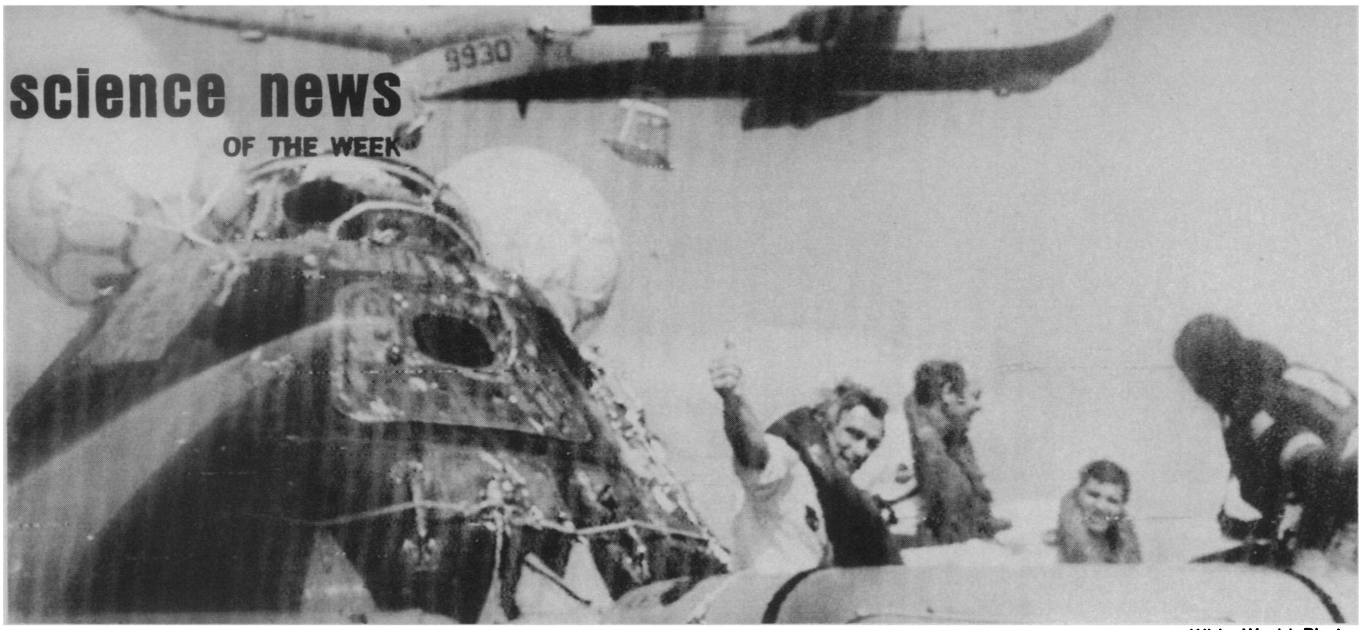


Wide World Photos

The crew returns to earth: "Apollo 17 will be remembered as the most scientifically sophisticated lunar landing."

A perfect ending for the final Apollo

"This valley of history has seen mankind complete its first evolutionary steps into the universe, leaving the planet earth and going forward into the universe. I think no more significant contribution has Apollo made to history." Harrison (Jack) Schmitt before leaving the surface after EVA III.

"As I take these last steps from the surface [to go] *back home, . . . I'd like to just list what I believe history will record—that America's challenge of today has forged man's destiny of tomorrow. And as we leave the moon at Taurus-Littrow, we leave as we came, and God willing, as we shall return, with peace and hope for all mankind. 'God speed the crew of Apollo 17.'"* Eugene A. Cernan's last words from the moon's surface, Dec. 13, 1972.

Project Apollo ended this week. The last moon men, Eugene A. Cernan, Ronald E. Evans and Jack Schmitt, returned to earth at a speed of about 25,000 miles per hour and splashed down on target in the Pacific Dec. 19, at 2:25 p.m., EST.

Apollo 17 was an almost perfect mission with only a few minor glitches, crew ailments (gastric problems) and lost items, including a rover fender and a pair of scissors. "We've had two outstanding vehicles," Evans said in a space press conference before splashdown. The hardware, the men and the mission itself were, remarked one scientist, "a fitting finale to the most incredible exploration venture and scientific endeavor in the history of man."

Cernan and Schmitt broke all records. They were on the surface (outside the lunar module or LM) for 23 hours and 12 minutes collecting 249 pounds of surface material which included 67 bags of documented rocks, 12 loose rocks, 4 bags of rake samples, 48 bags of soil, 9 deep and driven core samples and 2 special samples. (These were estimates based on the crew's verbal reports.) They drove more than 35 kilometers in the moon jeep and took at least 2,200 photographs from the surface.

