

## Chapter 2-6

# The Copernicus Traverse

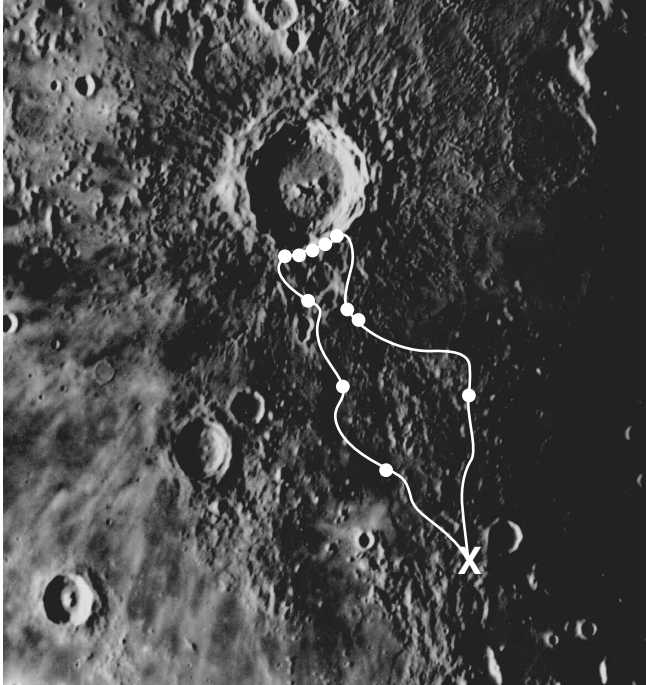
**Thursday, July 4, 2014**

The 4<sup>th</sup> of July, Independence Day for the US, was celebrated at the Fra Mauro Lunar Base by a very early breakfast and an early start of the long anticipated Copernicus Traverse — the first use of the Traverse Vehicle.

Lunar sunrise had occurred 2 days earlier and the crew had readied the Traverse Vehicle for its maiden voyage across the frozen lunar seas. It was fully fuelled and carried life support and fuel cell power for 3 weeks. Though mission rules limited the traverse to 2 weeks, the Traverse Vehicle always carried a 50% life support and power contingency and the planned Copernicus Traverse was to last only 12 days — 13 at most, so there was plenty of food, oxygen, water, and power to spare. Also, the southern rim of Copernicus, the goal of the traverse, was only about 250 kilometers to the NNW of the Base, and so the round trip was only going to use half of the 1000-kilometer range of the vehicle. Thus, the maiden voyage would not stretch the capabilities of the Traverse Vehicle, but would give it a good shakedown.

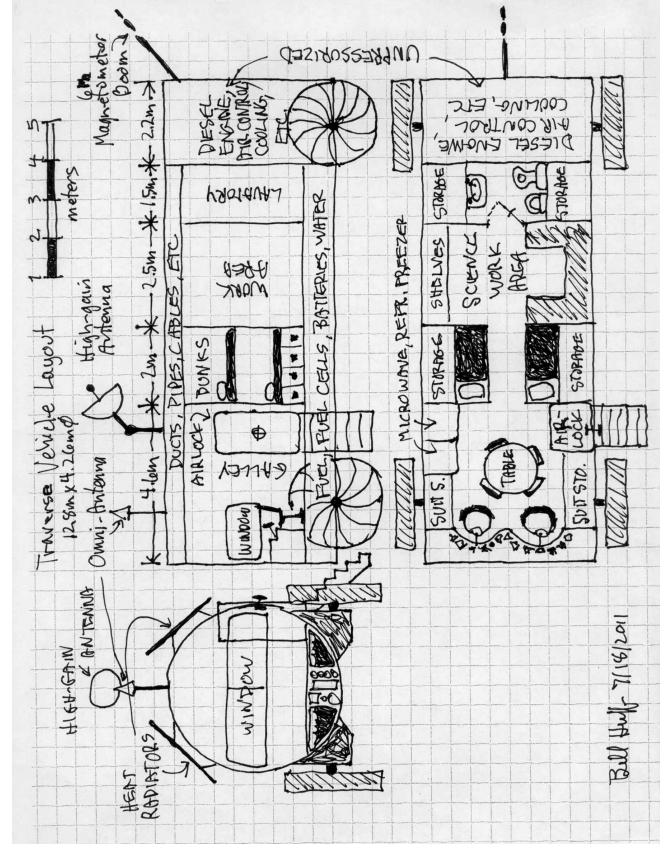
Shortly before 7:00 GMT, the crew went out the NE airlock and walked around the Traverse Vehicle for a last visual inspection. To reduce costs, Boeing had built the Traverse Vehicle using the same basic, 4.26-meter diameter, 12.8-meter long module used for Dorm, Kitchen, Lab, and Utility for its body. In fact, the Traverse Vehicle was just a mobile mini-base with all the functions found in the Base's 4 modules crammed into just 1 module. It had four, 2.5-meter diameter, springy, metallic wheels, a large front window, and 2 smaller side windows just aft of the front of the vehicle.

