



High Drama of Bold Thrust



AUTHOR STEINBECK AND PHOTOGRAPHER GORO ON DECK OF THE CUSS I

through Ocean Floor

EARTH'S SECOND LAYER IS TAPPED IN PRELUDE TO MOHOLE

Last week Project Mohole (LIFE, April 7) made scientific history when its drilling barge, CUSS I (whose name is made up of the initials of oil companies who developed it: Continental, Union, Shell and Superior), pierced 601 feet into the sea floor to get core samples of the earth's never-before-penetrated second layer. On board to describe the extraordinary operation for LIFE was Novelist John Steinbeck, who is also an amateur oceanographer.

by JOHN STEINBECK

This is a short and casual log of CUSS I, the experimental drilling barge of Project Mohole. I am aboard because of a long-time interest in oceanography and some small experience in matters of the sea. I feel privileged and greatly excited.

CUSS I is a Navy barge redesigned to take sample cores from deep in the earth's surface under 12,000 feet of ocean. Our station is 44 miles east of Guadalupe and 220 miles south of San Diego. The sea bottom there is 11,700 feet beneath the surface. In a practice run we drilled a hole under 3,100 feet of water off La Jolla so we know it can be done.

CUSS I has the sleek race lines of an outhouse standing on a garbage scow. Actually it is an oil rig, straddle-legged over a hole cut through the middle of a barge 260 feet long and 48 feet wide. In addition to drilling

equipment, cores and diamond bits it is loaded with electronic equipment, much of it invented and designed for this project. But the most important and unique equipment we have is the group of men aboard, an elite and motley crew. The drilling men are the cream of a very special profession already trained in offshore oil drilling in shallow water. Then we have engineers of a dozen kinds, oceanographers, geologists, paleontologists, petrologists, geophysicists and seismologists. Our expedition should destroy the old and well loved error that doers and thinkers are different breeds—and about time too.

This is the opening move in a long-term plan of exploration of the unknown two thirds of our planet that lies under the sea. We know less about this area than we do about the moon. Therefore this log will concern itself with men and events rather than with scientific conclusions. Those will have to come later after analysis of what we find.

Thursday March 23—After five days in a San Diego shipyard refitting and taking on additional equipment, we sailed at 1:30 for our Guadalupe Station, a point in the Pacific Ocean described as 27° North latitude, 117° 30' West longitude.

Sailed is a status word for what we did. CUSS I waddled like a duck into the channel on its four gigantic Diesel outboard motors. Come to

STEINBECK CONTINUED ON PAGE 118



← WORKING THROUGH NIGHT, drillers adjust "kelly" which fits over drill pipe so it can be rotated. Man on high perch (top, center) affixes gauge to measure strain on pipe.

AGLOW WITH LIGHTS, CUSS I lies hove to off Guadalupe Island on Easter eve—a night when its drill was busy making its unprecedented thrust into earth's second layer.



LOCATION of CUSS operation is about 150 miles off west coast of Mexico's Lower California peninsula.

