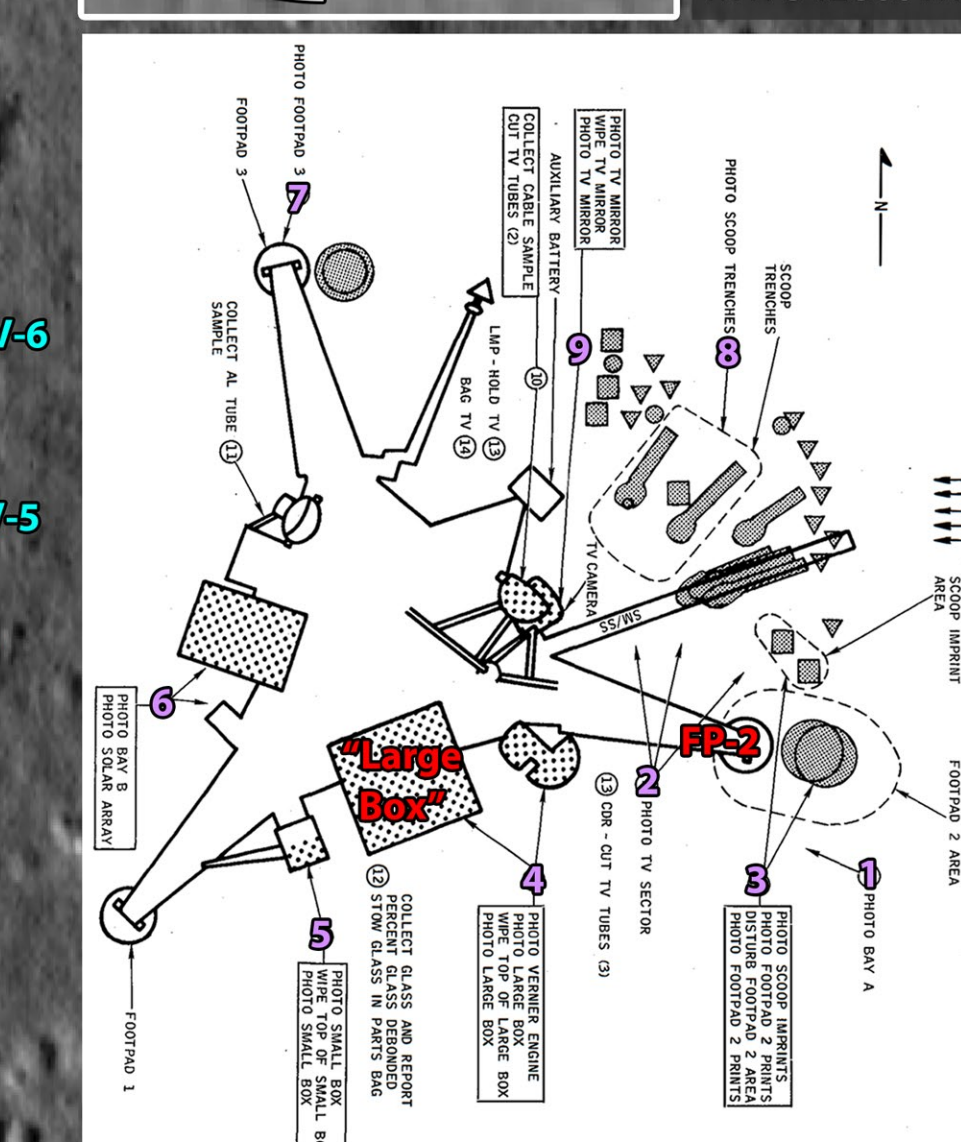
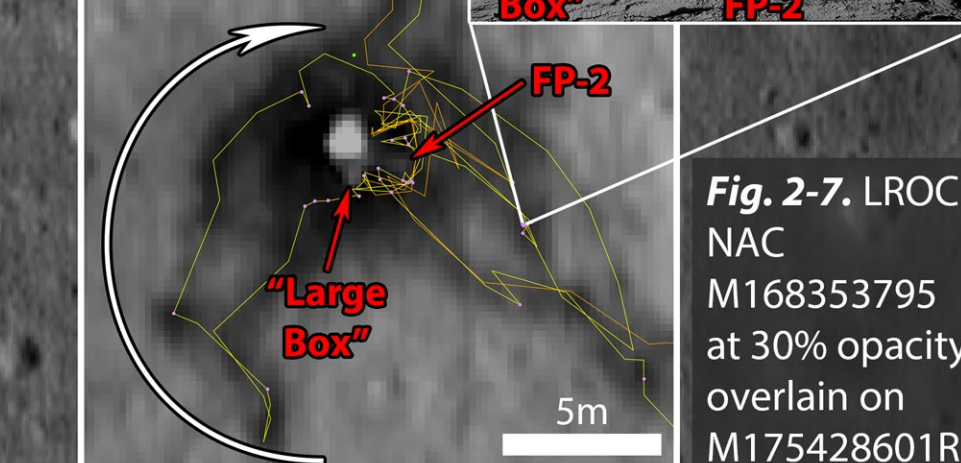