At 7:32 GMT, Bill, sitting in the driver's seat, with Jim next to him in the passenger seat and with Maria and Karl standing immediately behind them, called Tom on the radio, "Ok, we're ready to go. Is everything ready on your end?"



## COPERNICUS TRAVERSE

The Copernicus Traverse started at the Base (X) and proceeded NNW to the southern rim of the 92-kilometer (57-mile) diameter crater, Copernicus, which is 250 kilometers (155 miles) from the Base. The return leg of the traverse was to the east of the leg to Copernicus. The dots along the traverse path mark the sites where the vehicle was parked while the crew slept. North is up.



## TRAVERSE VEHICLE DETAILS

A ROUGH SKETCH FROM BILL HUFF'S NOTEBOOK

Bill Huff 7/16/2011

Tom answered, "Yes, we are getting excellent engineering telemetry and we have clear voice communications. You can get started. Have a nice trip."

With the final ok, Bill started the diesel and hydrogen peroxide motor and began driving north along the graveled road to the landing pads at a brisk 15 km/hr.

Twenty minutes later, they passed South Landing Pad and just before 8:00 GMT, they passed North Landing Pad and the end of the graveled roadway. Thus their speed dropped to 12 km/hr as Bill drove through the bumpy, cratered moon-escape. About 45 minutes later and 15 kilometers from the Base, Tom called and said, "You're signal is beginning to break up. Please switch to the Earth-link."

Some 2½ hours later, at a distance of 45 kilometers from the Base, Bill drove the Traverse Vehicle off the light colored Fra Mauro onto the dark mare basalt units that stretched 150 kilometers to Copernicus' continuous ejecta blanket. Once Bill had driven a couple of kilometers onto the mare surface, that was peppered with innumerable, large and small secondary craters from Copernicus, he stopped at Karl's first mare basalt sample collection site. Since they were stopped and since it was nearly 11:30, Bill said, "Let's have lunch, then you three can go hunt rocks."

Since Bill liked to "cook," he went about heating the TV dinner-type lunches in the microwave in the little galley behind the right front seat. As Bill tended to the food, Jim, Karl, and Maria inspected their suits and PLSSs in the adjacent suit-area, in preparation for their leaving the vehicle.

As the quiet and brief lunch ended, Karl said, "Schatz, do you want to be the first to go, before we suit-up?"

Laughing a little, Maria answered, "That's very gallant of you, cariño," and she walked from the galley, though the narrow passageway between the two sets of bunk beds and through the small work area to the little lavatory at the far end of the Traverse Vehicle. She was soon finished and was ready to start suiting up.

As Karl started towards the lavatory, Bill said in a light-hearted tone, "Make sure your aim is good in there. I don't want to have to clean up after you and Jim," and Karl and Jim

chuckled, knowing full well that, even after living at ½-g for 2½ months, the males of the crew still did not always correctly compensate for the differences in gravity while unconsciously calculating the trajectories of their urine streams. Though the three males laughed at what they considered to be great humor, Maria said, in mock disgust, "Can't you men ever stop behaving like Neanderthals?" which made Karl, Jim, and Bill laugh even louder and longer.

Soon, Maria, Karl, and Jim each cycled through the airlock and began their standard sample collection activities, work that lasted about an hour. Using the same strategy as on their Rover fieldtrip, in addition to collecting mare basalt samples, they would also collect samples of Copernicus ejecta that came from deeper and deeper depths in the pre-impact crust, as they got closer to Copernicus. Since Copernicus is 92 kilometers in diameter, they expected to find rocks from depths as great as 13 kilometers below the original crust — an important and exciting possibility.

Karl also made some gravity measurements, which could only be made when the vehicle was stopped and when he was on the surface with the gravimeter. But Karl did not have to use the portable magnetometer, except when he wanted to measure the magnetic fields in an area within walking distance of the Traverse Vehicle. The Traverse Vehicle had a magnetometer mast sticking out the back, which carried an inboard magnetometer to monitor the magnetic fields generated by the vehicle and an outboard magnetometer that, when its data were corrected for the effects of the vehicle's magnetic fields, made continuous magnetic field measurements as they drove the vehicle.