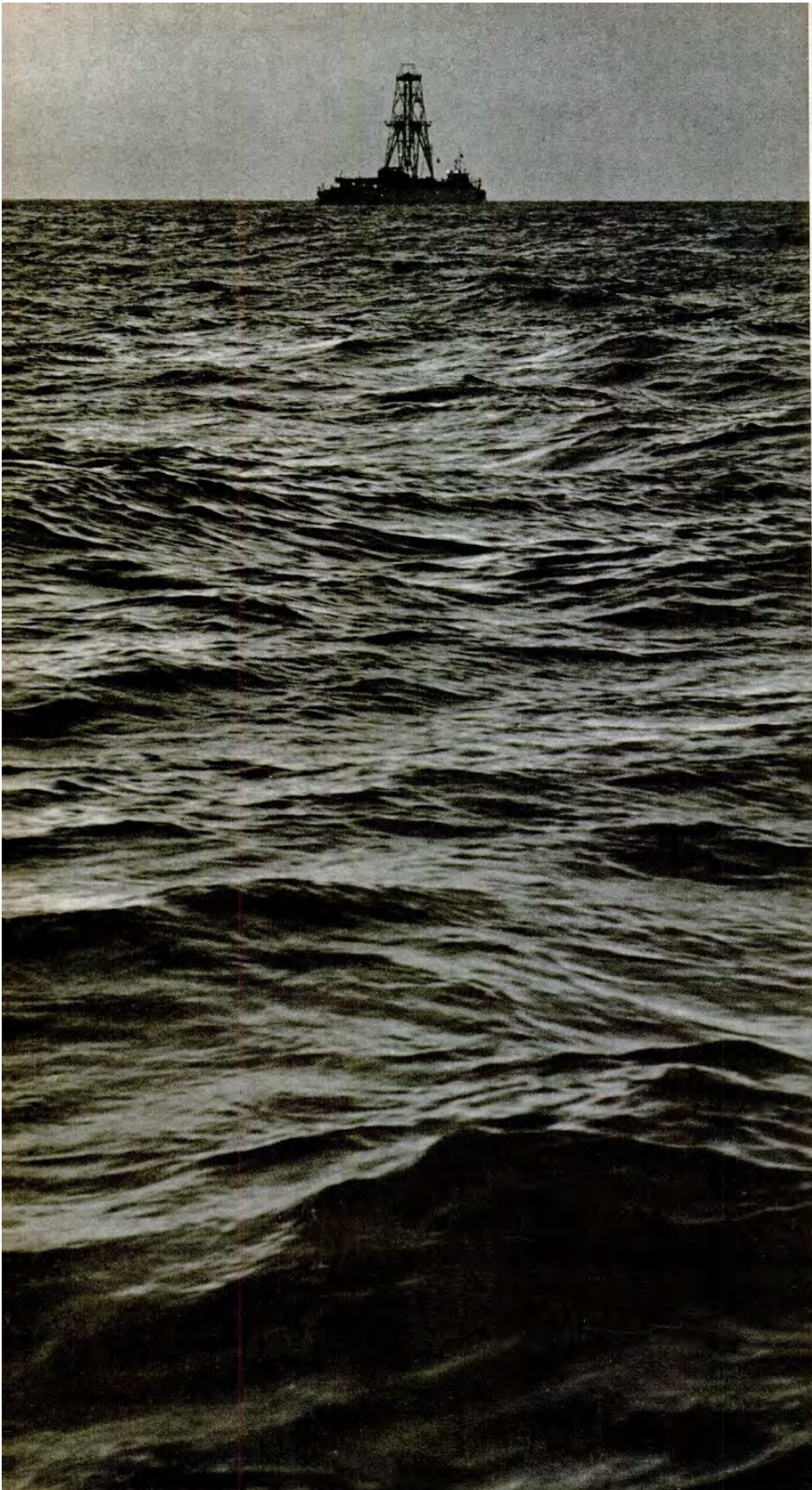
Photographed for LIFE by FRITZ GORO

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MOHOLE CONTINUED

A major job:

Success or failure of the daring enterprise off Guadalupe Island—and of the entire Mohole project—hinged upon the ability of the pilot to hold the CUSS at a precise position, as unmoving as if planted in concrete instead of being adrift on a turbulent ocean. To achieve this the pilot used a complex control console (*right*) designed by Marine Engineer Robert Taggart (*far right*) to regulate four outboard motors, two on each side of the CUSS, which could nudge the vessel in any desired direction. The crucial task was to keep the drilling derrick directly over the hole in the ocean bottom, 2.3 miles below, where the drill turned in the earth's crust. The long string of pipe would bend only so much. If the barge moved more than 1,000 feet from center, the pipe would snap, the drilling operation would be over—and the resulting recoil would jolt the craft and seriously endanger the crew. To avert such a disaster, the pilot watched blips on his radar and sonar screens. They were made by echoes received continuously from strategically placed radar buoys on the surface and sonar buoys beneath it. Their pattern told him at any given moment whether and where he was drifting so he could compensate by manipulating motors.