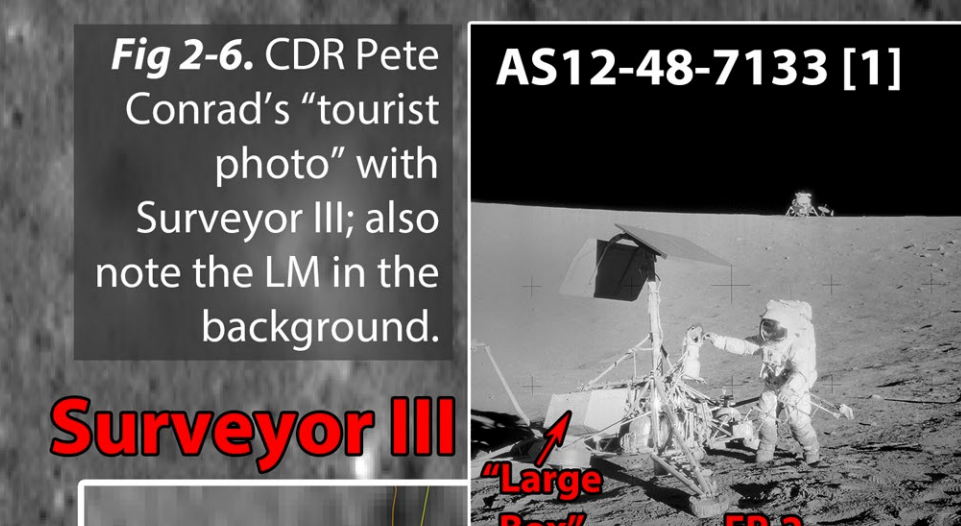
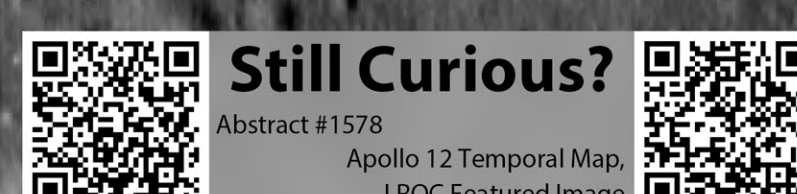


