UNited States
Department of the Interior
Geological Survey

INTERAGENCY REPORT: ASTROGEOLOGY 21

PARAPHRASED GEOLOGIC EXCERPTS FROM
APOLLO 12 MISSION

by

David Schleicher, Editor

June 1970

Prepared under NASA Contract T-65253G

This report is preliminary and has not
been edited or reviewed for conformity
with U.S. Geological Survey standards
and nomenclature.

Prepared by the Geological Survey for the
National Aeronautics and Space
Administration
INTERAGENCY REPORT: ASTROGEOLOGY 21

PARAPHRASED GEOLOGIC EXCERPTS FROM
APOLLO 12 MISSION

by

David Schleicher, Editor

June 1970

Prepared under NASA Contract T-65253G
### CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation of punctuation devices</td>
<td>2</td>
</tr>
<tr>
<td>Abbreviations</td>
<td>3</td>
</tr>
<tr>
<td>LM descent and touchdown</td>
<td>5</td>
</tr>
<tr>
<td>Geologic description from LM windows</td>
<td>6</td>
</tr>
<tr>
<td>EVA 1</td>
<td>15</td>
</tr>
<tr>
<td>Debriefing between EVA's</td>
<td>45</td>
</tr>
<tr>
<td>Traverse planning for EVA 2</td>
<td>48</td>
</tr>
<tr>
<td>EVA 2</td>
<td>53</td>
</tr>
<tr>
<td>Debriefing during trans-Earth coast</td>
<td>111</td>
</tr>
<tr>
<td>News conference during trans-Earth coast</td>
<td>126</td>
</tr>
</tbody>
</table>
Paraphrased Geologic Excerpts from Apollo 12 Mission*
by
David Schleicher, Editor

This transcript is intended to assemble in convenient form all data of potential geologic significance transmitted by the astronauts and capcom during the Apollo 12 mission. It includes descriptions made during descent to the Moon, before and during each EVA, and during the trans-Earth coast. The geologic data have been edited and paraphrased to condense the transcript and resolve some of the ambiguities that arise from literal transcription of extemporaneous oral descriptions. I have not attempted to edit informal expressions into formal prose unless they could be significantly shortened or clarified. Ambiguous statements that could not be resolved are presented verbatim.

Records used in editing the transcript include the transcript compiled by the Geology Experiment team during the EVA's, the Public Affairs Office "Mission Commentary," the Manned Spacecraft Center "Air-to-Ground Voice Transcript," and, most importantly, audio tapes of the mission.

*Prepared on behalf of the National Space and Aeronautics Administration under contract number T-65253G.
Explanation of Punctuation Devices

Communications problems

------------- signal totally unintelligible (04 22 10 53)

----- ----- signal broken, but recognizable (04 22 14 44)

as individual words or syllables of number indicated

Interpretation of poorly intelligible words

film(?) almost-certain interpretation (05 11 58 54)

[white] more speculative interpretation (05 11 59 49)

[1, 2, 3,] editorial addition of words not transmitted or omitted in conversation, but understood from context

Punctuation

I can see the glitter-- pause or interrupted sentence (05 12 36 36)

... glass beads. incomplete sentence (05 13 14 51)

* * * words within a single uninterrupted radio transmission deleted in editing (04 14 29 18)

* * * considerable elapsed time between communications (e. g., no radio transmissions between 04 14 05 16 and 04 14 06 55)
All times are expressed as Ground Elapsed Time (GET) after lift-off from Earth, e.g.:

\[
\text{day hr min sec} \quad 04 \quad 11 \quad 20 \quad 13
\]

For a few parts of the transcript that have been considerably rearranged in editing, the times may be wrong by several minutes.

**ABBREVIATIONS**

ASC ALSEP Central Station
ALHT Apollo Lunar Handtool(s)
ALHTC Apollo Lunar Hand Tool Carrier
ALSD Apollo Lunar Surface Drill
ALSEP Apollo Lunar Surface Experiments Package
A/S Ascent Stage
BS Bulk Sample
BTU British Thermal Unit
CCGE Cold Cathode Gauge Experiment
CCW Counterclockwise
CDR Commander (Conrad)
CM Command Module
CMP Command Module Pilot (Gordon)
CPLEE Charged Particle Lunar Environment Experiment
CSRC Contingency Sample (Return Container)
CSC Lunar Surface Close-up Camera
CSM Command and Service Modules
CW Clockwise
DD Dust Detector (Experiment)
DPS Descent Propulsion System
DRT Dome Removal Tool
DS Documented Sample
D/S Descent Stage
ECS Environmental Control System
EMU Extravehicular Mobility Unit
ETB  Equipment Transfer Bag
EVA  Extravehicular Activity
FPS  Frame Rate (Sequence Camera)
FTT  Fuel Transfer Tool
HFE  Heat Flow Experiment
HOU  Houston (Capcom)
IFR  Instrument Flight Rules
INT  Intrepid (Conrad or Bean)
ITMG  Integrated Thermal-Meteoroid Garment
LD   Lunar Day (TV Lens)
LEC  Lunar Equipment Conveyor
LHSSC  Left Hand Side Stowage Compartment
LM   Lunar Module
LMP  Lunar Module Pilot (Bean)
LRL  Lunar Receiving Laboratory
MCC-H  Mission Control Center - Houston
MESA  Modularized Equipment Stowage Assembly (Descent Stage)
MSFN  Manned Spaceflight Network
OPS  Oxygen Purge System
PLSS  Portable Life Support System
PSE  Passive Seismic Experiment
RCS  Reaction Control System
RTG  Radioisotope Thermoelectric Generator
SC   Sequence Camera
S/C  Spacecraft
SEQ  Scientific Equipment (Bay) (Descent Stage)
SRC  Sample Return Container
SWC  Solar Wind Composition (Experiment S-080)
TV   Television
UHT  Universal Handling Tool
WA   Wide Angle (TV Lens)
LM descent and touchdown.

04 14 05 16  CDR  We're looking for the Snowman.
                *  *  *
04 14 06 55  CDR  I sure hope you have us lined up right, because there sure are some big mountains right in front of us now. I hope we go down the middle; there's one valley.
                *  *  *
04 14 08 36  CDR  Houston, where are we--over Fra Mauro?
                *  *  *
04 14 10 36  HOU  You probably just passed over Theophilus.
04 14 10 43  LMP  Pretty darn rugged down there.
                *  *  *
04 14 27 37  LMP  I'm going to turn the sequence camera on. It's running.
                *  *  *
04 14 27 57  LMP?  OK, we're out at 19,000 ft. I've got some kind of horizon out there; I've got some craters too, but I don't know where I am yet.
                *  *  *
04 14 29 03  INT  I'm trying to look out there. I think I see my crater, but I'm not sure.
04 14 29 18  CDR  Hey, there it is! Right down the middle of the road. *** We're targeted(?) right for the center of the crater.
                *  *  *
LMP 366 ft.

(?)04 14 29 47 CDR I got to get over to the right.
04 14 30 56 LMP You're at 330 ft, coming down at 4  *  *  *  300 ft, coming down at 5.
04 14 31 06 CDR Oh, look at that crater--right where it's supposed to be.
     *  *  *  *
LMP 240 coming down at 5. Hey, you're really maneuvering around.
04 14 31 19 CDR Yeah
     *  *  *  *
04 14 31 31 LMP 180 ft, 9 percent. You're looking good. Gonna get some dust before long.
130 ft. *  *  *  50 ft. Coming down. Watch for the dust.
04 14 32 04 CDR Yeah
LMP 46. *  *  *  40. Coming down at 2. Looking good. Watch the dust. 32. *  *  *
04 14 32 35 24 ft. Contact light!

Geologic description from LM windows.--

04 14 33 58 CDR I think this place is a lot dustier than Neil's. It's a good thing we had a simulator, because that was IFR landing.
     *  *  *  *
04 14 35 11 CDR We flew right by the crater, (Houston,) but this ground looks neat out here.
We're not going to have any trouble going back there.
     *  *  *  *
We landed about half way between Site 4 and Site 3. I flew by the right side of the crater and then had to fly over to the left and land.

* * *

It's a nice place to land.

Boy, it sure was dusty though.

* * *

It's a good thing we leveled off high and then came down, because I sure couldn't see what was underneath us once I got into the dust. That was a long way. That stuff was going to the right.

Do you really(?) just like you say? Look at those boulders out there on your right, Pete. Those rocks over there might be part of a Copernicus ray.

* * *

I think I shut the engines down before touchdown. I was on the gauges; that's the only way I could see where I was going. I saw that blue contact light, and I shut down, and we hit from about 6 ft.

* * *

We landed very close to the head of the Snowman, probably on exactly the same line as selected Site 3, but a little bit farther left. Let me give you some approximate coordinates here.

* * *

We're having a little trouble judging distances. How long is our shadow?
Your shadow length on the level surface is 250 ft.

You've got to be kidding me.

We could shorten that a bit to 230.

Well, if my shadow is 230 ft long, we're really misjudging distances. I'd say that my shadow is much shorter than that.

If we assume a uniform 3.5-degree slope, your shadow length is 150 ft.

OK, then I'm judging about right. What is the diameter of the head of the Snowman?

Rim-to-rim diameter of Head crater is 400 to 500 ft.

Houston, on Map 7-6 at coordinates L.5 and 10.5--just to the left of the Snowman's head--I think there's a very sharp blocky-rimmed crater. Do you agree?

I think I'm sitting just to the right of the Snowman's head at coordinates R.2 and 13.3.

The coordinates you gave us are for Bench crater.

Yes, it is Bench crater. And I think I landed at Head crater, just a bit past one of our planned traverses.

I think we know our location within a few hundred feet. I flew right by the side of [Surveyor] Crater and landed near by, but that's about my best guess on location right now.
04 16 35 36  HOU  On your earlier question on Bench Crater--from our map we can't tell whether it has a blocky rim.

04 16 35 49  CDR  This crater is about 5° to the left of the LM shadow. It has a very blocky rim with blocks that may be up to 8 ft across, depending on its distance.

04 16 38 32  HOU  To help us pin down your location--can you see an 8- to 10-ft block about 50 ft in front of you at coordinates R.S 13.1?

04 16 39 23  INT  Negative, but there is one great big block that's probably 1500 to 2000 ft in front of us that may fit that description. *** But the illumination is confusing. There is another large crater directly in front of us, but it's not obvious to us because there's no shadow in it. The head of the Snowman may be farther past us. We may be sitting right on the other side of the Surveyor Crater, or just a little bit past it. I really think the best thing for us to do is to get out and look around. The sooner we do that, the quicker we will figure out where we are.

04 16 46 43  CDR  You already know that we flew right by the side of the Snowman and landed just beyond him. Our yaw angle is 10°. Almost all the rocks around us are angular.
On the blocky rimmed crater that I mentioned previously there are big blocky boulders that look pure white through the monocular. Some of them are 8 or 10 ft across, and some on the horizon must be 20 ft across.

* * *

A general comment about all the blocks in the surrounding terrain: at first glance out of the spacecraft, I can distinguish absolutely no differences in color, composition, or texture. About the only difference is looking cross sun versus down sun. We have a pretty low sun angle, and I'm looking at the rocks at a low angle, and in the monocular they all appear white. They're all very blocky, and the size goes all the way up to about 20 ft for a couple of big rocks on the horizon.