When their hour's work was over, they stashed the rock box and equipment in the external bays of the vehicle and cycled back in through the little airlock and de-suited. When they were done, Bill began to drive in the direction of Copernicus at the fast clip of 8 to 12 km/hr, depending on the roughness of the moonscape.

Towards 19:00 GMT, and some 90 kilometers from the Base, they reached the second sample collection site and the "night's camp site." While it was possible to lie in the bunks

when the Traverse Vehicle was moving, it was not possible to sleep as the vehicle bounced along the rough lunar surface. Protocol demanded they stop for the “night” and do the sample collecting the next “morning.”

After Bill microwaved a simple supper, each crewmember took a turn in the lavatory to cleanup before bed. As always, Maria was given the honors first. Unfortunately, because of the limited supply of water and space, there was no shower. So all one could do was to take a sparse sponge-bath, which removed only a limited amount of the sweat and soil accumulated after a day of riding in the bouncing vehicle and after spending a few hours in a spacesuit.

Maria emerged from the lavatory 25 minutes later, dressed in modest pajamas and a robe, looking somewhat refreshed and smelling of her White Diamonds perfume. She hugged Karl, gave him a quick kiss, and got into the lower bunk on the right side of the passageway, as Jim and Bill discreetly kept busy at the front of the cabin.

#### **Friday, July 5, 2014**

After breakfast the next morning, it was Bill’s turn to assist Karl and Maria in their fieldwork and then they drove off towards their next stop. By evening, they were close to the southern edge of Copernicus’ continuous ejecta blanket and they made more frequent stops to collect samples and make measurements.

#### **Saturday, July 6, 2014**

The day began with a call from Houston. After the usual technical communications, Houston said, “Bill, we have someone here who wants to talk to Jim.”

Having heard that, Jim took the mike and said, “Jim here, go ahead.”

A female voice came through the ether, “Jim, honey, you’re not going to believe this, but I’m pregnant — it must have happened the last night you were here. At first, I didn’t think anything about it — you know how irregular I am. But after the second month, I went to the doctor to see if something was wrong. He did some tests and said I was pregnant.

I didn’t want to tell you until he did additional tests to see if the baby is all right — given my age. But the baby is fine and so I came to JSC to tell you, we’re going to have the third baby we always wanted.”

Jim was ecstatic; in his excitement, he jumped up, forgetting about the low lunar gravity, and banged his head against the top of the cabin. Ignoring the growing bump on his head, he said, “Honey, that’s great — that’s wonderful. Hey, I’ll be back home before he’s born. Have you told Ben and Jan? What did they say?”

Patty answered, “No I haven’t, I wanted to tell you first. Oh, I’m getting the sign to wrap up now. I love you. Bye”

After the light-time delay, Jim said, “I love you, too, darling, bye.”

Jim turned to Bill, Maria, and Karl and said, with tears in his eyes, “I’m going to be a dad again, and I’m on the Moon. Could life get any better?”

Maria said, as she hugged him, “Congratulations Jim, I’m so happy for you.”

Bill slapped Jim on the back and shook his hand, “Way to go old man.”

Karl shook Jim’s hand and said with Germanic seriousness, “Congratulations.”

By the end of that happy day, they were on the ejecta blanket and less than 30 kilometers from Copernicus’ rim. The next day, Karl and Maria, with Bill’s help, planned to set up the 2<sup>nd</sup> Selenophysical Station, about 15 kilometers south of the rim, and then they would camp that night on the rim and spend the next 4 days exploring the rim area.

#### **Sunday, July 7, 2014**

As Karl, Maria, and Bill were setting up the Copernicus Selenophysical Station on the 4<sup>th</sup> day, things came to a head between John and Isabel back at the Base.

Having determined that Pam was with Tom in the com-cubicle and that Isabel was alone in Hospital, John barged into Hospital without knocking. As Isabel looked up from her work with a mixture of surprise, anger, and a little fear on her face, John said, forcefully, “Well beautiful, it looks like we’re

finally alone and can get down to business.” Before Isabel could say a word, John continued, holding up his right hand to ward off any response, “I know, I know, you’re married, etc., etc., but I’m tired of your little game of hard to get, which I don’t believe for a minute. The traverse crew is hundreds of kilometers away and Pam and Tom are glued to Tom’s radio, so there’s no one to bother us and no one will know. Do you want it here or shall we go to Dorm?”