ON A LONELY SEA the ungainly CUSS holds its stationary position, despite wind and waves, over the tiny drill hole in the ocean floor below.

IN ROUGH WATER men from the laboratory ship *Spencer F. Baird* maneuver small craft in ship's turbulent lee to repair damaged radar buoy.

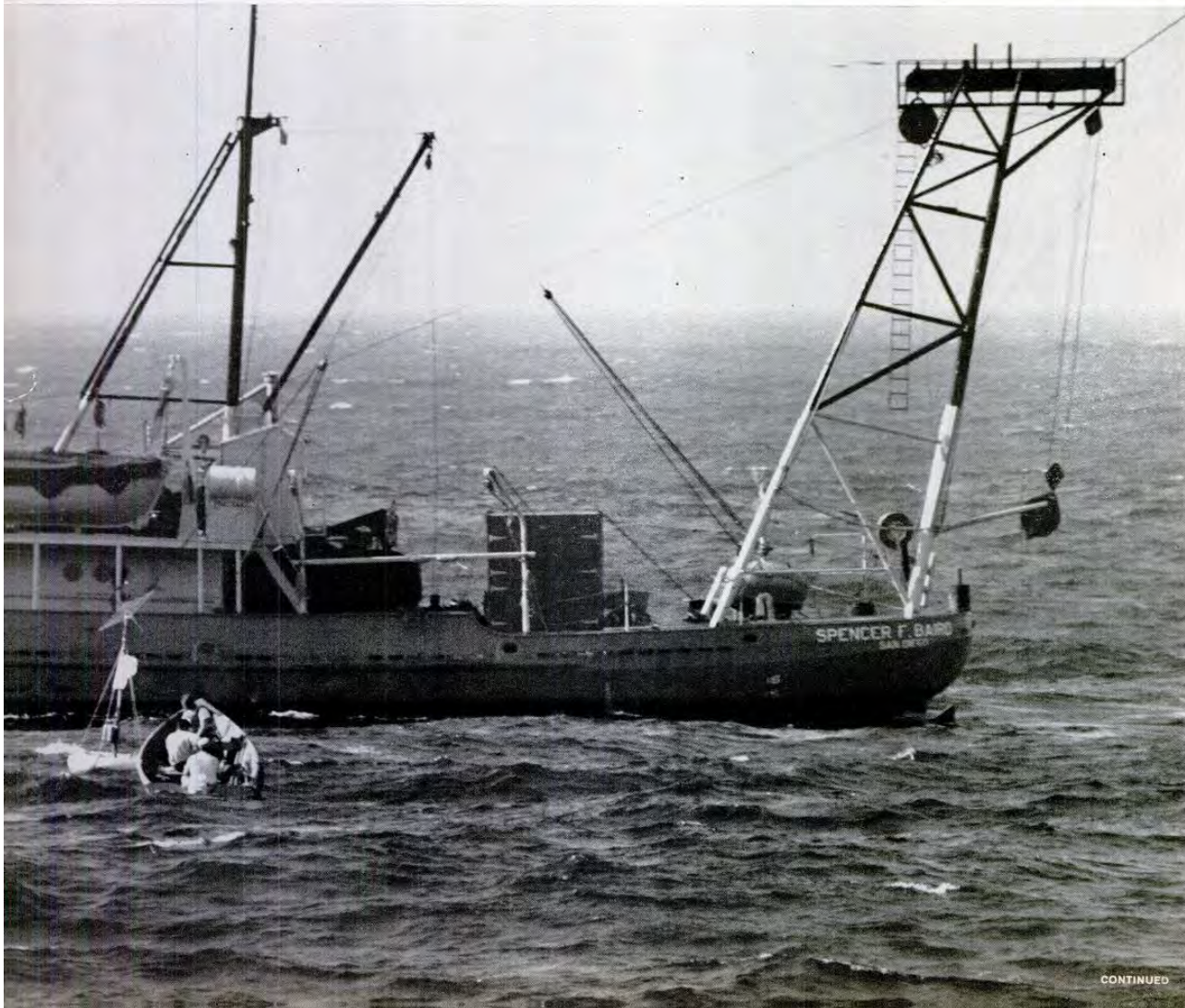
holding still on a rough sea



KEEPING BARGE CENTERED, Pilot Norman Fowler watches radar and sonar scopes showing locations of buoys which serve as reference points.