* * *

In order to pin down your location a little bit better, would you give us the distance and angle from your Z axis to the large blocks that you see on the horizon and also of craters that are roughly 20 ft or more in diameter, that is, slightly larger than the LM shadow width. * * *

I'll give you a quick description instead, and when we get out we'll show you the craters in the TV.

We are sitting on an undulating plain with no mountains or high hills, so that you can see quite far in all directions. The only relief in this generally rolling country is caused by blocky-rimmed craters that are visible in almost...
every direction at various distances. Pete described one at 12:00 o'clock about 2,000 or 3,000 ft away; if it didn't have large boulders on it and a rim about 10 ft high, we wouldn't be able to see it. The diameter of that crater must be on the order of 600 or 700 ft.

There are a number of more weathered craters around us of every size, from one 15 ft away at 2:00 o'clock that's about 6 ft in diameter and about 3 ft deep, all the way up to one with a subdued rim at 1:00 o'clock with a diameter on the order of 400 or 500 ft.

There are many rocks scattered around on the surface. Most of them are partly buried and have little fillets of dirt built up around them. I can't tell, of course, whether the fillets are all on this side, but all these rocks seem to have the same characteristics whether they're small or large.

About 20 ft away at 12:00 o'clock there's a surface that's different from the rest in that it has parallel lines or trenches about 1/8 in. deep and running north-south. It extends from my 2:00 or 3:00 o'clock position all the way over into Pete's window. The left(?) seems to be some sort of force that apparently caused these traces to be made in the surface. I don't think it was our engine because the trenches are perpendicular to those that our engines would have made. We'll take a closer look at them when we get out and take some closeup stereo pictures.
Pete also pointed out that there don't seem to be any contacts between materials of different colors. There may be contacts between materials of different texture, for example, the area I described directly in front of the LM with the north-south trenches.

There are no immediately apparent white(?)-rimmed craters near us. Most of the ones that I can see from my window don't have a raised rim at all. They don't have any particular elongation. They seem to have about the same texture as the areas surrounding them.

On the edges of some craters not too far away are some pretty nice-sized rocks that we suspect could be bedrock from below the regolith. * * * It looks as if there are some good places out to the west for the ALSEP. * * * This is a lot better surface than Pete or I had imagined before we got here. I think we'll be able to move around pretty well, and there seem to be a lot of different sample types.

What is the distance to the 400-ft crater which you see at 1:00 o'clock?

It's about 500 ft. It runs from about my 12:30 to my 2:00 o'clock position. It doesn't seem to have any particular blocks on the rim.

If I peer around the corner of the window I'm right on the edge of another great big crater not 20 ft behind me. It slopes at 10° or more and it's about
300 to 400 ft in diameter. It's very subdued(?), and it wasn't apparent to me that it was there when I came in for the landing, but I turned around and flew around the back.

* * *

04 18 23 33 CMP I've sighted Intrepid on the rim of Surveyor crater, about 1/4 crater diameter to the north-west.
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>CDR</th>
</tr>
</thead>
<tbody>
<tr>
<td>04 19 18 40</td>
<td>CDR Egress</td>
<td>We're about 25 ft in front of the Surveyor crater.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I'll bet I can see the Surveyor from the bottom of the ladder.</td>
</tr>
<tr>
<td>04 19 21 20</td>
<td>CDR deploys LEC</td>
<td>They aren't kidding when they say things get dusty.</td>
</tr>
<tr>
<td>04 19 21 24</td>
<td>CDR descends ladder</td>
<td></td>
</tr>
<tr>
<td>04 19 21 58</td>
<td>CDR appears in TV picture</td>
<td></td>
</tr>
<tr>
<td>04 19 22 06</td>
<td></td>
<td>I've got the sequence camera running.</td>
</tr>
<tr>
<td>04 19 22 24</td>
<td>CDR steps off pad</td>
<td></td>
</tr>
<tr>
<td>04 19 22 25</td>
<td></td>
<td>* * * Oooh! Is that sloppy!* * * I don't sink in too far. * * * I can see the Surveyor sitting on the side of the crater. It can't be farther than 600 ft from here. * * * It's sitting on quite a steep slope.</td>
</tr>
<tr>
<td>04 19 25 03</td>
<td></td>
<td>As you might expect from the Apollo 11 photos, there are several small rocks in front of me with</td>
</tr>
</tbody>
</table>
CDR moves to contingency sample site
CDR collects contingency sample (LRL samples 12070-12077)

(LRL rock samples 12075 and 12073; largest in contingency sample)

mounds of dirt built up around them. My descent engine may have built them.

As a matter of fact the dirt is built up on the side closest to the LM.

There's one scoop.

Here's another with some more rocks in it.

That spurts(?) just like the 1/6-g airplane.

Here's another good-looking rock ______ in the sample.

Another rock I want to get in it.

I think that's about enough. Except this one big rock too pretty to pass up. It won't fit, but I'm going to go over here and get this other one.

* * *

I can see little glass beads. I'm putting a piece about 0.25 in. across into the contingency sample bag.

* * *

Your boots dig into the soil quite a bit. If you don't pick up your feet, you really kick up a load of dirt ahead of you.
Your left foot's pushing ahead a big mound right now. 

* * * * *

04 19 28 40  CDR  I really sink in. 

* * * * *

04 19 29 36  CDR takes _______ apart  

04 19 29 53  CDR  Our descent engine didn't dig any crater at all. 

* * * * *

04 19 30 20  CDR working on MESA  

04 19 33 38  CDR  We hardly stroked the gear at all, and we landed just about vertical. 

* * * * *

04 19 38 06  CDR  _______ _____ color chart. 

* * * * *

04 19 38 55  CDR  I got dirt all over myself. 

* * * * *

04 19 40 47  CDR  We're going to be a couple of dirty boogers. 

* * * * *

04 19 40 56  CDR  I'm about to fall into this little crater. 

* * * * Another crater. 

04 19 41 01  It's a regular obstacle course over there.
Man! Am I going to get dirty!

* * *

That contingency sample is black! ** *

I may have filled the bag too full.

* * *

All right, LEC(?), possible TV deploy, LMP egress,
contingency sample area.

Deploy color chart and place 70-mm on the mesa
get me a camera.

I'll set the sequence camera and be right out.

All right. Let me know so I can photograph you.

Contingency sample: f/8 at 5 ft.

I sampled at quite a few places, so I'm taking a
bunch of pictures.

Your shadow length right now is about 45 ft on a
level plain.

I've got the contingency sample area. Deploy the
color chart.

* * *

I wonder if I can get in the bottom of this crater.

* * *
Wait, Al. I've got to run through this crater.
LMP egress: f/5.6 at 15 ft. I just made a
shambles of that color chart.
I tried to throw it on the ground, and it went in
sideways and is so covered with dirt you wouldn't
know what color it is. * * *

If I had landed
20 ft behind where I did, we
would have landed right smack in that crater.
* * *

I tried to spike the color chart into the ground
so it was perpendicular to the sun, but it didn't
do that, and it's all covered with dirt.
* * *

Deploy color chart on undisturbed surface--I
didn't make it. I got the contingency sample area
and the LMP egress.
* * *

Look how close we landed to Surveyor Crater. * * *
Look at the descent engine; it didn't even dig a
hole.
04 19 53 32  CDR  My boot penetration is exactly the same as Neil's and Buzz's. Every time I get near one of these little craters, I sink in a lot farther.

04 19 54 05  LMP  I notice the material seems to compact into a very shiny surface. I guess the particles are very small and very cohesive, so every bootprint is so well defined it looks almost like a piece of rubber itself. The grains are subresolvable.

04 19 55 00  LMP  I'm glad you didn't land back about 50 ft. You can see some little shiny glass in these rocks. You can also see some pure glass if you look around.

04 19 55 18  LMP  Houston, I was going to deploy the TV camera 20 ft out at 10:00 o'clock, but because of the sun being where it is, I'm going to have to deploy it slightly closer to the 2:00 o'clock position. I think that'll be OK though. That'll give you a good shot right in here. I'll see if I can keep the sun from getting in the camera now.

04 19 59 26  LMP deploys TV  LMP
04 19 59 45  HOU  Al, we have a pretty bright image on that TV. Could you either move it or stop it down.
04 19 59 52  LMP  OK, I'm going to have to stop it down.
04 20 07 17  CDR and LMP align  CDR  When you're trying to stabilize the antenna, you push it in the . . .
04 20 07 41  LMP?  Let's push these legs into the dirt a little bit and get this thing more stable.
04 20 07 50  CDR?  Don't break them. That thing's delicate.
04 20 09 09  LMP  I'll put out the solar wind collector, but before I do, let me get a camera so I can take your picture, Pete.
04 20 10 24  LMP  I have a camera with me.
04 20 12 25  LMP emplaces SWC  LMP  This looks like a good place for the solar wind collector, Pete. I think I'll stick it right here.
04 20 13 19 LMP Solar wind collector. _____ _____ _____

04 20 13 39 LMP That looks good.

04 20 14 12 CDR and LMP drive SWC LMP? It goes right into the ground. The pole (?) just drives right in.

04 20 14 47 LMP goes to TV camera LMP I pounded it in probably over a foot, and it didn't seem to be any harder towards the end than right at the beginning.

04 20 19 33 CDR sets up flag

04 20 20 20 LMP takes two photos

04 20 21 22 CDR I'll go get my camera. I got some pan shots, and next the ALSEP.

04 20 21 58 CDR I'm headed out to do the pan photographs right now. * * * Al's taking shots of the solar wind, and I'm hopping out here to the number one slot.

04 20 22 19 LMP Boy, you sure can move on this surface.

04 20 22 21 CDR Yeah, but watch it when you hit a rock.
f/11.
1, 2 [3(?)].
Now f/8; 4, 5, 6, 7, 6(?), 7(?)
*  *  *

I marked out Snowman with the telescope, and we're going to get some good pictures.

[1, 2, 3,]4, 5, 6
*  *  *

Two of the pans are done.
I think we'll be able to get to the Surveyor quite readily. I'm going to head into the crater a little bit, but [it's going to be] ________ anyhow(?).

Be careful, it's easy to slide.

You can say that again.

You've been over here, haven't you?

Yes.

I'm trying to show how the front gear ______ed itself and how it ______ itself, but I don't think it's bright enough. I'll photograph it though.
The +Y pad bounced about a pad diameter.
The footpads went in a little bit farther than did Neil's; most of them penetrated about 0.5 to 2 in. It looks as if we were moving slightly forward, and that pretty well killed off our left-right velocity when we touched down. The +Y footpad seems to have bounced, but the others apparently didn't. The +Y may have hit first, and rocked back and forth or something.
The surface under the DPS is clean; it doesn't have the loose dust particles that characterize the rest of the lunar surface around here. It also has a number of small round dirt "clods" that seem to be rolling off in a radial direction from underneath the DPS skirt. I'll take a couple of pictures ______ good shots, because it looks about 8 in. or so off the ground.