Fig 2-8. Supplementary data, such as diagrams from the Final Lunar Surface Operations Plan (17), were crucial to determining where the Astronauts were without the video footage. Here, it helped illustrate that the LMP, Alan Bean, orbited Surveyor III in a clockwise direction while taking inspection photos.

References:

Apollo 12 mission data, generated between 1969-1979: [1] (<http://tothemoon.ser.asu.edu/gallery/apollo/>), [2] NASA JSC (2010) (<https://archive.org/details/Apollo12Audio>), [3] Gray (2005) (https://spacehistory.tv/blog/?page_id=66), [4] NASA JSC, Apollo Film Archives, Vol. 1, [5] JAXA DARTS (2019) Moon Seismic Monitor, [6] Apollo 12 MR (1970) MSC-01855, [7] Apollo 12 PSR (1970) NASA-SP-235, [8] Meyer (2012) (<https://curator.jsc.nasa.gov/lunar/lsc/index.cfm>), [9] Sutton & Schaber (1971) LSC II, 1, 17, 2, **Transcripts** [10] Bailey & Ulrich (1975) NASA-CR-145520, [11] Jones (2016) ALSC, (<https://www.hq.nasa.gov/alsj/a12/a12.html>), **Recent studies using LROC NAC imagery**: [12] McInall (2018) (https://www.hq.nasa.gov/alsj/a12/A12_Grand_Traverse_Planimetric_Map-LROC_M175428601R_Mar_2018.jpg), [13] Schwagmeier & Jones (2011) (<https://www.hq.nasa.gov/alsj/a12/a12TraverseOnM168353795R.jpg>), **LROC Work**: [14] Gonzales et al. (2019) LPSC L, Abs. #3080, [15] Henriksen et al. (2015) PDW II, Abs. #7033, [16] Wagner et al. (2017) Icarus, 283, 90-103, **Additional Resources**: [17] Apollo 12 Final Lunar Surface Operations Plan, Fig 3-10, (<https://www.hq.nasa.gov/alsj/a12/a12LSOpsPlanFig3-10.jpg>)



Abstract #1578
Apollo 12 Temporal Map
LROC Featured Image

Fifty years after Apollo 12, we remember the historic significance of the second manned lunar landing mission with a new map, charting the movements of Astronauts Charles "Pete" Conrad and Alan Bean across the Moon's surface in more detail than has been attempted to-date. Here, we explore some of the significant steps Apollo 12 Astronauts took, where each colored dot represents every photo they took, every sample they collected, and every piece of equipment they deployed. Surveyor III, a robotic lander used as a precision landing target and equipment retrieval opportunity for Apollo 12, can also be seen. An interactive version, that includes the Astronauts' location at every moment throughout both traverses, can be found at the link in the "Still Curious" section below.

Key
● Sample Collection Site
● Hasselblad Photo Site
● ALSCC Photo Site
● Mobile Equipment Site
— CDR Charles "Pete" Conrad Traverse
— LMP Alan Bean Traverse
— EVA Station Acronym
— Equipment Left on the Moon

Fig. 1-4. View of LMP Alan Bean setting up the ALSEP as seen from NM-ALSEP-1, looking to the south (photo cropped for detail).

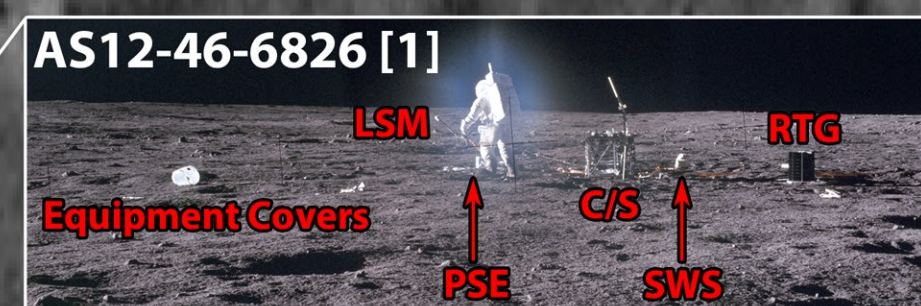


Fig. 1-6. At GET 118:26:05, CDR Pete Conrad jokingly remarked: "What I hate to see is an LMP laying on the lunar surface". LMP Alan Bean had just become the first person to fall over on the Moon. This visible splash is the disturbed dust that went flying when he hit the surface.