All of the surface and orbital instruments appear to be working with the exception of the surface gravimeter of Joseph Weber of the University of Maryland (SN: 10/21/72, p. 268).

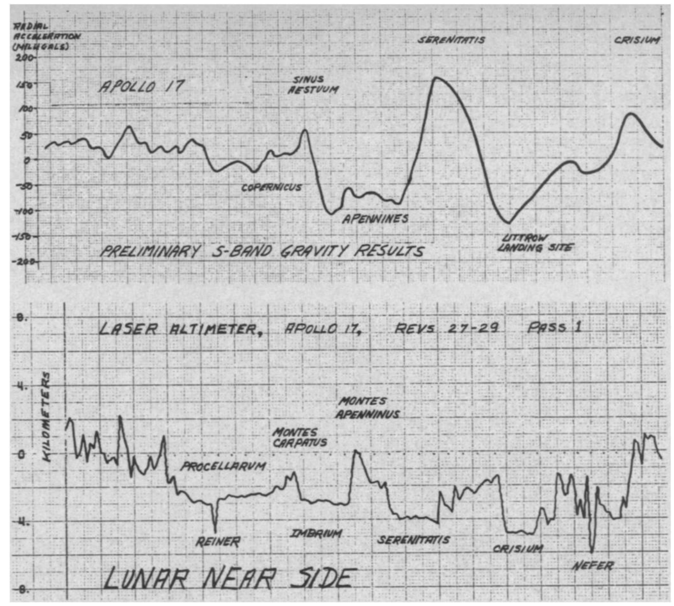
Harold Masursky of the U.S. Geological Survey reported the orbital cameras obtained more than 60 billion data bits, and other investigators of the orbital instruments reported similar successes. The news media from round the world and NASA personnel and scientists at the Manned Spacecraft Center had 12 days of "instant science." "It was honest-to-goodness geology and science . . . involving reasoning and deductions," said Paul Gast of MSC of the Apollo 17 performance. The geology investigation team summed it up this way: "Apollo 17 will be remembered as the most scientifically sophisticated, not as the last, manned lunar landing." Unlike the Apollo 16 site (SN: 4/8/72, p. 235), the Taurus-Littrow site itself had few surprises. "The site held great promise that we were going to get a chance to unravel much of the early lunar history as well as sample and study what appeared to be very young volcanism," said William R. Muehlberger of the University of Texas and head of the field geology. "I think this promise was fulfilled. We accomplished everything we had hoped to do in understanding the geology of the site."

The site turned out to fit reasonably well the preflight theories. That fact alone, says Gast, shows that "science is working . . . and maturing." The valley where Challenger landed was probably caused by faulting at the time of the impact that formed the Serenitatis basin. It is surrounded by mountains composed of uplifted crustal material (anorthositic gabbros high in aluminum and calcium) as well as mountains that appear to be ejecta from the impact. The valley was later filled with what the crew called gabbroic rock—or lava flows. On top of this are two types of even later mantling—a light debris thought to be landslide from the south massif and a dark material thought to be pyroclastics (violent volcanics). Two structures still remain somewhat mysterious—the sculptured hills (probably ejecta) and the Lincoln scarp.

Everything that was known this week of the site was gleaned from Cernan and Schmitt's observations. Cernan turned out to be more of a geologist than some had expected, and Schmitt, more of an exuberant astronaut, as well as an even more critical and observant geologist. What usually is learned about the rocks only after their return to Houston, Schmitt and Cernan described in real-time from the surface. Schmitt called out grain size and structure (he was able to differentiate between orthopyroxene and clinopyroxene crystals in gabbros), mineral content (ilmenite and magnetite),

Wide World Photos

The last Apollo moon men: Cernan, Evans and Schmitt.



Wm. Wollenhaupt

Scientists are already sifting preliminary orbital data.

The record-setting Apollo 17 mission brings the moon program to a close. 'We accomplished everything we had hoped . . . in understanding the geology of the site.'

boulder population and size. He deduced the origin of much of the material. The two men sampled all the major features at the site, having to omit only two craters, Emory and Sherlock, because of time. They collected vesicular basalts, fine-grained basalts, blue-gray breccias, tan-gray breccias and anorthositic gabbros. It is "the most diverse collection of samples yet," said one geologist of the haul.

Cernan and Schmitt's dialogue reveals their enthusiasm for the geological tasks.

Cernan: "I think I'm down here on a boulder track. How does that make you feel?"

Schmitt: "That makes me feel like I'm coming over to do some sampling. Think how it would have been if you were standing there before that boulder came by." Cernan: "I'd rather not think about it."