LMP "in back"; ready to start ALSEP offload
04 20 30 16  CDR "coming around"
*   *   *   *
04 20 31 29  Saddle bags on CDR
*   *   *   *
04 20 31 34  CDR and LMP offload ALSEP
*   *   *   *
04 20 40 15  CDR and LMP remove fuel
element from cask
*   *   *   *
04 20 41 40  CDR  As we set out the components of the ALSEP, it's
               obvious that these thermal coatings are going to
get very dirty.
*   *   *   *
04 20 42 05  LMP  Everything that touches the ground picks up dust.
               This suit is about half dirt, because the strap
               landed on it. There's a little dirt even on top
               of the fuel element.
*   *   *   *
04 20 48 23  CDR  Oh man, look at the dust fly!
*   *   *   *
04 20 49 28  CDR and LMP put fuel
element in RTG
04 20 50 29  CDR  That [thermal coating?] is really getting covered with dirt.

04 20 51 14  CDR leaves to "scout over" ALSEP site; takes SIDE and tongs

04 20 51 31  CDR and LMP head for "little mound over there"

04 20 52 16  CDR?  Is our LM shadow 150 ft long?

04 20 52 26  LMP?  No, that's not 150 ft.

04 20 53 08  CDR and LMP move toward Head Crater

04 20 53 22  LMP  What direction do you want me to go?

04 20 53 26  CDR  Probably either the direction you're headed or a little bit more to the right. We'll have to go far enough so we don't end up in one of the craters when we __________ deploy.

04 20 53 44  CDR heads out at about 10° from takeoff angle; LMP stays behind
You're getting pretty far out.

LM shadow length is about 110 ft.

I'm about 300 ft from the LM at 12:00 o'clock, and there's a very peculiar mound sticking up out of the ground here. It's in the bottom of a shallow crater that you can probably see on your map. The crater is one of a doublet.

I'm headed for the right-hand edge of Head Crater.

Here's a good flat spot to put up the ALSEP.

It's probably at least 500 to 600 ft from the LM.

I'm taking a stereo pair of this mound.

I can't imagine how it got here or what would make it.

* * *

There is another mound over there.

It looks something like a small volcano about 4 ft high. Its diameter at the top is about 5 ft and it_____ slopes down into the surrounding
terrain. The diameter at the base is about 15 or 20 ft.

There's a couple of them out here. They look as if they're normally (?) made out of mud (?) or something. I don't know whether there's a central vent, but we'll look them over after deploying the ALSEP.

This is a good spot for ALSEP deployment.

There are a lot more rocks up here.

We've seen all different kinds of rocks.

Here is a different one.

I'm getting a quick pan of the area to tie down (?) the ALSEP deployment.

I'm going to move just a little bit farther to the north, so that I won't end up over in that hole with the SIDE.

We don't have any good solid bedrock or anything to set the seismometer on. All we've got is this dirt. I don't see any area around that has any rock.
This ground doesn't get hard as you move down a couple of inches. I plan to tamp it, but I don't know what will happen.

Man, are you dirty!

We are really getting dirty out here. ** * * *

Every time you move something the dust flies.

I'd estimate we're at least 600 to 700 ft from the LM.

When you tamp, every time you lift your foot it re-dusts the area.

I'm down in a little crater now, and the dust right in the bottom is slightly, but noticeably, softer than that on the rim. I don't think the
sides are slippery at all. I don't think it's going to bother us going over to the Surveyor.

We request the following photographs:

1. documentation of the dirt that has gotten on the equipment;
2. close-ups showing the dirt on thermally sensitive areas;
3. one or two extra pictures showing the ALSEP with the mound that you described earlier in the background for a geometric reference.
04 21 50 25  CDR  Roger.  I need a pan out here at the . . .
*  *  *

04 21 56 42  SIDE deployed; LMP(?)
takes photo

*  *  *

04 21 00 02  CDR starts toward small mound

*  *  *

04 21 00 46  CDR photographs small mound at f/8

04 22 01 29  CDR  I think I know what this mound(?) is: I think that rock-- I think it's just a little secondary impact crater. That sure is a funny rock; it looks--

04 22 01 47  LMP  Here's a rock they'll be glad to see in Houston. ______ an interesting one; it looks like a solid glass chunk. . . . shiny black . . . ______ anything like it before.

04 22 03 46  Probably LRL rock sample 12017(?)

04 22 04 03  LMP takes photos; CDR starts toward "big mound"

INT  Look at that; it's got all that glass spatter on it.
04 22 05 54  CDR       Here's another big rock.
04 22 06 33  LMP       I'll be there in a minute.
          LMP moves toward CDR to start selected sample
04 22 07 49  CDR and LMP at Head
                     Crater; start sampling;
                     LMP photos rock--"5 at f/8;"
                     CDR collects rock
04 22 08 31  HOU       We'd like you to do two things on the return
                     traverse:
                     1. sample and document the mounds,
                     2. go to the 1,000-foot crater northwest of the
                        ALSEP and get documented (sic) samples there.
04 22 08 56  CDR       Let's get some of this mound. Al.
04 22 09 17  CDR       Here's a black rock.
                     CDR has photo(s) of
                     mound from 15 ft;
                     takes close-ups.
                     LRL rock sample 12008
04 22 09 19  CDR       Here's a black rock.
04 22 09 21  CDR       before LMP photos it
LMP rock sample 12022?...
CDR? Let's go around the other side. ... not kick any dirt on it.
HOU The 1,000-ft crater is about 300 ft northwest of Head Crater.
CDR I see it; it's the great big one over here.
LMP We can go over there.
LMP Let me see if I can get some of that off with this.
LMP I'm trying to knock a piece of that off.
LMP I get the feeling that when that crater was made, it just threw out a big blob of dirt, and this is where it landed.
LMP I'll bet this is microbreccia. 

CDR We quite frequently see linear patterns on the surface. They generally seem to run from north to south. They're just little lines; they're
CDR and LMP almost to 1,000-ft crater

04 22 16 09

LMP

CDR

It looks fresh; it doesn't have that old look that all the rest have.
There's some of that glass in the bottom of there.
We're not getting very many rocks by going this far.

04 22 16 12

CDR

This looks like a brilliant spanking-fresh impact crater.

04 22 16 22

LMP goes to photo crater; CDR CDR photos sample area

04 22 16 32

CDR

These sure look fresh. It must be just a difference in material.
Here's another sample.
We need to find a grapefruit, too.
There's a bunch around.

I made a dent in this rock.

I'm going to get right to the edge of this crater and get a pan in it, so we won't have to come back this way. That crater sure is spectacular, isn't it. It's a monster.

Look at that rock. I'd like to--

... get some of this bedrock.

There's bedrock about 50 yds right down here.

Look at those fresh little jobber-does at zero phase.

Now wait a minute; I want to go ahead and pan.

Let me get this 74. Seventy-four, --

You ought to have ______ ______.

f/8
04 22 18 06     LMP? --right?
04 22 18 08     LMP  50 and(?) you're looking down sun,
04 22 18 11     CDR? You ought to have f/8 over there, and f/11 right
                 there, and f/8 over there.
04 22 18 15     LMP  1, 2, 3, 4 * * * 5.
04 22 18 23     LMP  Now let me go back to f/11.
                 *    *    *
04 22 18 37     LRL rock 12004(?)
                 LMP  I was just ______ing ______ this rock down
                 here; it looks like--
                 *    *    *
04 22 18 41     CDR  I'm going aways over here and give them a stereo
                 of this baby.
04 22 18 50     LMP  We're looking down at this big crater now. It
                 looks rather old.
04 22 18 53     CDR  ________ some bedrock _________--
04 22 18 53     LMP  _________ in the bottom of it, that I think
                 are ________.
04 22 18 57     CDR  --big boulders.
04 22 18 57     LMP  There are some big boulders resting inside the
                 rim, none on the rim like we see on a large
                 crater about 1,000 ft to the west. We don't see
any rock outcrop below, say, 20 ft or so of ejecta.** But there are large blocks of rock inside the crater. We'll try to sample some of them.

**Considerably paraphrased: "But we don't see any outcropping of rocks, either, that--you know--that we could look down and say, well from the top of the rim down to about 20 ft of something, then we come to the underlying rocks."
Near ALSEP

CDR and LMP "about half way"

CDR collects three samples; LMP photographs first two, second sample at f/8; possibly takes one shot of "this thing" (sample area or ALSEP)

Continue toward LM

About 300 ft from LM

I can't judge distance here because there's nothing [familiar for scale]. Everything looks the same.

We must have been at least 1,200 to 1,300 ft from the LM.
04 22 25 14  CDR and LMP photo(?) and
collect green, glinting(?)
rock unlike any they had
seen before

04 22 25 36  Collect other samples,
including one or more
similar to gabbro

04 22 26 44  Collect piece of "pure
glass"

04 22 26 49  Comment on and collect(?)
green or black beads
about 3/8 in. in diameter
(included in LRL samples
12001 or 12003)

04 22 27 22  CDR and LMP at LM; CDR
gets rock box down, LMP
retakes pan photograph
(probably taken previously
at 15 ft by mistake); takes
15 photos in each pan at
"front, and over on
left and rear."

04 22 28 49 CDR(?) puts "camera in
ETB"

04 22 29 25 LMP The walls of Surveyor Crater are pretty steep.

04 22 29 46 LMP takes "the other
two pans"

04 22 29 54 CDR gets "still(?) 70-mm,"
hammer, extension handle

04 22 30 30 CDR gets out SRC No. 1

04 22 30 50 LMP pans Surveyor(?) from
"a higher place"

04 22 31 49 LMP completes pan

04 22 31 51 CDR has "one rock box
open;" LMP has "one more
set to go"
CDR has rock box on scale

LMP lays "it" in hand tool carrier
and hangs "those" on it

CDR takes LMP's rock bag;
LMP goes to get core tube near TV camera

CDR fills SRC with fines;
LMP has core tube "down almost full length"

Takes photo of core tube LMP at f/8(?), 5(?) ft

It's a little hard to drive in; you have to auger it a bit and then pound it. Now it's full length and I'll take a picture of it.

The core tube comes right out.
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>04 22 41 34</td>
<td>LMP returns to LM; gives hammer and core tube to CDR</td>
<td></td>
</tr>
<tr>
<td>04 22 41 56</td>
<td>CDR caps core tube; puts it &quot;in the bag&quot;</td>
<td>It looks as though all the dirt is in the core tube.</td>
</tr>
<tr>
<td>04 22 42 27</td>
<td>Throw &quot;bit in the box&quot;</td>
<td></td>
</tr>
<tr>
<td>04 22 43 46</td>
<td>CDR and LMP fill bag with dirt</td>
<td></td>
</tr>
<tr>
<td>04 22 45 58</td>
<td>LMP</td>
<td>I may have used up all my film today.</td>
</tr>
<tr>
<td>04 22 47 28</td>
<td>CDR moves stereo camera into the sunlight</td>
<td></td>
</tr>
<tr>
<td>04 22 49 29</td>
<td>CDR and LMP dust each other off</td>
<td></td>
</tr>
<tr>
<td>04 22 52 20</td>
<td>LMP ingress</td>
<td></td>
</tr>
</tbody>
</table>
04 22 52 43  CDR and LMP transfer ETB
              and rock box into LM

04 23 05 19  CDR ingress

04 23 06 38  Hatch closed
Debriefing between EVA's

* * * *

05 01 16 33  CDR  We really didn't have a chance to look too hard, but I think it's obvious that there are many different kinds of rocks. I think we're in a most favorable position to get to the Surveyor. I don't think we should walk down the east crater wall, because that looks far too steep. I think we should walk down into the crater from the LM, cross the bottom, and walk up to the Surveyor. We can compare data packages and combine traverses 3 and 4.