Isabel was boiling. She had had enough and was getting more than a little frightened at John’s persistent passes and increasingly erratic behavior. She “screwed her courage to the sticking place” and said sternly, “John, I am sick and tired of your persistent sexual advances. If you do not stop bothering Maria, Pam, and me right now, I will have Pam put something in your food that will stop you from having an erection for the next year and I will inform Houston officially that you are no longer fit to command the Base or be in the Astronaut Corps. Do I make myself absolutely clear?”

John turned red with anger and humiliation and, taken back by her serious threat, he could say nothing — he just glared at Isabel.

Seeing that she had him where she wanted him, she added the very unprofessional comment, “However, I recognize you have a very high sex drive. So as your physician, I recommend that, in the privacy of your bedroom, you masturbate at least twice a day. That will relieve your sexual tension and you will, at last, have a willing partner here at the Base.”

The insult enraged John even more, as well as added to his humiliation. The twisted expression of hate on his face suggested he wanted to smash her in the face, throw her on the floor, rip her clothes off, and rape her on the spot. But, despite John’s exploitation of women, he was neither a rapist nor had he ever physically hurt a woman. All he could do was to shout at her, “Go to hell, you conceited bitch. We’ll see who gets who thrown out of the Corps,” even though he knew full well he could do nothing to harm a flight MD, and he left Hospital in a total rage.

Though she had put up a brave front against a physically larger and stronger adversary, Isabel began shaking uncon-

trollably as John rushed out of Hospital and slammed the door as hard as he could. Though she had won without John getting physically violent, he was clearly capable of violence. To calm herself, she took out a bottle of medicinal whisky — a bottle known only to her — and took a big swig right from the bottle. As the whisky took effect, she called Tom’s cubicle over the Base Intercom and said urgently, “Pam, come to Hospital, immediately!”

When Pam arrived, Isabel told her about her encounter with John, gave her some tranquilizers to put in John’s food, and said, “Pam, be very careful of John. Let me know if he does anything strange or threatens you in any way, ok?”

Pam answered uncharacteristically, “I sure as hell will. I’m as sick of him as you are and I’m glad you put him down. But we do need to be careful of him. I assume you’ll warn Maria as soon as she gets back. And you better say something to Karl, too. John hates Karl with a passion, especially because of Maria — if you know what I mean.”

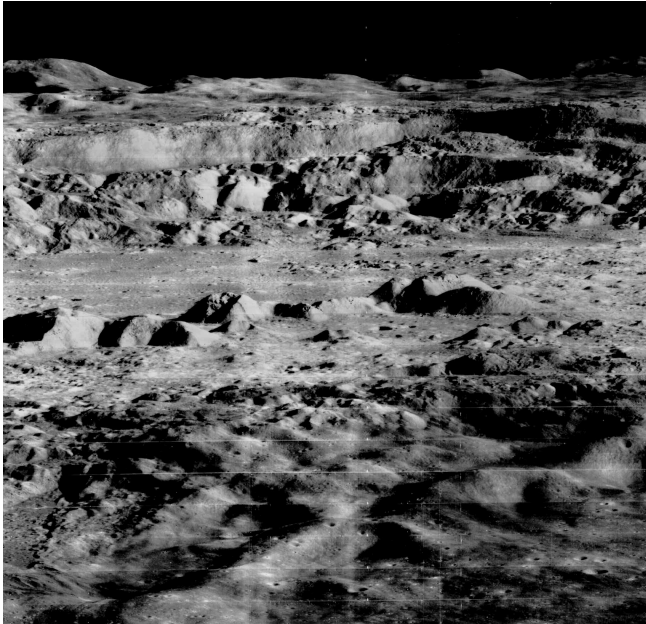
Isabel answered, “Yes I do, and yes I will.”

Isabel paused and added, “If we can’t keep him in check with tranquilizers, I’ll have to report this to NASA. I hate to do it unless it’s absolutely necessary. If I do, they will relieve him of his Command and that might make him become psychotic — and we do not have the means to deal with a potentially violent madman here for 3 months. Also, it would mean the end of his career, and I would hate to destroy his career over something we might be able to handle with tranquilizers and that might pass when we get back home.”

Worried, Pam responded, “I hope you’re right. Just to be sure, shouldn’t I put a double dose in his food at lunch today? It’s a good thing he never fixes his own food, or we might not be able to keep him loaded with pills. Just give me the amounts you want and I’ll see to it he gets them.”