Methodology for Both EVAs

- Spatially located the station using NAC images (Figs. 1-1, 1-6, 2-1, 2-5, 2-7 & basemaps) & transcripts (Tables 1-1, 2-1)**
 - a.) searched the transcripts for locational clues
 - b.) followed the tracks seen in the NAC images to find the station
 - c.) mapped deployed equipment that can still be seen in NACs (Figs. 1-5, 1-7)
- Spatially located events using Hasselblad Photos (Figs. 1-2, 1-4, 2-2, 2-6)**
 - a.) mapped where the astronauts were when they took the photos
 - b.) mapped any equipment seen in the photos
 - c.) mapped any samples seen in the photos
 - d.) mapped astronaut movements from footprints & shadows in photos
- Spatially located points & temporally located events using videos (Fig. 1-3)**
 - TV (lost when accidentally pointed at the sun ~40 min into EVA-1)
 - DAC (limited by length of film and frame rate)
 - allowed mapping of small movements
- Temporally located remaining points using audio & seismometer (PSE) (Fig. 2-4)**
 - PSE was turned on about two-thirds of the way through EVA-1
 - for much of EVA-2 they were out of range of the PSE
- Refined details using mission documents [1-9, 17] (Fig. 2-8) & prior studies [12-13]**
 - diagrams of equipment setup and photography, and preliminary maps
 - descriptions of ALSCC photos, etc.
- Developed the database (Fig. 2-3)**
 - a.) collected details on (often done simultaneously with steps 1-5):
 - samples (bag #, sample ID, size, Hasselblad photos of each sample)
 - Hasselblad contents
 - ALSCC descriptions, etc.
 - b.) developed station naming scheme (see "Station Acronyms")

Example Mapping Process for EVA-1: CDR Exiting LM

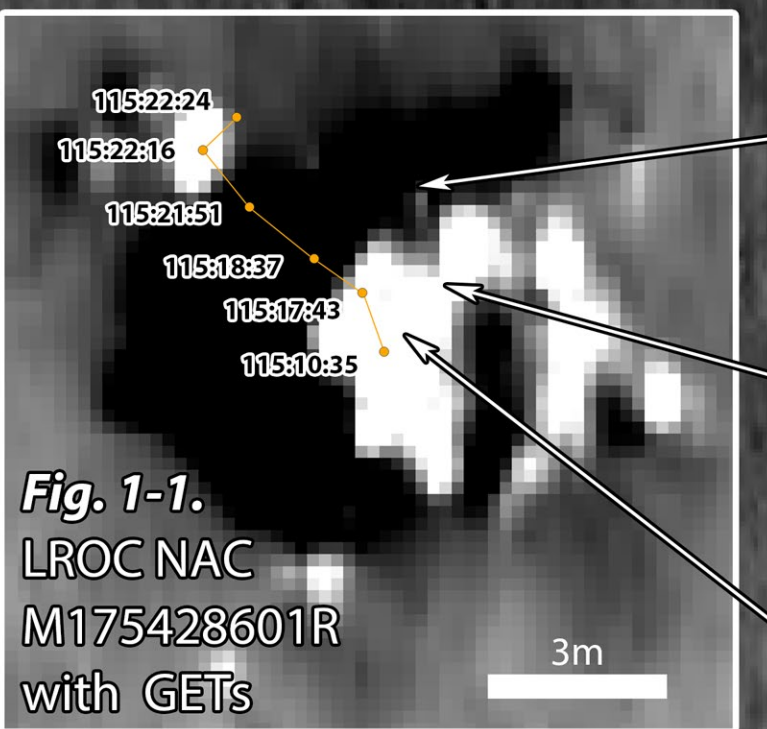


Fig. 1-2. Hasselblad Photos of CDR Exiting LM (EVA-1)

The LMP, Alan Bean, took a series of 4 photos (AS12-46-6715 to 6718) from inside the LM of CDR Pete Conrad descending the ladder.

Expanding on step 2 of the Methodology, we first found the time the photos were most likely taken. This series corresponds to the moment the LMP asked the CDR to hold still (see Table 1-1). Then, we mapped where both astronauts were standing at that moment (see Fig. 1-1 for location of CDR). The arrow points to the spot the LMP was standing to take the photos.