05 01 18 14  HOU  We're leaning right now toward using traverse 4, although we'd suggest modifying the order of the stations.

05 01 19 17  CDR  That should work out pretty well. We could start at FZ(?), which is essentially where we landed.

05 01 19 37  Hou  Our present best coordinates for landing location are R.2 and 15.0. I can suggest an order for hitting stations A through G.

05 01 19 56  CDR  I can refine that landing location. We are approximately 120 ft northeast of the crater that is number three in age and that is on the east side of Head crater, at approximate coordinates Q.5 and 14.1.

* * * *
Our recommended order for the stations is:

1: F--Head Crater
2: B--Bench Crater
3: A--Sharp Crater (We may delete this, depending on time.)
4: C--Halo Crater
5: D--Surveyor Crater
6: E--Block Crater, and we will omit G.

Don't we also want to get out onto this possible Copernican ray material?

Affirmative, if there's time; but it may be too far away, and we're not sure exactly where the contact lies.

Referring to Map 5, we got over to Shelf Crater, so we may have already sampled some Copernican ray material. We also have photos of the shelf, and I have a set of stereo photos all the way around the big crater. It was easy to get over there, so I think your traverse proposal is reasonable. The order would be point F, Sharp Crater, Bench Crater, Halo Crater, Surveyor Crater, Block Crater, and back to the spacecraft.

That sounds good. We understand you'd like to go to Sharp and then to Bench Crater.

Yes, we can try that.

Do you think it's feasible to join two core tubes together and get something on the order of one and one-half core-tube lengths?
It got harder as I drove it in, just as it does on Earth. But I think you could drive one in, although it might take three times as long. I don't know if we could do it now with those pins in, but maybe we could take the pins out and put two tubes together.

Apparently the augering is what made the difference there.

* * *

Is the object at R.5, 13.1 a mound or a rock?

I believe the mound is too small to show up like that on the map. Those coordinates are for a crater.

Did you sample material from the mound itself as well as the material around the mound?

We have lots of samples of the mound material.

We can sample it again in the documented sample if you want.

What was the final ratio of fine-grained materials to rocks?

I think there are three rather large rocks in one bag and two large scoops of fines. The other bag of rocks contains 10 or 12 rocks and fills half of the rock box. The rock box is full to the top.

* * *

We probably have about 15 to 20 rocks, and the rock box is heavy; I'd estimate it is maximum weight.

* * *

* * *
Traverse planning for EVA 2:

05 09 -- --* HOU We’re using Map LSE 76G. We consider Bench and Sharp Craters the two prime sites. We can pretty much use the traverse we discussed before. I'd like to give you additional information that you don't have on your sheet, and also discuss how we'll fit the ALSEP revisit into the traverse. We'd like to modify the location of the first station, which is shown as F at Head Crater: we'd like to move that first station to the northwest rim of Head Crater at coordinates R.0, 11.0. Otherwise, we'll follow the original plan for Head Crater, that is two partial pans across the crater and documentation of the slumps and ledges. In addition, can you roll a large boulder into the crater and take a stereo pair of the rock before rolling and a stereo pair of the track made by the rock after rolling.

*Between 05 09 34 45 and 05 09 45 31
We'll go first to the ALSEP and then to Head Crater. I can see Bench (sic) Crater from the window, but I can't see Sharp Crater. It looks as if it will be relatively easy to go to the ALSEP and then to the coordinates you gave me for Head Crater, and I see several rocks which we might be able to roll down the side of that crater.

Next go to Bench Crater and then to Sharp. We want to move point B from the southwest rim of Bench Crater to the northwest rim, at coordinates M.0 and 10.0.

We'd like you to do three things in addition to what we already discussed on your plan:

1. Take stereo pairs of features of interest in Bench Crater, especially the bench.
2. Determine whether the bench is bedrock or breccia near the base of the regolith; and if the bench is bedrock, sample ejecta representative of the bench or sample the bench itself, if possible.
3. Look northwest and southwest from the rim of Bench Crater to see if Copernican ray material is obviously different from other units.

The next station is at point A at Sharp Crater. Since this is about the farthest point from the LM, we'd like a full trenchsite sample in the rim of Sharp Crater, as well as the gas-analysis sample. We'd also like a
full pan from the rim of Sharp Crater. Crew option at this point is to extend your traverse west into what appears to be Copernican ray material. Finally, sample and describe differences across the contact between M1 and M2, if the contact is apparent when you reach that region. On your map it is shown as a dotted line running northwest-southeast.

It will be pretty hard to do that. Looking cross sun, the materials all look the same, and looking down sun, they all look the same except their color is different.

You may not see any color differences, but you might keep your eye open for differences in rock type. At the fourth point, Halo Crater, try to join two core tubes together and core through the thin ejecta of crater six or Halo Crater. You'll have to pull the pit-pin off the core tube which you make the bottom tube. We'd like you to avoid the rockiest parts of the crater. If the tubes can't be joined, take one tube on the rim and one about 100 ft west of that location. Give us a pan of that location and document patterned ground and fillets on different slopes and blocks, especially asymmetric fillets. This comment really applies to all of the traverse, but we especially call for it in Halo Crater because this type of information is most interesting for the youngest materials. The best way to document patterned ground is to photo into the sun, near field, so as to show the pattern best.
Finally, go down into Surveyor Crater and then to Blocky Crater. At Blocky Crater, collect samples of major rock types and take a partial pan across Surveyor Crater.

We may have a little trouble getting to Blocky Crater. I'm not sure whether it is an optical illusion or what, but the wall that the Surveyor is on looks a lot steeper than 14°. Surveyor Crater gets pretty rugged on that side, especially near Blocky Crater, as I remember it from yesterday.

Do you want a core tube at Head Crater, or do you want us to skip that one?

Let's get the third core tube at Sharp Crater. You will be taking it as the biological core-tube sample as part of your trench-site sample.
CDR steps onto surface

One of these contrast charts fell down here yesterday, so there are only two good ones; the other one is too dirty, and the dirt doesn't rap off.

Transfer ETB

It looks as if the lock on the LEC is jammed with dirt.

CDR on surface; both prepare for traverse

Here's the gnomon. I'd forgotten it was sitting here.

As I look into the sun the material around the spacecraft is a very rich brown color. It reminds me of a good plowed field. Looking down sun, it's still the same white or very light ash gray.

Other than the large-size rocks, it is very difficult to determine a contact around here.
LMP cuts TV cable

05 11 52 04

CDR

The slope that the Surveyor is on doesn't look nearly so bad now that the sun is higher.

* * *

05 11 53 01

CDR

There's an angular rock about 3.5 by 3.5 in. sitting loose on the lunar surface about 6 in. from the engine exhaust skirt. It's not stuck in the ground, and the ground is blasted clean all the way around it. Yet the engine exhaust blast didn't blow that rock away.

* * *

05 11 58 25

LMP

Houston, from your knowledge of the local terrain, are there any places on the way to theALSEP or to Head Crater where you'd like me to take pictures with the polarizing filter?

05 11 58 51

CDR

Here let me have it.

05 11 58 53

LMP

Let me film(?) the handle.

05 11 59 06

HOU

Take polarized photos as called for in the cuff checklist.

* * *
05 11 59 19  CDR  My plan of attack is for Al to take one picture of that rock under the descent stage, then to grab the handtool carrier and head for the Solar Wind and grab a picture of that. Meanwhile, I'll lope off to the ALSEP and check the SIDE. I'll meet Al at point 1 at Head Crater.

05 11 59 49  HOU  Al, have you got the [white] readings on contrast chart?

05 11 59 07  LMP  I plan to do that right away.

05 12 01 20  CDR  en route to ALSEP

05 12 02 47  LMP  works with contrast chart; CDR starts toward Head Crater

05 12 02 57  CDR  finds grapefruit-sized rock; LMP puts contrast charts in crater--one in sun, one in shadow
CDR: CDR approaches Head Crater.

LMP: Head Crater is a lot steeper than it looks from the LM.

LMP: I can see all the different shades on the contrast chart in the sun. I'm taking a photo of it. What I can see on the chart in the shadow depends upon how close I am; if I'm within 3 or 4 ft of it, I can see all six shades. I'll take a picture here, then I'll back up.

CDR: Houston, I'll roll a boulder into Head Crater. I'll give you a mark when I roll it. How big should the rock be? Is a grapefruit-sized rock OK? I am holding one in my hand, and these other rocks that I was talking to you about are pretty well buried, and they're pretty large.

HOU: Any size is fine.

CDR: Houston, on my mark, I am going to roll it. Mark.

Mark, stopped.

LMP Houston, I'm looking at the contrast chart in the shadow. As I mentioned, from 3 ft I can see all six shades. From about 10 ft, if I can stand here a moment and adapt my eyes, I can see all six also. The thing that seems to have the biggest effect is how high the sun is. The sun is high now, so I don't have to squint particularly looking up sun. Yesterday, looking into the same crater, even though it couldn't have been any darker, because the sun was low, I would never have been able to adapt. I'm taking a photograph. I'm going to go out and do the Solar Wind now.

Visibility here is pretty much the same as on earth. You adapt just as well, and the only major difference I've noticed is...
LMP takes "a couple pictures" of Solar Wind foil

LMP working on handtool carrier

LMP leaves LM; CDR works with camera

HOU Pete, could conveniently roll another rock.

CDR OK, I was setting up my rock(?) hole(?) for the polarizing light.

I'm looking at a rock that has small crystals in it. Some of them are shining very bright green, like gingerale-bottle green.

LMP As I run across the area, I can see everything from fine-grained basalts to a few fairly coarse-grained ones. I see some rather light reddish-gray-colored rock
CDR takes polarized photos

LMP photos and samples from 3-foot crater; takes "stereopair of this"

Sample ld,
LRL rock 12030

takes polarized photos

CDR LMP

that looks almost like granite; it probably isn't, but it has the same sort of texture. The individual crystals aren't as big, but it still has the same appearance.

Al, when you get up to me, will you stop up sun at 15 ft and take that shot of what I'm shooting: f/11, 15 ft, two pictures, one before and one after.

I'm at a crater about 3 ft in diameter that doesn't look as if it was made by a fast-moving or energetic or heavy projectile. Yet right in the middle are some glass-covered rock fragments. There are a lot of little droplets or blebs. But the fragments in the crater look different from the . . . I'm taking samples both of glass-covered rock fragments and of some other rock fragments that don't have any coating at all. When I pick them up with the tongs, they don't seem to hold together too well. They're rather weak.
If you're going to document that, try to get some of the material around the glass as well as the glass itself.

OK, I'll just get this as a bonus.

Head Crater is a lot deeper than it looks.

Here's a crater 5 ft in diameter with a white rim.