Isabel nodded and gave Pam the extra pills for the double dose she had suggested.

To Isabel and Pam’s surprise, John appeared at dinner in an apparently good mood. He was friendly and, for the first time, almost polite and that frightened Pam and Isabel even more. As Isabel said later to Pam, “I don’t think the change in



**LUNAR ORBITER II PHOTO OF COPERNICUS**

John's mood is just because of the tranquilizers, I think John has gone over the edge and is a danger to all of us, including himself. We have to be very careful."

By the time supper was over at the Base and at Copernicus, and against all mission rules that at least 1 crewmember had to be in the Traverse Vehicle at all times, Maria, Karl, Bill, and Jim were all standing on the rim of the gaping hole — 92 kilometers from rim to rim and over 3 kilometers deep — called Copernicus. The panorama before them was breathtaking. Though Maria had the famous Lunar Orbiter II, oblique angle photograph of Copernicus on her office wall back in Houston, a picture whose beauty had stunned the non-scientific world back in 1966, seeing the beautiful expanse before them was beyond description.

Bill was the first to speak and was thrilled by the magnificent view, "Man, what a view. This makes the Grand Canyon look like a brook. No wonder you guys like studying the Moon — it's just beautiful. But what exactly are we seeing?"

Karl, keeping the good-natured banter alive that always exists when scientists and engineers work together, replied teasingly, "Gee, I didn't know an engineer could find anything beautiful, except some kind of machine. Aber ja<sup>1</sup>, the Moon is extremely beautiful, though most uninformed people think it's just a dead lump of rock. Now you see how wrong they are."

Then Karl said, wanting his Maria to show off her stuff and because he was also in a giddy mood brought on by the enthralling sight before him, "As to what you are seeing, you had better ask the beautiful and talented selenologist to my right."

Taking Karl's cue, an equally excited Maria explained, "All along the inner wall, you see multiple, irregular terraces caused when huge sections of the initial, unstable crater wall slumped down, as the transient crater collapsed immediately after the impact. The individual terraces are up to 4 kilometers wide and there are 4 to 6 of them before the floor is reached, some 3 kilometers below the rim and the drops

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Note: <sup>1</sup>Sure

along the scarps between the terraces are up to a kilometer. As you can see, the depressions in the terraces' surfaces were immediately filled with impact melt that rained down with the fallback — to form kilometer-scale lakes of impact melt. See how some of the impact melt overflowed the terraces and cascaded down to the next ones and over and over again, until it reached the growing lake of impact melt that was filling the floor of the crater?"

What Maria described and what the mesmerized crew saw, were solidified lakes — and contorted, solidified cascades — of impact melt, all of which dramatically depicted the incredible events and processes that had formed the magnificent crater. If selenologists were correct, the crater had formed a billion year earlier, a deduction that would be tested when the samples from similar solidified lakes of impact melt, that Maria and Karl would collect along the rim, were age-dated back on Earth.

The floor itself displayed a fantastic amount of detail, which Maria began to describe. "Now to the floor. As you can see, except for the young impact craters that pepper it, its northwest quadrant has a relatively smooth surface of solidified impact melt. In contrast, the northeast quadrant is covered by innumerable hummocks that are hundreds of meters in dimensions and that formed when large chunks of fallback ejecta fell into the growing impact melt lake at the bottom of the crater. You can also see the entire southern half of the floor is covered with similar hummocks, but their dimensions are up to the kilometer-scale. Also, the floor has numerous secondary vents and associated flows, where molten impact melt from below the solidifying crust erupted and spread short distances across the floor."

Maria stopped a minute to again take in the beauty of the scene before her and then continued, "Finally, there, in the middle of the floor, is its magnificent central peak complex — a complex of about a dozen mountains, the tallest of which reaches a kilometer above the crater floor."

There was just too much detail for the crew to grasp; only the pictures that Karl and Maria started taking would capture all the features they were looking at. Below them was

a selenologist's paradise and Maria said, "I'd give anything to go down there." But that was far too dangerous with the equipment they had; such magnificent fieldtrips would have to wait until there was a Lunar Lander-like ballistic research vehicle available to "fly" into craters like Copernicus. Though, if NASA would allow it, the existing Lunar Landers would do the job nicely, but. . . .

After spending a couple of hours at the rim, absorbing the majestic scene and photographing it, they went back to the Traverse Vehicle for a night's rest.