Table 1-1. Transcript of CDR Exiting LM (EVA-1)

115:10:35 - CDR: "Okay the hatch is open now."
115:17:43 - CDR: "Okay, I'm out on the porch."
115:19:02 - LMP: "Okay, now hold it there just a second, Pete." (Hasselblad photos)
115:19:11 - CDR: "Do you have any TV, Houston?"
115:19:14 - CapCom: "Roger. We've got a TV. No Pete Conrad as yet." (TV is sending a signal)
115:19:19 - CDR: "No, I'm at the top of the ladder."
115:21:51 - CDR: "Man is that a pretty looking sight, that LM."
115:21:58 - CapCom: "You're coming into the picture now, Pete."
115:22:06 - LMP: "Okay. Got the old camera up and running." (DAC is recording)
115:22:16 - CDR: "Whoopie! Man, that may have been a small one for Neil, but that's a long one for me."
115:22:22 - CDR: "I'm going to step off the pad." (shown in TV and DAC footage examples, above)
115:22:24 - CDR: "Mark."
115:22:30 - CDR: "Off the -- ooooh, is that soft and queasy."

Example Mapping Process for EVA-2: Sampling Head Crater

Table 2-1. Transcript for Station HD-5

132:31:20 - LMP: "I took 3 quick pictures of Triple Craters, Houston." (leaving the Triple Craters station, TR-1)
132:31:40 - LMP: "I'm kind of wondering, we're passing up these here and they got to be bedrock from somewhere. We need to get a pretty large-sized one here, before we leave this area, Pete."
132:31:47 - CDR: "I'll tell you what we'll do. I'll stop right here and take a pan." (CDR at HD-5)
132:31:55 - LMP: "Now these rocks obviously came outta the crater because they're scattered more uniformly around, there's a bunch of 'em on the rim, and there's not many far away."
132:32:07 - LMP: "We're moving straight south now."
132:32:08 - CDR: (starts taking a 360-degree panorama of Head Crater)
132:33:12 - CDR: "Okay, now. Back to rock-taking settings: 5 feet, f/8, 1/250. Okay. All right, Al, where do you want to grab a sample here?"
132:33:20 - LMP: "Right here. I'd like to grab that rock right there, because it's got kind of a sharp edge on it and all the rest of them are, I don't know, it's got...uhh... it's got kind of an oblique edge on it, and you don't see many like that around here."
132:33:32 - CDR: "Which one?"
132:33:33 - LMP: "This one right here, this gray one. It looks a little bit different than the rest."
132:33:43 - CDR: "Ho, ho, ho! Wait until I get the pictures." (taking Hasselblad photos of the samples prior to collection)
132:34:18 - CDR: "That's all right. All right. Picking 'em up, no sweat." (while collecting the sample, they dropped it)

Fig. 2-2. Hasselblad Photos Taken at HD-5 (all EVA-2 photos are in grayscale)

AS12-49-7201 to 7216 = Head Crater Pan (CDR)
AS12-48-7059 = sample #12052 (LMP)
AS12-49-7217 to 7218 = sample #12052 stereo (CDR)

Fig. 2-3. Head Crater Sample

In the photo below (NASA #570-44633 [8]), sample #12052 is viewed from a different angle than in Hasselblad AS12-49-7217. Although this sample was too large for a numbered sample bag, it has been positively identified in several prior studies [6-9, 12-13], and was confirmed to be #12052 in this study.