As I came walking over here to Head Crater, I've been concentrating to see if there were any changes in texture, slope, color— anything at all that would suggest that I was walking on a surface different from that where I started. But I haven't seen any differences; it all looks the same. It all looks as if it's covered with this black(?) rock(?).

Slow up, don't kick dust in the middle of my polarized picture area.

I'll stop right here.

Get your up-sun pictures. You see this
rock pile right straight in front of me where my footsteps are--that great big rock that's half buried and the two rocks beside it that I have turned over in my footsteps?

It's 15 ft, f/11, two shots. Unfortunately you won't get a "before" shot.

LMP takes two photos

CDR I've shot 15 pictures.
On my mark, I'm going to send a slightly smaller rock into Head Crater.
Mark.
I didn't kick it hard enough. I'll do it again.
Mark.
In 1/6g, even though the slopes are steep, these rocks just don't want to go anywhere.

HOU Roger, Pete. We haven't been able to pick it up on the PSE.

CDR That was too small a rock.
We're at the northwest corner of Head Crater.

We probably ought to dig a little trench and compare soil profiles.

There are little white spatter-type (?) craters; they look like very fresh impact craters, like that little one right there. Here are three in a row. Let's work here on the rim up to the rim crest.

This is a little secondary impact crater, huh?

I'll get the cross-sun photos.

We are looking for two partial pans from the northwest rim.

We'll get them.

Let me get my pictures, Pete.

I'm sampling a very typical rock fragment.
We are about 50 ft inside the rim crest. Pete walked across the rim crest, and he scraped an area there with his foot, exposing some much lighter-colored soil-like cement. It's the first time we have seen that. It looks like maybe this darker material—well, I don't know. I'll photograph it.

* * * * *

Sample bag number 13.
Let me photograph this thing, and let's trench this whole area. I'll drop the gnomon right here over my footsteps on the light soil versus the dark, and we can trench there.

I just put it into 3D.

Five ft, f/8, 1/250.
Let me get a picture for you, ________.
CDR takes "stereopair of the thing"

LMP The boulders are not uniformly distributed in(?) Head Crater. There are quite a few more over here on the western wall than on the other walls.

CDR digs trench

CDR gets "some photos of that"

LMP The boulders are not uniformly distributed in(?) Head Crater. There are quite a few more over here on the western wall than on the other walls.

CDR looks at that white soil with the brown.

CDR gets another scoop

LMP You can see where you dug in, that there's still some--

CDR looks at that white soil with the brown.

LMP You can see where you dug in, that there's still some--

CDR looks at that white soil with the brown.

LMP You can see where you dug in, that there's still some--

CDR gets another scoop

Right under the surface where Pete digs, the soil is much lighter gray. I can see several places where we've walked, where the same thing has occurred. I have not seen this at all in areas where we were before.
It is not caused by the higher sun angle; it is definitely a change to light gray. The soil remains light gray down to at least 4 in., which is the depth of the trench now. The composition of this soil must be different from that outside the crater, because we haven't--

This soil is different from that around the spacecraft, because we kicked up all kinds of stuff around the spacecraft, and it's all the same color.

Top and bottom. This is quite a bit different. Why don't you dig as deep as you can and then get me a sample right out of the bottom. This will be something new, and I'll put it in sample bag 5D. This sample comes from a depth of about 6 in; it's light gray but there's some darker material in the bag that fell in off the side of the trench. The angle of repose is about 85°, but the minute you bump the side, it falls in.
It's not cohesive at all, even though it seems to remain nearly vertical. I guess it's the low gravity.

Let's sample the rock that I dug up from down deep. Let me get a picture of it first. . . . stereopair . . .

The rock from the bottom of the hole is covered with gray dirt or soil. I don't see anything in it other than the gray.

As you move off, Pete, I can occasionally see some white. You kicked over a rock that has a white bottom that's quite a bit different from the top. It's right behind you. Might want to take a picture of it. It's quite a bit different from those others.

* * *

CDR looks for triple craters on map; LMP takes photo of rock, uses shovel to move it
HOU  Pete, that triple crater is just south of your present position.

LMP  --got to turn over one of these rocks on the rim. This rock is about 6 in. in diameter. The bottom part of the rock is gray, and the top is the same color as the--

LMP  You got it in your shadow.

LMP  I can see glints of crystals or something even in these rocks out here, even in the ones that are almost completely covered with soil.

CDR  Every one of them.

LMP  Things are quite a bit lighter gray up
05 12 31 20  LMP takes "three quick pictures"; leave triple craters without taking pan; move toward Bench Crater

05 12 31 27  CDR

05 12 31 40  LMP

05 12 31 47  CDR stops to take pan

05 12 31 55  LMP

05 12 32 06  CDR

05 12 32 07  Move "straight south"

That looks like a real interesting area on the far corner of Bench Crater. Some of those big rocks look as if they could be bedrock out of somewhere.

These rocks here must be bedrock from somewhere. We need to get a pretty large one before leaving this area.

These rocks obviously came out of the crater, because they are scattered more uniformly around it. There are a lot of them on the rim and relatively few far away. We probably ought to grab a big one of them.

74.
Both cameras on 36

CDR re-sets camera to photograph rocks: 5 ft, f/8, 1/250

Here's an interesting rock. Let's get it.

There are glass beads in every crater you come to and look in.

I'd like to sample that big gray rock there, because it has a rather sharp edge, and most of the other rocks are rounded. It looks a little bit different from the rest in the way it's shaped; it's partly rounded and has some angles on it.

The thing that was giving it that unusual shape was the dirt adhering to it. It's typical of the rocks around this crater.
There's about 5 percent rock in the area we're moving along now.

The fragments range from about 3 ft all the way down to small fragments.

Stop to describe and photo rock

There's a well-rounded rock about 3 ft in diameter and about 2 ft thick. It has a fillet that's about equally well developed all the way around the rock. Maybe we can photograph it on two or three sides.

This rock is typical of the rocks in this area: they all seem to be the same type. The couple of rocks that we did sample previously are the same type. There are a lot of coarse pits on the surface of this rock. Some of them are as large as about 3/8 in. in diameter, but most of
them are small. Some of the pits have glass in them, and many of them don't. I can see the glitter--
It doesn't look like basalt, although the grains are too small for me to identify.

This looks like a very interesting and different crater. I see some really different rocks. There's a big one.

That looks like bedrock.

Hey, Al, come over here.

I've got to get some of this.

Let me get some pans in there.

They must be bedrock.

Boy, there are some big fragments!

It looks to me as if stuff is melted in the bottom of the crater. I can't swear to that, but I'll get you some pictures.

CDR approaches Bench Crater

CDR

LMP

CDR? 

CDR? 

CDR

LMP

CDR

CDR

CDR takes stereo-pans: f/8; six photos in first pan
LMP  This rock looks pretty much the same from a distance.
     . . . kicked out of this crater.
LMP  It looks to me as if we have a small central peak—a little rebound there.
CDR  Don't they look melted on top?
     They're not completely jagged.
LMP  No, they're not. It's hard to tell. When I looked at that rock back there really close, I noticed it's been hit by meteorites so much, I guess, that it's been given a rounded appearance something like those in the hole. But there are a couple over there, as you say, that don't look that way. We ought to sample one of these pieces of rock.
CDR  Here's some good rock samples right here.
CDR  That rock looks a little different.
LMP  I don't think it's going to fit, but I think it will fit in one of these bags.
     It's going in sample bag ____ 4. I think
Let's just put it in here. We've got a nice picture of it, so we can tell where it's from.

Let's put two or three other little ones from that same area in bag 64.

This one here, that we took the picture of. I don't think I got that in the picture.

Here on the rim, the soil is the same light gray beneath the surface. Apparently this is characteristic of crater rims, but not of inter-crater areas.

Let's go over to the corner and try to break off a piece of that big rock. It looks like bedrock to me.

*   *   *

Here is a partly buried rock that's not unlike the others around here, except it
appears to have some sort of very iridescent coating with a lot of crystals shining in it.

It's been lying there, and it's been hit by another fragment. There are glass beads all over the place.

Let me get the sample of it: sample bag 7L(sic).

Pete's picking up a small piece of this rock.

I'm trying to get a piece that's fractured right off the middle.

This rock may be more newly exposed. It may have been struck by something.

Let me scoop up some of these glass beads and stuff there.

That's sample 8D.

If you could, climb down into the crater and take a look at the bedrock on the bench.

It's awfully steep. I'll get you some bedrock from on the rim here. All of it
We're now bagging some soil that was right next to the rock that we described previously. Pete's picking up a nice fragment of that rock, and we'll put it in this bag too.

That thing is very weak. It fractures right off.

Let's go over here and get some of this rock. It looks like bedrock to me. It looks a lot like the fragments we have been seeing lying all over the place, but this stuff's obviously... I'd say that we have a total of about 3 pounds of rock right now.

I want to sample this area right here, if I don't fall down into the crater.

This is different. We've got to get some of this.
There's glass all over those rocks. That's a good one. Put that thing in there. Let's take a big sample of that big piece right there with spattered glass or something all over it. The sample we just picked up and described is sample 9D(?). Put this right in here, Pete. Wait a minute. Here's a better one. Now we are working on sample bag 10D(?). On your way out, would you get that partial pan. I already got a stereo partial pan. That's a good rock, and that fills that one up.
OS 12 51 37
OS 12 52 13
OS 12 52 18
OS 12 52 27
OS 12 54 09
OS 12 52 44
OS 12 54 14
OS 12 54 27
OS 12 54 36

LMP    Big fragments out here.
*       *       *

HOU    Are you going to get a back-sight survey
       at that point, Pete?

CDR    I'll get a full pan.

HOU    OK, a full pan when you get over to Sharp
       Crater.
*       *       *

LMP    The rim of this crater is raised about
       2 ft; it's white, and it looks pretty
       much like the subsurface material we
       kicked up on previous craters.
*       *       *

CDR    It's awfully soft in here, watch it.
       There's what looks like a radial blast
       effect or spray pattern all the way around
       the crater. This must be fairly fresh.
05 12 54 53  CDR sets camera to 74;  
takes photos

05 12 55 00  LMP  The rim is quite a bit softer than the 
others.
*  *  *

05 12 55 23  LMP  We're supposed to look rough(?) for  
Copernican rays here.

05 12 55 40  CDR  I see no evidence of a contact.

05 12 55 45  LMP  None at all. This crater is fresh enough  
that you can see some of its rays. But  
in craters older than this there doesn't  
seem to be any way to distinguish the  
material exposed inside the crater from  
that that was on the surface before the  
crater was formed.
*  *  *

05 12 58 06  CDR digs trench;  

05 12 58 18  takes "trench pictures";

05 12 58 46  CDR's camera on 105; LMP's  
camera on 50

05 12 59 04  CDR fills big container  
with dirt
LMP    That sure is soft.  Pete's down about 8 in. in very fine gray soil.

CDR?   The cores(?) didn't go in.

* * *    

LMP    That's soft. Watch yourself, you're getting close to the crater.

* * *    

LMP    That soil is totally incohesive.

* * *    

LMP    Container full

CDR    This dirt came from about 8 in. down.

* * *    

LMP    Cap container for "deep trench sample"

LMP    This is core tube number 2.