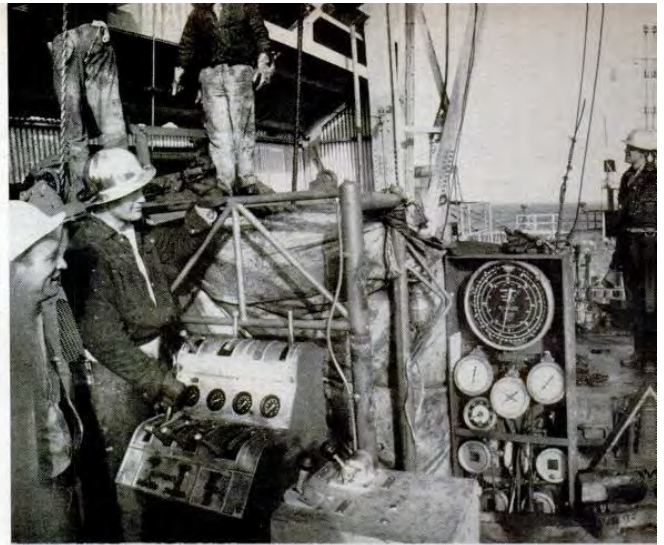


DESIGNER OF CONTROLS, Robert Taggart watches drilling operation with Gordon Lill (*rear*), scientific administrator of Project Mohole team.





PROJECT DIRECTOR WILLARD BASCOM TENSELY SWEATS OUT KEY DRILLING



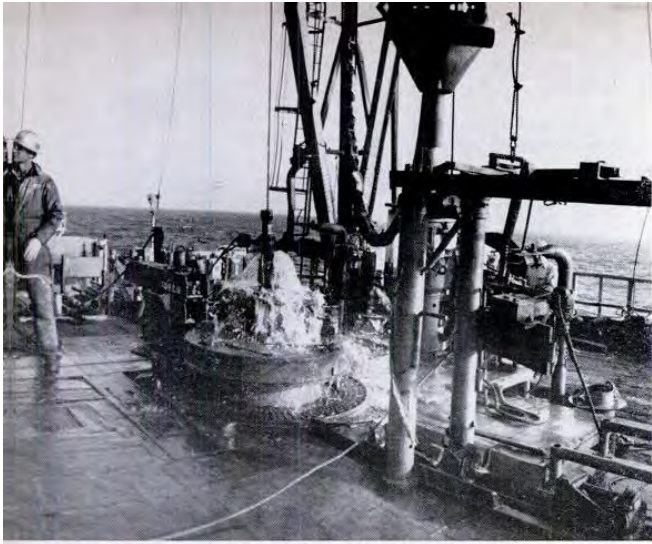
AS CORE BARREL IS RAISED BY CONTROLS (LEFT), FOUNTAIN OF SEA WATER

PAY DIRT was brought up before Easter. Here the first core is gently, almost reverently, eased from core barrel into plastic tube by Geologist Jobst Hul-

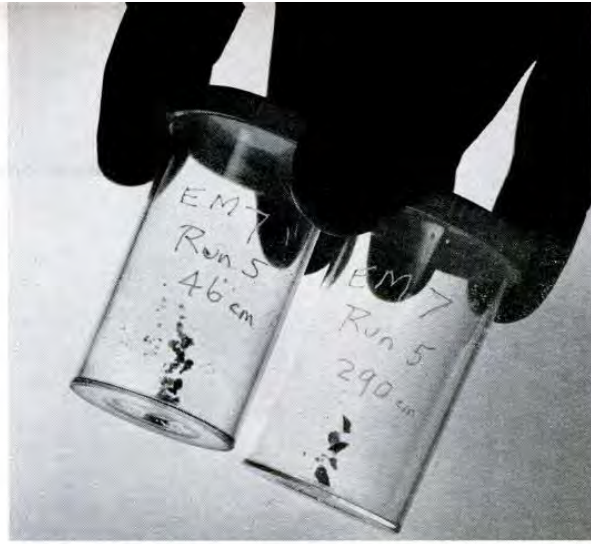
semann (*center*) and Paleontologist William Riedel (*left*), chief scientist of expedition. Core is 2¾ inches across, of gray-green clay 10-30 million years old.