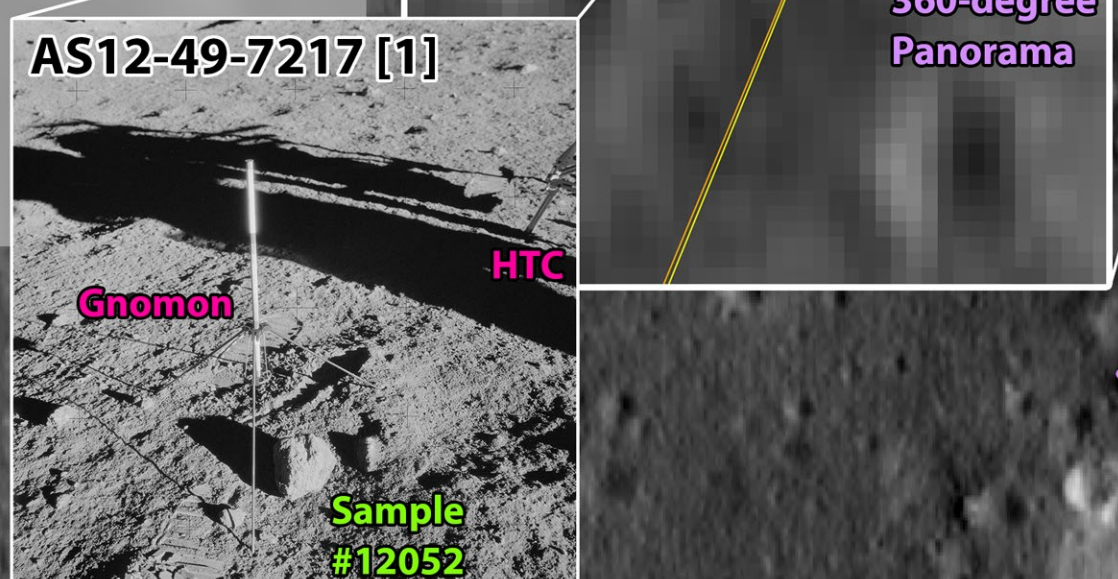
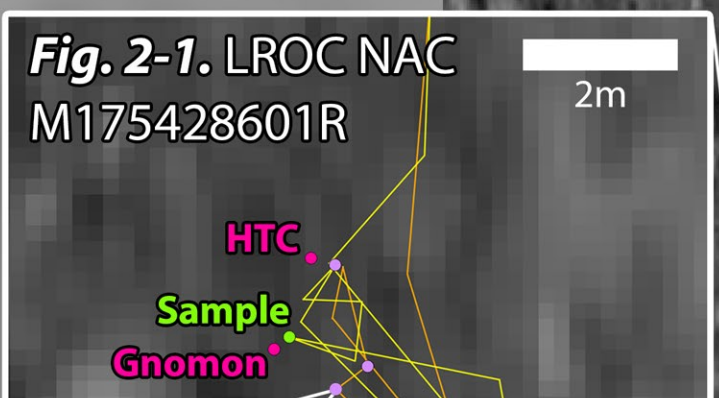
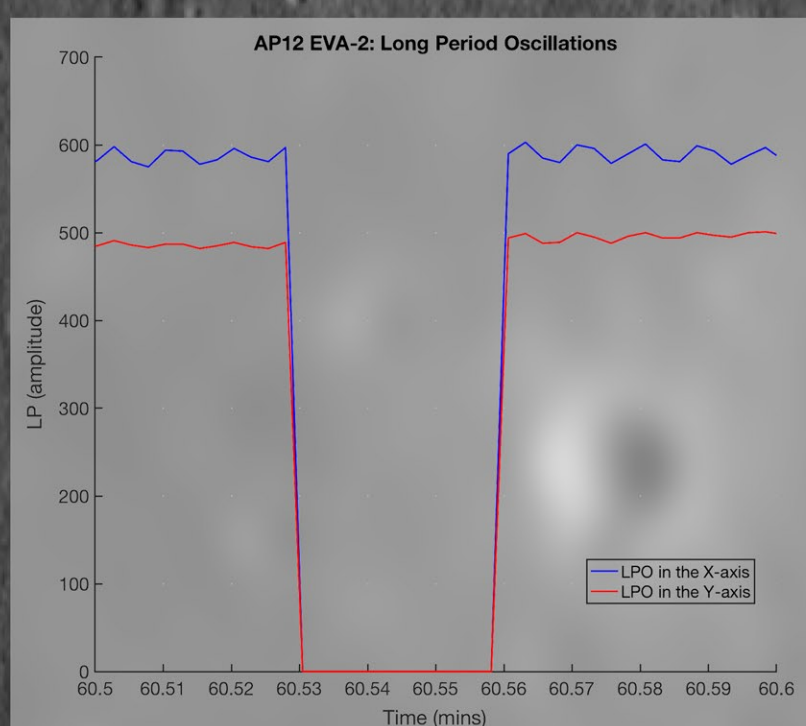


Fig. 2-4. PSE Data Long period oscillations along the x (blue) and y (red) of the seismometer are plotted as amplitude on the x-axis. The large drop, indicates the moment CDR Pete Conrad landed on the footpad at the start of EVA-2, at GET 131:38:54.



Sharp Crater

Bench Crater

Halo Crater

Surveyor III Robotic Lander