* * *    

LMP    This ought to be a good place because the material is relatively fresh.

LMP    I could almost drive the core tube without a hammer.
I want to take a couple more shots of this before we leave.

Get it all in? I'll get the pictures.

We're driving it all the way in; it's pretty easy.

My camera is so dirty I can't see the settings any more.

I hope the soil stays in there. It probably will because it stayed in your scoop so well.

Full'!

We need some little rock fragments for the gas analysis sample.
Move toward Halo Crater

Move across the south side of Bench Crater

Try to identify Halo Crater

LMP

Good turning, Pete.

Is the front of my lens clean?

CDR

Relatively speaking; nothing else is.

LMP

* * *

CDR

The LM is now at our 10:00 o'clock position.

* * *

CDR

The soil is much firmer here.

LMP

You land flat-footed, so your heels sink in only about 1/8 in.; but as you push off with your toes, they sink in about 3 in. Every time you land, you send out a radial spray of little particles around your boot. They go out about 2 or 3 ft.
Sample 11D is a round glass ball, about 1/4 in. in diameter.

Now you(?) can take a picture.

Watch that crater behind you.

. . . glass beads.

We now have a total of about 5 lbs of rock.

Sample 11D is a round glass ball, about 1/4 in. in diameter.

Now you(?) can take a picture.

Watch that crater behind you.

. . . glass beads.

We now have a total of about 5 lbs of rock.
"shooting about(?) 4"

05 13 19 02

think it was real soft dirt that had just been rained on. Not a hard rain, but just a sprinkle, so that the droplets __________

This material looks like the material we discussed on EVA 1 in front of the LM. It may run past the LM down into this area.

It's rather like the material at Sharp Crater, but it may be finer.

05 13 17 20

Sample 12D
LRL soil 12042

05 13 18 47

Use map to try to locate
Halo Crater

05 13 20 35

LMP
There's a lot of glass in the bottom of that crater.

*       *       *

05 13 22 02

CDR
Lots of glass out of the bottom of this baby. __________.

05 13 22 34

Camera readout:
CDR--110, LMP--60

05 13 22 54

CDR
My camera hasn't been taking every picture.

*       *       *

05 13 23 02
We're going to take the double core tube. The upper tube is number 1; the lower tube is number 3.

Let's go over to this crater right here. It's soft around those little ______.

I can shove it in a little. This seems to be a good soft place. I hit something solid there. I shoved it in about 7 in., using all my weight. Now I'll pound on it. It seems to be going in OK.

Keep augering.

I don't think this is really the right place.

Got awful solid, didn't it.

Now it's going.

Wiggle it a bit.

One core tube is completely in now. I have to hit it harder.

* * *

He's up to the bottom of the hand-grip
05 13 27 51
LMP We almost got it.

05 13 27 54
CDR Hit something solid there, didn't you.

05 13 27 56
LMP No, it was just getting down there.

05 13 28 00
LMP We've got a good one.

05 13 28 15
LMP Better get some of these nearby rocks.

05 13 28 37
CDR and LMP trade cameras

05 13 32 15
CDR You sure beat on the core tube.

05 13 32 23
LMP That's what it took to get it into the ground.

05 13 32 26
CDR But's coming up real easy.

05 13 32 35
LMP Pulling on the core tube pushes your feet down into the dirt.

05 13 33 24
LMP The soil doesn't look any different half down.

05 13 34 15
LMP portion of the upper tube.

LMP takes down-sun photo: f/11, 1/250

LMP and CDR trade cameras

CDR pulls out core tube

Separate core tubes
Cap core tubes

CDR

Al is going to take the panorama using my camera. By the time we got done handling his camera, with the handle off it and everything, we'd gotten dirt all over the lens. We've run out of film, but we happen to have another magazine with us.

LMP takes pan:
74, f/11, 1/250

LMP completes pan

Sample 13D: surface rocks and soil; one photo of sampling area

Move to rim of Surveyor Crater to collect rocks

These rocks look a little bit different. There's glass in the bottom of that one. They look like granites.
This rock is very different.

It has a big glass splotch on it.

I'll take the cross-suns from where you are.

The rock has a lot of--

*   *   *

Photograph that rock right there with the gnomon, so as to show the crater it came out of.

We're on the rim of Surveyor Crater at 9:00 o'clock with respect to west at 12:00 o'clock.

*   *   *

Look at the shear face on that rock.

Something whistled by it or something.
05 13 44 43  
LMP  It has some pretty interesting fracture marks on it. It also has what appear to be abrasion marks. Maybe that's just hard-packed dirt. There are a lot of flashing crystal faces in that rock.

05 13 45 05  
LMP takes photo of where rock was

05 13 45 36  
LMP takes pan, including Surveyor

05 13 46 01  
* * * *

05 13 46 21  
CDR  I think we can walk down here about 300 ft and then walk straight down the slope to the Surveyor. We'll go directly east and then curve around almost to north, curving around and down to it.

05 13 46 49  
CDR and LMP trade film magazines

05 13 47 19  
LMP  Boy those cameras sure got dirty.

05 13 48 47  
* * * *

05 13 48 47  
CDR  That lens is good and clean.
Move on

CDR  Al, grab a shot of that bead of glass there and we'll bag it. It looks better than the Hope diamond.

LMP photos(?) and samples glass bead; gets some rocks with it

LMP  We keep collecting a lot of the same type of rocks, but there just don't seem to be any other kinds. We haven't seen any microbreccias all day, even though I have looked for them. All I have seen is basalt. I've seen nothing that looked vesicular at all, except on the surface.

The rocks aren't at all like those of Apollo 11. The closest I've come is that gabbro--
05 13 52 15  Sample 14D  CDR  Sample 14D includes a glass bead and some local rock from the south rim of Surveyor Crater.
LRL rock 12043
LRL soil 12044

05 13 52 44  Move toward Surveyor

05 13 53 08  LMP  We can now see the scoop on Surveyor.

05 13 53 24  CDR  We are not sinking in very far at all.
This is fairly firm stuff. We're about 200 ft from Surveyor at the same level.
We'll just contour around the crater wall to it.

05 13 54 25  Stop; LMP photos
Surveyor

05 13 54 57  CDR  The dust we stirred up during our descent probably went right over the top of the Surveyor.

05 13 55 15  LMP  That's right. Any dust you hit on the edge of the crater would never go down into the crater.
*   *   *

05 13 55 35  CDR  We'll take the tool carrier with us. I think we can go right up the other rim
and around to that big blocky crater.

LMP

There's probably bedrock at that neat crater where all the rock is.
Pete, would you carry the hand-tool carrier down there, and let me take some pictures up here around it.

CDR

Now you can see the way it came in. The scoop head dug in over there and dug up dirt, and it's still sitting there. It's going to make a good shot. We're not supposed to take pictures of that leg, but we'll have to do it.

LMP

The Surveyor is now a light tan.

This crater isn't as steep as we had thought.

CDR

I'd better be careful or I'm going to get dust on it.

LMP

I'll stop here, and this will be my last picture.

*   *   *
On the slopes here the soil is just a little bit softer, but there is no tendency to slip down slope or anything like that. It may be a little deeper, although I don't think so. Let me take a _____ down here where we can see it better.

Just make sure we don't get any dirt on it.

OK, we'll walk real slow. Look there where it dug those scoops. You can still see the . . . That's going to make some beautiful pictures on the way that's weathered. It looks as if something has rained on it.

I wonder if that was from us.

I don't think so.

There's a general trend of little lines running along.
The linear patterns are not in the same direction as on the rim; they weren't caused by the LM descent engine.

CDR Al, did you get a picture right across there?

LMP Yes.

* * *
* * *

CDR Why don't you mosey down there and start taking photographs.

The first thing is photo Bay A: f/11, 15 ft, one picture.

LMP The Surveyor has turned kind of a light tan, and some of the things are even a dark brown.

LMP The Surveyor sure dug in the ground. The pad marks are still there, and the waffle imprints are preserved.

CDR Next photo TV sector: f/8, 15 ft, three pictures.

LMP OK, let me move down.
The dirt is still on the footpad. I raised my visor, and the Surveyor isn't quite so brown, but it's tan.

I don't want to kick up any of this dirt because I would like to get a picture of the compacting of the dirt there.

That color chart has sure changed colors. Let me get a quick shot here: f/8, about 2 ft.

Now photo scoop imprint: f/8, 5 ft, two in stereo.

The scoop imprints look different than I had imagined.

Next, photo the footpads: two prints(?), f/8, 5 ft, two in stereo.
LMP  I'll get the footpads and then also get
       the dirt that's on them.

* * *

CDR  Footpad 2 area: f/8, 5 ft, stereopair.

LMP  Footpad 2 disturbed the surface all
       right. We'll(?) be able to get the
       rocks the Surveyor is on(?). No strain.
       Get a bunch.

       Here's one.

CDR  Next photo, vernier engine, Bay A: f/11,
       5 ft, one picture.

LMP  The engine is still green. In fact, it
       seems to have changed less than most of
       the other colors.

CDR  Photo large box A: f/8, 5 ft, one
       picture. They want you to smoke(?) that
       over carefully and wipe and then photo
       the . . .

LMP  Not a bit of this glass is cracked. One
       little piece down here looks as if it
       no longer reflects. It's a little warped,
but other than that it's in perfect condition.

It wipes off just as you would expect dust to wipe off glass.

It's going to be tough to show this; it's in the shadow.

Next, photo small box: f/8, 5 ft, one picture.

It's pretty much in the shadow of the landing radar or the instrument(?) I'm going to open up the camera a little bit.

There's no way that the Surveyor could slide down the hill on us, the way it's dug in.

Now let me get Footpad 3 in stereo.

It's pretty low; let me try f/5.6.

That aft honeycomb shock absorber struck the dirt. It looks as if it took some of the shock. The front one didn't appear to do that.

f/11, 15 ft, one photo.
LMP  It's going to be a tough shot, because
      it's in the sun. Let me get over here;
      that might help it.
     *     *     *     *

CDR  You're pointing too high.

LMP  I know; I'm trying to shoot the [top of
      her] again. Give them a few extras.

CDR  Photo solar array: f/5.6, 15 ft, one
      photo.

LMP  Let me try that from here. The solar
      arrays are not blue any more; they're
      black.
     *     *     *     *

CDR  Photo Footpad 3: f/11, 5 ft, one photo.

LMP  It dug in real well too--right to the
      top of the--

CDR  And another thing to photo is the scoop
      trenches: f/8, 5 ft, stereopair.

LMP  Let me get the top of this little in-
      strument box, because the glass is
      fractured there.

CDR? Up the hill here is where it hit.
CDR Be careful or you'll get dust in the trenches.

* * *

CDR Photo the TV mirror: f/8, 5 ft, one photo.

LMP The TV mirror is brown.

CDR I'll come in and wipe it

It's got a fine dust on it.

LMP I photographed the mirror at f/5.6 by mistake. I'll take it again at f/8. Let me get over here and get one more shot. I'll shoot a few extras since we have lots of film.

CDR Go ahead and get yourself in the photo too.

LMP I'll try for 15 ft.

* * *

CDR I am jiggling the Surveyor, and it's firmly planted here.