PEERING UP BARREL, Riedel makes sure he has removed every grain so he can examine for fossils that tell core's age. In box is barrel base which keeps





(RIGHT) SQUIRTS UP PIPE. DIALS MEASURE PIPE'S WEIGHT AND TORQUE



TINY CRYSTALS FOUND IN CRACKS OF BASALT CORE ARE SAVED IN VIALS

core from sliding out. Watching eagerly from behind him are William Benson (*right, rear*) and Walter Munk (*left*). Munk first suggested Mohole drill.

MYSTERY EXPOSED—a core of basalt from puzzling second layer (*under top sediment*) lies on deck in sections. Don Handley hammers barrel to loosen

other chunks. Basalt was found layered, mixed with dolomite and with volcanic ash and a gray mud containing sea fossils and ancient sediment from land.



CONTINUED



DISPLAYING A SPECIMEN, one of first chunks of basalt to come up. Riedel studies it for volcanic bubble holes. Watching with obvious satisfaction is François Lampietti, who helped design some of the drill-pipe equipment.

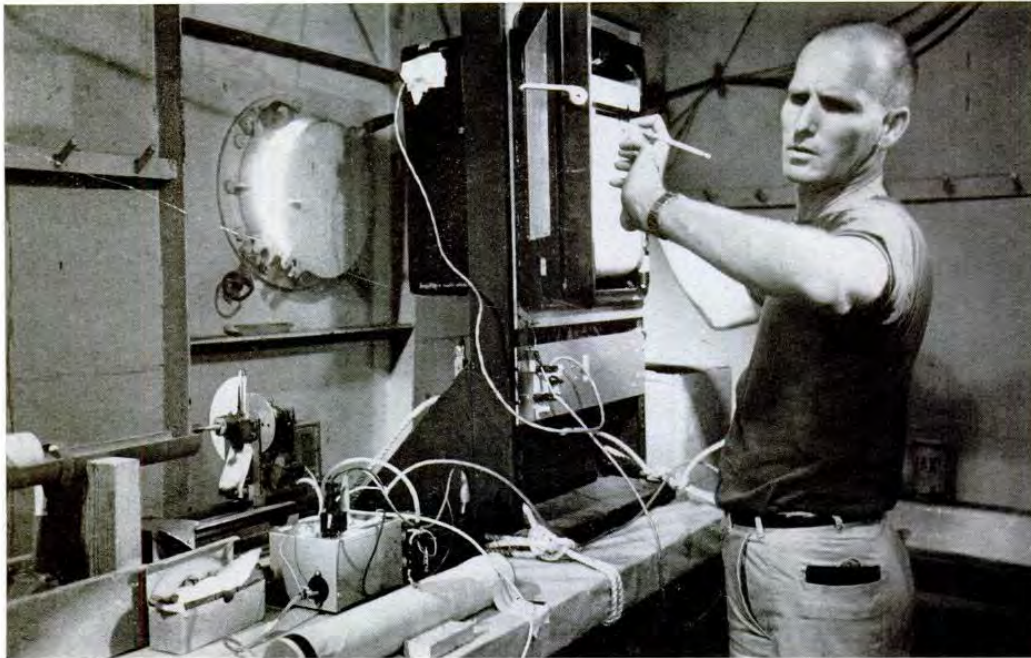
MOHOLE CONTINUED

Tension, joy: first data from the deep

Down to a depth of 560 feet, the drilling went rapidly through the soft gray-green clay of the ocean floor. At that point it slowed abruptly as the bit chewed into the hard second layer of the earth's crust. The scientists waited eagerly to see the cores. A sample of the earth's second layer would provide evidence to crack a great geophysical mystery.