#### **Monday, July 8, 2014, through Thursday, July 11, 2014**

They spent the next 4 days exploring the outer slopes along some 20 kilometers of the rim, gathering numerous samples of ejecta and impact melt rock from the solidified pools and lakes that had formed on the outer slopes.

#### **Friday, July 12, 2014, through Sunday, July 14, 2014**

Finally, on the 9<sup>th</sup> day of the traverse, they began driving to a 5-kilometer diameter, dark halo crater blasted into Copernicus' continuous ejecta blanket, some 40 kilometers from the rim. Selenologists believed that the impact had punched through Copernicus' light colored ejecta and excavated dark mare basalts from the pre-Copernicus mare surface — thus causing the dark halo. The crew spent the next day at the dark halo crater, collecting samples at various distances from its rim — to get samples from different depths in the Copernicus ejecta blanket and from the pre-existing mare basalt units below the ejecta.

The next day, they drove further to the SE and off Copernicus' ejecta blanket to get more mare basalt samples from another mare volcanic unit and then they turned towards the Base, which was more than a hard days drive — and more than 150 kilometers — away.

#### **Monday, July 15, 2014, to Tuesday, July 16, 2014**

At 20:40 GMT, at the end of the 12<sup>th</sup> day of the traverse, the vehicle came within the 15-kilometer range of the 50-meter antenna and Bill switched transmitters. A little over

an hour later, Bill parked the Traverse Vehicle near the NE Access Tunnel and the tired, dirty, and smelly crew began cycling out the Traverse Vehicle's airlock.

As Bill began hooking up the power cable from the nuke to the Traverse Vehicle, Maria, Karl, and Jim retrieved the precious rock boxes from the bays in the sides of the vehicle and carried them into the NE airlock. When all the rock boxes were inside, Karl and Maria entered, pushed the cycle button, and were soon standing in East Access Tunnel, where Isabel, Pam, Tom, and a well-behaved John were waiting to greet them.

Maria and Karl took off their suit helmets and almost everyone shouted, "Welcome back. We're glad the trip went so well."

Too tired and dirty — Karl had a two day stubble and like Karl's formerly nice, blond hair, Maria's previously beautiful, shiny, dark brown hair was greasy and stringy and their faces were smudged — to really care about their crewmates' heartfelt greetings, they smiled and said exhausted, "We're glad to be back and to be able to shower."

To which John said, "Whew, we can smell that."

Karl asked, "Would somebody take the rock boxes into Lab, so Jim and Bill can get in through the airlock and so Maria and I can start getting out of these smelly suits."

John, in a surprisingly helpful mood, which Karl and Maria were too tired to notice, answered, "Sure. Tom, will you help me with the boxes?"

An hour later, shortly after 23:00 GMT and after quick showers, the tired and hungry traverse crew sat down at the table in Kitchen as Pam said, with pride, "I've made a special celebration dinner for everyone — not prepared meals, but real steak, grilled to perfection, with baked potatoes and corn on the cob, both dripping with butter, and a freshly baked blackberry pie, not from scratch of course, rather a Mrs. Smith frozen pie I just baked."

Isabel said in surprise, "I thought it smelled exceptionally good in here," and the traverse crewmembers were too weary to say much more than, "Thanks, let's eat," which they did with relish, after 12 days of TV dinners and canned meals.

After supper, Maria and Karl went to Lab to check on the sample boxes and for Karl to take a quick look at the data coming in from the Copernicus Selenophysical Station.

While they were in Lab, Bill went to Utility for a quick check on the status of the Base and then, at a little before midnight, everyone went to his or her room in Dorm.

As Karl gave Maria a quick kiss and hug in front of their opposing doors, he asked, "Schatz, if I wake up early, do you want me to wake you up so we can get an early start on the samples?"

Maria, who usually slept later than Karl, who almost always woke up with the chickens, answered, "Sí cariño, wake me up when you are ready to shower. Te quiero muchísimo, mi amado<sup>1</sup>."

And Karl responded lovingly, "Ich liebe Dich auch, so sehr, mein Liebling<sup>2</sup>," and gave his sweetheart another good-night kiss and hug.

Then they went inside their small rooms, flopped into their beds, and almost immediately fell fast asleep.

A few minutes later, the Base's master clock ticked to 00:00:01 GMT, Tuesday, July 16 — the new day had started.

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Notes: <sup>1</sup>I love you very much, my love; <sup>2</sup>I love you, too, very much, my darling