* * *

INT ... soft dirt.
Dismantle Surveyor

05 14 18 18

05 14 20 50

05 14 21 58

05 14 22 23

05 14 22 40

05 14 22 52

05 14 22 53

05 14 23 55

05 14 27 00

LMP Did you see that material disintegrate?
That's easy to cut.

* * * * *

LMP It has weathered a little bit in 31 months.

* * * *

Have "cable and tube"

* * *

LMP Look how that stuff has fractured; it's
lying(?) on the ground.

* * *

CDR Yes; the paint has flaked off.

LMP That looks like a shiny mirror--some
sort of thermal coating.

* * *

Break glass and take
photo(s) of it; first(?)
at 5 ft; second(?) at f/8(?)

* * *

Remove TV camera

* * *
I-’

05 14 29 15 Collect Surveyor scoop LMP We have an extra sample for you: the scoop has dirt in it.

* * * *

05 14 29 54 LMP We thought the Surveyor had changed color, but I think it's just dust. When we rubbed against that battery, it became shiny again. Let me get a shot of it. Maybe it's just collecting all this red dust.

* * * *

05 14 30 23 Begin geo-sampling CDR --rock right here?

05 14 31 04 LMP I think that rock was too close for the TV to see.

05 14 31 04 CDR How about this one?

05 14 31 11 LMP _____ _____ down with you.

05 14 31 15 CDR? Got us a platy one?

05 14 31 25 LMP I see a square one up there right now.

05 14 31 28 CDR Where's that one that had the lines in it?

05 14 31 31 LRL rock 12056? LMP I think it's right over here; I'll show you. It looks like a ________ --

* * * *
05 14 31 52  LRL rock 12063?  CDR  Let me get this in the bag too.
* * *

05 14 31 57  CDR  The Surveyor is quite brown whether you look at it from up sun, down sun, or cross sun.

05 14 32 05  LMP  That light brown rubs off. That's the funny part, because the dirt here is not brown.

05 14 32 11  CDR  Is that the rock right there? These rocks all have fillets of soil built up around them, as they showed in the Surveyor pictures.

05 14 32 30  CDR  I can't orient myself to the pictures. Shall we grab this one right here?

05 14 32 37  LMP  Let's get that brick-like one up the hill a little way. I think that's one they saw.

05 14 32 51  Sample rock

05 14 33 06  CDR  Let's head for Blocky Crater and pick up a couple more of these en route.

05 14 33 12  LRL rock 12064  LMP  Let's get that brick-like one up the hill a little way. I think that's one they saw.
Collect square rock
Move toward Blocky Crater

* * *
Here's the square one.

Most of these rocks are too big for a sample bag. They're all at least 6 in. in diameter. I think these are some of the rocks you wanted, Houston. We weren't able to identify specific rocks in the Surveyor photographs from memory.

It's pretty easy to move along this slope. The soil is just a little bit deeper and a little bit softer.

About 200 yds that way, over the top of the hill, is the biggest boulder we have seen.

These down here are bigger than that.

Let me turn around and look.

Gigantic right there.
LMP  That's a big one.

CDR  Come further left.

LMP  That's a pretty good-sized one.

CDR  Let's get out of the crater on level ground.

*     *     *

CDR  Let's document a sample here. I think you ought to photo that whole Blocky Crater.

LMP  That's got to be bedrock there.

CDR  Yes, let's get some samples of it.

CDR  The dimple crater is right behind the LM. It's a big, blocky impact crater.

*     *     *

At rim crest; rest

CDR  We're going to pick up one sample out of this blocky crater and get a partial pan of it. It has a lot of bedrock blown out of it--big, very angular, chunky rock. Then we'll get a sample(?) of the double craters on the side of the
My camera is completely dust-covered. Your lens is in good shape.

Why don't you start right here and get a partial pan while you're resting on this crater, either side--

* * *

I am beginning to think that if we cracked open these rocks that look red, they'd be plain old basalt.

Photograph the whole crater. Get about four shots across it, and then move over and get another four.

LMP photos crater; camera set at 30 ft

Shoot way down into that crater right there. Get a stereo of it with those big blocks down there.

It's rather dark.

This is probably one of the most recent craters we've seen. These blocks are Surveyor Crater, and then head for the LM.
a lot more sharp-cornered than any we've seen anywhere else. I'd guess the Surveyor Crater blasted out bedrock, and then more recently this crater blasted it out again.

I got the idea that the bedrock is not too far below the surface and may have been exposed on the walls of Surveyor Crater. The projectile that formed Blocky Crater penetrated the bedrock in the wall of Surveyor Crater and ejected fragments of bedrock.

Let's get a sample of that rock.

LMP I think it's going to be the same as-- Let's just document a couple of big pieces.

This right here looks all the same. Let me get a shot of it across sun.

CDR Get a stereopair. You don't need the gnomon. I'll put the--
Sample 15D
LRL rock 12045
LRL rock 12046
LRL rock 12047

Let me get some rocks. This will be sample 15D.

LRL rock 12045
LRL rock 12046
LRL rock 12047

Pete's going to put two or three local rocks in here, and I'll photograph them.

Most of the rocks we have seen today looked exactly like this.

There's some of that light-colored undersoil.

I'll bet that everything we've got here is really black basalt. It's all been colored like the Surveyor. Everything we've seen has been the same type of fine-grained basalt. It's had different colors because of how long it's been
out on the surface or where it's been.

* * * * *

CDR  A1, you've got to get that close-up stereo camera going.

CDR at LM

05 14 47 12  LMP rests between +Y and -Z struts

05 14 47 49  LMP

05 14 48 09  It looks as if the engine really washed a lot of dirt off in this direction.

05 14 48 22  As I look back behind me, --

CDR  Get rocks over here.

05 14 52 02  I'm going to start packing up the gear.

05 14 55 26  Move TV cable

05 14 56 13  LMP goes to get SWC

05 14 59 04  LMP collects SWC, returns to LM

SRC #2 closed
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>05 14 59 24</td>
<td>CDR</td>
<td>I've got some of those bedrock ones in there.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>05 15 01 01</td>
<td>CDR gathers rocks;</td>
<td>I don't have a camera to go along with this, Houston, so I'll just tell you when I am taking a picture.</td>
</tr>
<tr>
<td>05 15 01 21</td>
<td>LMP takes close-up stereo photos</td>
<td>I'm taking a picture now, about 10 ft from the LM, between the +Y and -Z struts. I'm hoping to show the effects of the engine exhaust on the lunar surface.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Photo number 800.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Photo 801.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I took another one. The little counter doesn't seem to be working. I'm taking a fourth picture right up next to the engine. Another one about 2 ft from the engine. I'll go look for an undisturbed crater and take a picture down inside it.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Two photos of a rock.</td>
</tr>
<tr>
<td>Time</td>
<td>Event</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>05 15 06 27</td>
<td>LMP returns to LM; cleans off dust, gets in LM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CDR gets in LM</td>
<td></td>
</tr>
<tr>
<td>05 15 22 32</td>
<td>Hatch closed</td>
<td></td>
</tr>
</tbody>
</table>

A photo of Pete's footprint in the soil. I'm taking another one.

* * *
OK, I'll take this as my last one.
Debriefing during trans-Earth coast:--

<table>
<thead>
<tr>
<th>Time</th>
<th>User</th>
<th>Message</th>
</tr>
</thead>
</table>
| 08 00 17 15 | HOU | First geologic question: can you describe more fully the patterned ground; that is,  
1. were there several scales of patterning?  
2. was the bearing strength of the patterned ground different from that of non-patterned ground? |
| 08 00 17 39 | CDR | Are you referring to the streaks that were oriented in such a way that they could not have been caused by the LM exhaust plume? |
| 08 00 18 00 | HOU | Affirmative. You described some that were perpendicular to the patterning you'd expect from the exhaust plume. |
| 08 00 18 11 | CDR | If I remember correctly(?), that was at the Surveyor Crater. I think we noticed radial streaks almost everywhere. |
| 08 00 18 25 | LMP | Yes, we saw them frequently; we'd alternately go through areas that did and didn't have them. They weren't very isolated; they were all over. The ones in the Surveyor Crater trended north-northeast or northeast. The ones in front of the LM trended north and maybe northwest. The ridges were about 1/8 to 1/16 in. wide, they were about 1/16 in. high or less, and they were about 3/8 in. apart. |
| 08 00 20 11 | CDR | I don't remember any radial patterning out at Sharp Crater. |
| 08 00 20 20 | LMP | At the end of EVA 2, I used the Gold camera, but I don't think I got any photos of patterned ground. But I did get several with |
the 70-mm camera.

As for bearing strength--I think the firmest ground we were on was in the Surveyor Crater and around it as we approached it from the far side. Way out near Sharp Crater, we felt that the ground was much more soft and powdery.

How extensive were areas of patterned ground? Can you relate the patterning to anything you've seen back here?

When we were aware of it, it was all around us. For example, we noticed it while resting inside Surveyor Crater, before walking down to the Surveyor.

I do remember looking at patterned ground to see how far it extended. Usually it looked as if the grooves extended as far as I could resolve them. I never did look across the grooves, and I never saw any sort of contact along the transverse direction of the grooves, either in Surveyor Crater, in front of the LM, or at a couple of other places.

This may be more of an impression than anything else, but I really don't remember patterned ground out by Sharp Crater, and that's where the ground was relatively soft and maybe a finer-grained than elsewhere. So a very pertinent point may be that the firmer the ground, the more we would see the radial or patterned streaking.
The ground was firm too at the place where I described it as having little blobs in it and looking like a nice smooth, level dirt field that had just been sprinkled by a very light rain.

We saw and photographed at least three basic types of ground:
1. the kind we were on most of the time, like right outside the LM;
2. the kind with the grooves or patterning; and
3. the kind with the "rain-drop" impressions on it.

We also saw some more finely powdered ground out around Sharp Crater, down inside small crater, and to some extent on the inside of Surveyor Crater.

But they all had the same color. You'd suddenly become aware that you'd sunk in further, but there was no distinction in color. From a distance you might be able to see a subtle distinction for crater rays, but when you're standing right up close to it, the distinction was not at all apparent.

The colors were deceptive. I can recall on the first EVA looking at the materials around the LM and referring to them probably as gray-brown or gray-white. On the second EVA, in the very same places, although I wasn't really aware of it at the time, I referred to them as being light brown. I kept thinking that all the rocks had a light tan coating, whereas the first day I thought they had
a light gray coating. My impression now is that the interior of all these rocks would be dark gray basalt, despite their very minor differences in texture, shape, etc. Also, both times we came into the LM our suits looked the same gray color. I saw only dark gray, never any of the browns that I'd seen outside. Our suits looked as if they were covered with dull graphite. That's right; it was about that \_____ to it, and it clung to everything.

You occasionally reported large white boulders in the distance or other things that appeared white. Do you think that was their real color or that it was the way in which the sun reflected off those surfaces?