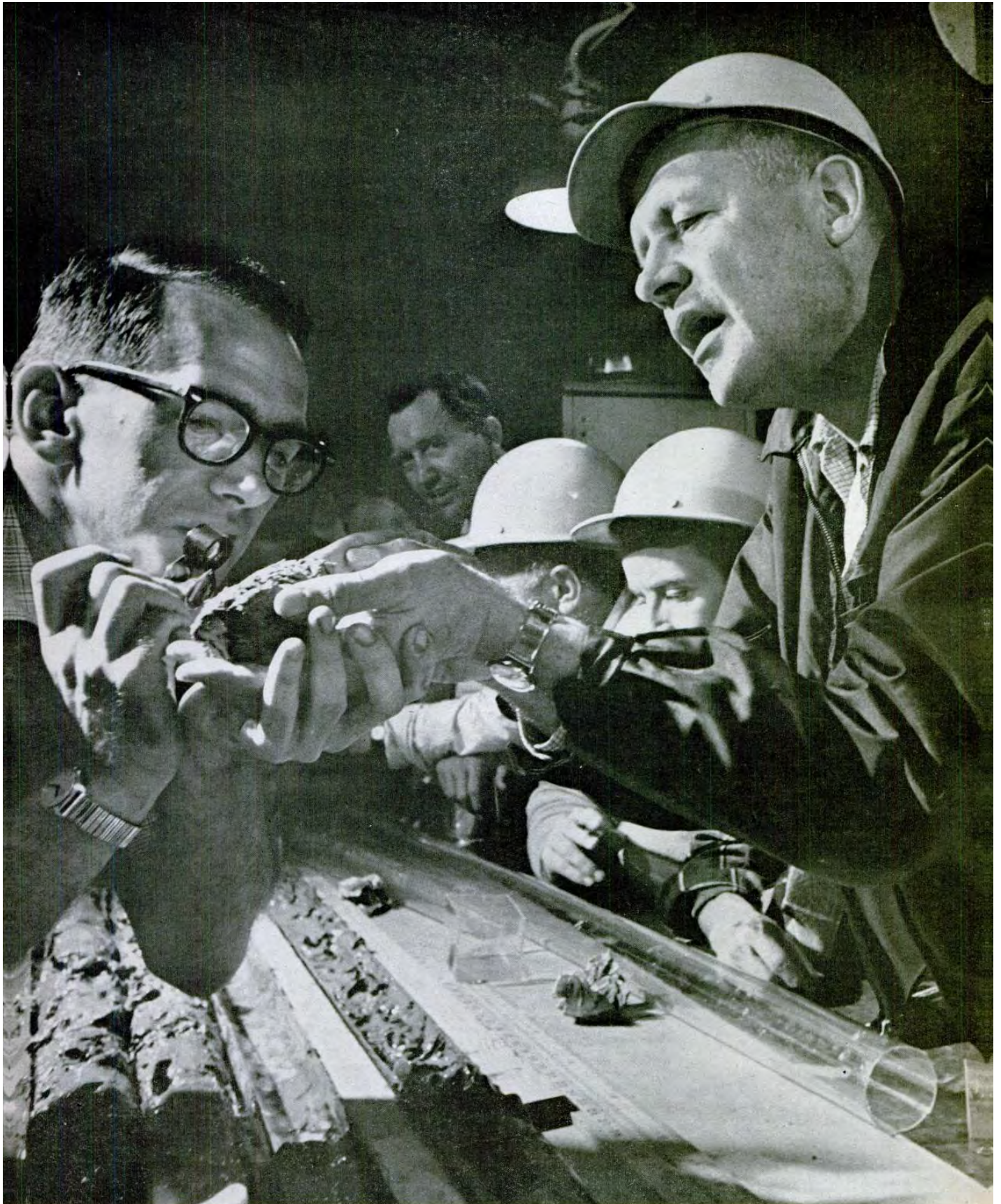
The soft top layer of the sea floor consists mostly of fossil sediments formed out of the stuff from eroding continents. But if scientists are right in their guess that the continents and the ocean floor are the same age—and that the continents have eroded at a constant rate through the ages—then the soft sedimentary layer ought to be five to ten times as thick as it actually is. Could the hard layer under it be nothing more than hard-packed older sediments? Or might the denser material be something else—like a lava flow—that covered up the more ancient sediments? The trouble with that theory is that no one was sure lava could flow at all under such immense water pressure.