Schmitt: "There is a spall lying on the ground here that has been knocked off up there from the top . . . and I tell you, the more I look at the south half of the boulder, the more heterogeneous in texture it looks. It looks as if it may be either a recrystallized breccia of some kind or a gabbroic anorthositic magma that caught up an awful lot of inclusions. I guess I prefer the latter explanation. . . ."

But the stops weren't spent exclusively rock hunting. The crew had to read out temperatures for the surface electrical properties experiments, give navigation readings from the rover (range and bearing from the LM), take readings from the traverse gravimeter, check on their own suit cooling and oxygen consumption and adjust the circulation, unload and load their equipment and remove dust from the television lens, the rover batteries and themselves.

Cernan: "You know what I'm getting tired of?—dusting. My primary tools are the dust brush, the hammer and my head." Schmitt: "You've got your pockets completely filled with dirt." Cernan: "Well, extra samples."

Schmitt used the rover-riding time "to do some thinking" and describe the terrain.

While Cernan was driving, trying to avoid unexpected craters and boulders, Schmitt was supposed to take pictures as well as navigate, look for rover samples and sometimes carry an explosive charge (eight charges were placed at the site and all have been detonated). Schmitt: "I wish I wouldn't look and start concentrating. I'm forgetting to take my pictures." The capsule communicator replied, "Okay, copy that, Jack, stop thinking and take pictures."

Sometimes the two disagreed—both with ground control and each other. Cernan: "The whole thing is obviously a breccia." Schmitt: "Well, let's see. I'm not sure its obviously a breccia, I think it may be a rock with breccia inclusions."

One of Cernan's observations added substantially to a discovery by Schmitt of orange and reddish soil at Short crater. Schmitt: "There is orange soil." Cernan: "Well, don't move it till I see it." Cernan: "Hey, it is. I can see it from here. . . . He's not going out of his wits, it really is." (At which time the geologists in the "backroom" at Houston hit the ceiling.) They later described the discovery as "the most significant in the Apollo program" and a "spectacular plus."

Cernan then observed that the orange and red material made radial stripes around the crater rim. Schmitt: "Man, if there ever was a—I'm not going to say it. But if there ever was something that looked like a fumarole alteration, this is it." Later he said it: "If I ever saw a classic alteration halo around a volcanic crater, this is it. It's ellipsoidal; it appears zoned. . . ." Fumaroles on earth are deposits from the last gasps of volcanism. They are created by gases and water vapor escaping through vents. The gases oxidize the material, turning it orange or red. Later Evans, from the orbiting command module, spotted more orange-tinted material in the ejecta blanket around a crater west of Serenitatis. It is in a region interpreted to consist of young volcanics similar to Taurus-Littrow. (Schmitt and Cernan later confirmed the color of the material from orbit.)

The crew had to take extra time to sample the material. CAPCOM tried to hurry them up. "Just a few more minutes," or "Nag, nag, nag" was the common response. CAPCOM: "Okay 17, we're looking at a nominal station 9 here. You've got about 25 minutes." Cernan: "No such thing as a nominal station anymore." Schmitt: "Geology won't let it be nominal." Station 9 was the Van Serg crater, and it wasn't nominal. Houston was trying to get the crew onto the rover while Schmitt was still analyzing: "I'm not sure I understand what happened here yet. This should have brought up subfloor according to the theory. . . ." CAPCOM: "But you've got 10 minutes. I'm just telling you to be thinking about getting back. Schmitt: "Yeah, we're always thinking that way. Come over here, Gene, quickly. We can't leave this."

Sometimes they debated CAPCOM. Houston wanted a double core; Schmitt didn't think is was possible, but Cernan proceeded to get it. Schmitt: "Well, you're not even going to debate the issue." Cernan: "No, it takes too much time debating it."

Later, while the crew was in lunar orbit, they began asking Houston questions about the scientific instruments. According to Sheldon Buck of the Massachusetts Institute of Technology, the traverse gravimeter indicated variations in the gravity at the site from minus 38.1 and minus 28.8 milligals at the north and south massifs and minus 26.4 and minus 25.9 a few meters from the base. Variations on the plains unit itself were much smaller. There was a small positive gravity reading at Shorty crater. The massif material extends to depth at a very steep angle under the mare, reported Marcus E. Langseth of the Lamont-Doherty Geological Observatory. If the density difference between the massifs (probably highland materials of anorthositic gabbros high in aluminum) and the lava material of the valley is 20 percent, the lava flows could be as deep as 1.5 kilometers. They could consist of many separate layers.