At high sun angles the ground looks white to us from orbit. When the sun is so bright, and when it shines from directly behind you on objects at a distance, everything has the appearance of being chalk white. I think that one of the greatest differences between the Earth and the Moon is that the sun has such a great effect on color. A rock lying on the ground on Earth looks pretty much the same, even though the sun moves a long way. If you shade it, you can usually get a good index of color. But if you do that on the Moon, you
can hardly see the rock. When it's in the sun, it changes color with the sunlight.
The ground definitely looked different on the second EVA than on the first, because the sun was higher. But objects on the horizon still looked about the same—chalk white. I think that's because the angle between the sun, a distant object, and us remained relatively small. I'll bet that if we stayed and watched the sun move through 90° that objects in the distance would change color.

At the Surveyor, my first impression was that radiation or something had darkened the paint. The only surfaces that didn't look this way were the mirrored surfaces. But a chrome surface, for example, that of the battery box, had changed to almost the same light tan color. Maybe if it had been in sunlight on the first EVA, it would have looked light gray instead; but we saw it as light tan, and the photographs may document that. When I rubbed the battery box, the light coloring came off, but it didn't dust off easily. I'm pretty sure we didn't deposit the dust with the LM, because it didn't look like house dust that's been there only a day or two. It was like dust that's collected for a long enough time to become a cohesive coating, even though it's not very thick. It was almost like a skin. You had to rub hard to get it off the
battery box. When you did, there was shiny chrome beneath it. I think you'll be able to see the effect on parts that have not been touched either by our gloves or by the camera bag.

The TV mirror has only my finger marks on it, and it was covered with fine dust.

There were also a lot of electronics behind the mirror that we didn't touch. They should have the same coating.

It's also significant that the Surveyor was equally brown all the way around. If we had covered it with dust during our descent, I don't think the dust would be uniformly distributed around the Surveyor. As a matter of fact, the way the dust flew when we landed, I don't think any of it landed within 10 miles.

Even if it did, it would have shot right across Surveyor Crater instead of falling into it.

The radiation damage to the Surveyor TV camera, which was exposed to the sun for the entire lunar day, should be compared with that inside the little hole where the mirror rotates, where there are parts, easily calculable, that were less exposed to solar radiation. Careful study of that mirrored surface on the back of the mirror and inside that little hollow place should indicate how fast this dust coating accumulates and when it does.
Did you notice any vertical gradient in color on the Surveyor, as you might expect for a dust coating?

No, the color was pretty uniform all over.

As we approached from the side opposite the LM, our first impression was that the Surveyor was brown.

It didn't look brown the day before when it was shadowed; it looked white. Of course it was in the sunlight by the time we got to it on the second EVA.

Were any of the rocks you saw vesicular?

We didn't see a single vesicular rock.

I once reported I did, but when we picked it up and looked at it, it had a bunch of pits on it, but no vesicles.

I think our samples are all pretty much the same. But we tried to sample anything that looked at all different.

I think we got a sample of almost everything that was there. We tried to sample everything that had a different texture, different weathering properties, different geologic setting, or anything else that seemed unusual to us.

Did you see any boulder tracks on Head Crater or any other crater that were similar to the type of tracks you saw after rolling that one rock?
None. But without walking down into the crater I couldn't tell what kind of track was made by the rock I rolled. I think we have enough stereo pan photos in craters that you'll be able to see boulder tracks if there are any.

I don't remember seeing any, but I also don't remember looking specifically for them. Usually, though, you'll remember anything that special.

There are just no contacts. I could never determine the outer limit of ejecta except by the difference in slope or the fact that the soil became a little bit more powdery. We never saw anything that had a different color or a different amount of rocks, except the times we kicked up the very light gray material, as opposed to the darker cement-gray material.

I think that much of the material is the same, the only difference being the time at which it was disturbed by meteorite impact.

The materials inside the craters look just like those in inter-crater areas, except there are a few rocks resting on the crater walls and in the bottom.

We didn't see any places, no matter how steep the slope, that
weren't completely covered by regolith.

* * * * * * * * * *

08 04 45 41  HOU  Did you get any soil samples from the Surveyor trenching area, other than the material that may be with the scoop itself?

08 04 46 00  SC  None other than that in the scoop.

08 04 46 09  HOU  Did you climb a mound? Can you describe the mounds more fully; specifically, did they have any apparent orientation or elongation? Were there any vent holes?

08 04 46 33  SC  The mounds weren't big enough to climb on. There were two of them, one bigger than the other. They did not have any vent holes. Both were apparently oriented east-west. They looked something like a strip about a foot wide that had been bent into a triangle. We sampled all around one mound. The mounds didn't seem to be volcanic in nature; they looked more like big globs that had been pitched into that area possibly from craters that were formed nearby or by something farther away. We saw no evidence of any ejecta from the mounds.

08 04 48 21  HOU  Did you notice any differential distribution of the glass beads and the glassy material?

08 04 48 42  SC  Generally speaking, we found it wherever we went, and no more in
one place than in another. We saw beads in the bottoms of even the smallest craters, and on the inter-crater areas, even a casual examination would reveal beads here and there. There were a lot of little ones around, but occasionally we'd see big ones about 1/4 to 3/8 in. in diameter, and they were pretty obvious. I think we have three or four documented samples of apparently identical glass from different places. One sample isn't documented, but I remember where we got it. There were usually both glass beads and glass-covered rocks in the bottom of small craters, 3 or 4 ft in diameter, and maybe a foot deep. There were a number of glass-covered small rocks, and we documented them real well. We had expected the beads to come only from larger craters, about 10 ft across. We also sampled a rock about 2 in. across that is spattered with glass. On the rim of a big crater, we saw a rock about 3 in. in diameter, that was almost completely covered with glass; the glass looked the same as that in Neil's close-up stereo photos from small craters.

Can you describe more fully the material that appeared to be melted in the bottom of Bench Crater. Did it just cover the central peak, or was it more extensively distributed?

The material looked like lava, but I don't mean to imply that the
crater was volcanic in origin. We were probably seeing the effects of a high-speed impact that caused melting of the material. We tried to sample material from the rim, although it didn't resemble the material in the bottom. But the crater wall was too steep and rugged for us to descend. We did take partial pans in stereo of the whole crater.

The appearance of the material reminded us of the Hawaiian fissure eruptions, where the lava bubbles out and spatters, making knobby-looking mounds of basalt. From the top of the crater all the material looked like knobby little mounds.

On the northwest side of Head Crater, you described a rock whose bottom looked different from the top. How was it different?

I probably overemphasized that, because it was the first time we'd turned over a rock and seen a difference. The bottom of this rock was a little bit lighter gray, because it had rested in the lighter gray subsoil. That was the area with a darker gray surface layer about 1/8 in. thick and lighter gray subsurface material.

Do you remember any special or unusual features that you didn't have time to describe? Can you recap each traverse, recalling what you think was the significant feature at each station.
We can't think of anything right now that we didn't describe. As for the second question---I guess the most significant thing at our second stop on the traverse---Bench Crater---was that there we first saw the difference in color between the surface soil and subsoil. And we've discussed the difference in texture of the rocks at the bottom of Bench Crater.

Somewhere between Bench Crater and Sharp Crater, as we were approaching Sharp Crater, we obviously crossed a contact, in that the ground very definitely became softer, finer dust, and we sank in deeper. Al first noticed it, because as I ran, I kicked up more dust.

I'm not sure we ever did get to Halo Crater, because there were about five little craters all together, any of which could have been Halo Crater. We suspect that we were not in Halo Crater, but very close to it.

Coming up to Halo Crater we got on a third type of soil, which was the firmest that we were on. It still had dust, and we still sank in, but in Surveyor Crater we sank in least of all, both going down to the Surveyor and going up toward the LM through that blocky crater on the side nearest the LM.
We already mentioned that we felt that bedrock must have been exposed in the walls of Surveyor Crater after impact, and that the bedrock had weathered to the extent that the crater was very smooth when the small Blocky Crater was formed. This suggests that bedrock was not too far below the surface, right where we were at Surveyor Crater. We have samples of that.

The Surveyor looked in very good shape, although it had changed color. Except for the one metal tube that I couldn't cut, the other tubes were much easier to cut than those of the mockup. The wire bundles that we cut, had the appearance of being very brittle, and cut very easily. The insulation flaked off.

* * * * * * *

Did you notice any boulder tracks in craters indicating that many rocks had rolled down, or were there accumulations of boulders at the bottoms of steep slopes?

We really didn't notice. When there were rocks at the bottom, it was in blocky craters, where it looked like the material had been all along. Because of the dust and my position, I just didn't notice whether the one rock that I rolled made a track. The other rock that I threw was so small that it didn't go very far. Dust flew, and the rocks both bounced and rolled, depending on how far
down the crater wall they were, but it was not obvious to me that they were making any tracks.

* * *

Most of the rocks that we saw on the walls of craters had dust around the bottom of them, and most of them looked as if they were partly buried. It looked as though they had been there for a long time.

There didn't seem to be any that were about to roll in the near future either.

When you pulled out the core tubes, did the holes collapse?

The minute you'd draw out the core tube, about 1 in. would crumble off the top and some parts would fall in. But the sides were still relatively vertical. The same thing happened in the trenches. The sides would be almost 90°, but they'd collapse if you accidentally tapped them with the scoop. But the part you didn't tap would remain at 90°.

I have an impression that there were angles greater than 90° in the trenches, implying layering, although there wasn't any difference in color. Possibly the material was built up at different periods of time.

When you deployed the solar wind experiment, did the staff go into
the ground far enough so that the bottom of the foil touched the surface?

No, it didn't touch the soil. I pushed on it as hard as I could, and then I pushed on it hard enough to lift my feet off the ground, and it went down about a foot or so. I took a photo, which will show the depth of penetration, and that was all the force that I could put on it.

* * *

Did you take any close-up stereo photos outside the disturbed area, and if so, where?

Yes, we did. I took some near the engine, as I mentioned. Then I walked out and took some in the bottom of some little craters that we had not walked in. Then I took three or four of Pete's footsteps. And then I went out into a couple of areas where we hadn't(?) been and took some photographs there.
During the EVA you mentioned finding three kinds of soil. Would you briefly describe the color, texture, etc., for each soil, and discuss whatever problems you had in handling the different kinds of lunar material.

That classification was somewhat subjective. All the colors were the same. But some soil was firmer, that is, you sank in less. The softer soil, that we sank into more deeply, was finer grained. The softest soil occurred near Sharp Crater. The soil near the LM was intermediate in bearing strength. And the soil on the south wall of Surveyor Crater was the firmest. We have samples of each type of soil.

The rocks and the soil all appeared the same dull gray color.

Closer examination would occasionally reveal a white rock, or you might disturb something and find a slightly darker gray, but generally everything was gray. On the second EVA, however, the same things that looked gray on EVA 1 started looking brown--dark brown or tannish brown. You recall the Surveyor looked brown to us, and the coating on it was the same brown as the soil. I wouldn't be surprised if the parts we returned look dark gray again on Earth.
Would you discuss changes in the appearance of the Surveyor spacecraft and give us your impressions or conclusions about what caused these changes.

The brown color is definitely due to lunar dust that's on it. It was evenly distributed all the way around the spacecraft, so I don't think it's dust that we blew on with the LM when we landed. It wasn't that easy to wipe off. The tubes we cut appeared much more brittle and easier to cut than those of the mockup, even though they were theoretically the same material. On the wire bundles that we cut, the insulation had become very dry and hard and brittle.