The lunar sounder data had some surprises. "We expected over the mare the signals would reveal smooth subsurface structure and the opposite would be true for the highlands," said Walter E. Brown Jr. of the Jet Propulsion Laboratory. But the sounder's signals were well-behaved over the highlands and bounced around over the mare "implying subsurface features."

There are some thermal surprises on the moon as well, reports Frank Low of the University of Arizona, principal investigator for the orbital infrared scanner. The normal surface soil heats to about 400 degrees K. during the lunar day, and cools to about 100 degrees K. during lunar night. But Low located a cold spot some 10 degrees K. cooler than the surrounding terrain near the crater Hohman in Mare Oriental. The spot appears to correspond to a feature that looks like a cinder cone.

The ultraviolet spectrometer, reports William E. Fastie of Johns Hopkins, revealed that the "moon is not outgasing." William Wollenhaupt of MSC says the gravity data from Apollo 17, as well as the laser altimeter data, agree well with Apollo 15's. The basins on the near side get gradually lower in elevation going east toward Smythii. From Smythii the terrain then rises 9.5 kilometers, to the highest farside point, Gagarin. Apollo 17 data show that the large depression on the far side, DeVries, which is 4 kilometers below the mean radius, is larger than expected. It is almost directly opposite to the highest point on the near side. The depression could explain why the moon's center of figure is displaced from the center of mass. The data also reveal that most of the basins show a gravity high while the highlands show a gravity low.

The crew was delighted to learn that the heat flow sensor was working. "We doubled our data," said Langseth. The most surprising result is that the heat flow from within the moon appears to be as high at this new site as at the Apollo 15 site. "If it turns out to be the same as Apollo 15," he said, "it would give support to the growing model of a warmer interior for the moon." This would mean that the moon has a greater abundance of radioactive elements than the earth—"a fundamental difference in composition between the earth and moon." It would also mean that the moon should be stratified or differentiated so that most of the radioisotopes would be concentrated in the upper layers of the moon.

Another surprise was preliminary data from the impacts of the F4B stage and LM ascent stage. Gary Latham of the University of Texas says the new data indicate a much thinner crust than previously thought (25 kilometers deep instead of 60 kilometers). The velocity of the signals had decreased from 7 kilometers per second to 6.3 kilometers per second, which he said might mean the crust is gabbroic rather than anorthositic. But factors other than chemical composition could change the velocity. "I will defend the proposition that the crust is aluminum plagioclase-rich rocks or anorthositic gabbros," says Gast. He suggests that the crust may just vary in thickness in different areas of the moon.

President Nixon's post-splashdown statement extolling the flight as "the end of the most significant chapters in the history of human endeavor" promised a continued major national role in making space history. But all manned missions currently planned will be confined to earth orbit.

What has become an incredible part of the everyday lives of those closely involved with the Apollo program—the sounds of air pressure in the spacesuits while the men are on the surface of the moon, their sighs and laughs, the sight of men hopping around and falling down on an eerie surface that looks like white and gray silk and satin on black velvet—is over. That silent ride in space with the earth seen out of one window and the moon out of another will not be a part of man's experience for some time to come. □

National Library of Medicine

Gout: The comforts of high living.

A molecular explanation for the perils of gout

Gout, a form of recurrent arthritis, has plagued man since Biblical times. It has long been a symbol of indulgence in rich foods and fine spirits, and also a mark of intelligence, creativity and achievement. Men are more vulnerable to gout than are women.

In the 19th century, high levels of uric acid in the blood were linked with gout. In this century it has become apparent that gout attacks relate to deposits of uric acid (urate) crystals in tissue. Gerald Weissmann of the New York University School of Medicine has been zeroing in ever closer on how urate crystals might cause gouty tissue inflammation.

Last year he reported that when white cells, which are normally immunologically active, are exposed to urate crystals, white cell lysosomes (membrane-bound vacuoles) release lysozymes and other immunologically active lysosomal enzymes. Then the cells die.

Now, in the Dec. 6 NATURE NEW BIOLOGY, he and Guiseppe A. Rita of the University of Turin in Italy report that urate crystals are able to disrupt white cell lysosomes. The specific site of the disruption is the phospholipid-rich membranes that constitute the border of the lysosomes. The crystals form hydrogen bonds with the phospholipids. Specific inhibitors prevented the bonding. Weissmann believes that these effects, observed in the laboratory, may also occur in people and cause gouty inflammation.

Here is his hypothesis of what happens: Urate crystals that lie in the spaces between joints, or in other susceptible tissues, attack white cells in those tissues. The crystals are sucked up by defensive white cells. The next step—still conjectural—is that proteins in the cytoplasm of the white cells,