The first inspection of the CUSS's cores have already shed light on the mystery. The top part of the second layer is not hard-packed sediment—but mostly basalt, which could only have come from a lava flow. Other curiosities in the cores: dolomite, a substance not being formed in the oceans today, and bits of sediment carried from ancient land, giving hope of more farther down.



MAKING HEAT MEASUREMENTS of core (wrapped, on table, foreground) from top sedimentary layer is Dr. Arthur Maxwell, Navy geophysicist. Apparatus, including thermometer inside

core, measures and records heat passing through it in a given period. This data will help determine if currents of hot rock exist below earth's surface, may help tell if earth is warming or cooling.



EXCITEMENT GRIPS SCIENTISTS as they identify as basalt a piece of rock which has just come up from second layer of the earth's crust. Chief Scientist Riedel (*left*), who has just been examining rock with magnifying glass,

shares it with curious visitor, Scripps Director Roger Revelle, who grasps the precious specimen. Revelle was one of prime movers in getting support for Project Mohole. Spread on table are muddy cores from which rock came.

ROLLING RHYTHM, the strenuous but graceful motions of roughnecks on the swaying, floodlit drilling platform, reminds Steinbeck of ballet. With perfect timing they connect a new piece of pipe to long string.



STEINBECK CONTINUED

'The first touching of a new world'

think of it we are licensed as an outboard craft, much to the disgust of the captain who is a big-ship master.

A powerful seagoing tug sidled up to us like a pill bug and took us in tow. We crawled slowly up San Diego Harbor between the channel markers, past active Navy installations, and we saw the sad steel regiments of obsolescence lined up bow and stern by stern, mothballed and perhaps useless in any conceivable future war, expensive reminders that the human species has not yet learned to make peace with itself and equally sad proof that we can always find money for violence.

Great activity aboard because the radio gives us dismal news of wind and waves. The drill rig men are lashing and chaining down everything movable. On the first sea test the seven-ton block for lowering the drill pipes broke loose and damn near tore off the 98-foot tower. Now it is chained four ways like a rogue elephant. The scientists have secured their beloved instruments. At every strange sound the electronics men glance nervously toward their banks of dials and tubes and switches.

In the overcast afternoon we rounded Point Loma and lunged into heavy swell, lurching like an old sow. The huge tower of the drill rig combed the clouds. We made a pool on the greatest roll and 24° won it.

Soon after dark everyone except the watch hit the sack. Five days on the beach and we were shore-leave weary, some wife-weary, some Tijuana-worn and others faded with the scholastic high life of the Scripps Institution of Oceanography. Our course is 270°, well west and north of target but necessary to keep her headed into the wind. This weather can slow us down seriously. Our tug, writhing and plunging against the tow cable, completely disappears behind the big waves. Old Speedy is making about three and a half knots.

I have the upper bunk in the infirmary. If anyone gets hurt or sick, I'm for the deck, but I did get in two nights' sleep in one night. The first ended about one o'clock when a chair came up fighting and tried to beat its way to freedom through an iron bulkhead. We lassoed it going by, threw it and tied it down. Then we had something to eat and climbed back to sleep our second stretch.

Friday March 24—All day rolling like a gut-bucket on a 230° course into the wind and westing so that when we turn south we'll have wind and current behind us. We're pitching so that when I asked Louie the cook for my eggs straight up, he said, "Better have 'em scrambled so I can keep them in the pan."

Kind of a restless inertia among the men. I climbed up the tower to the catwalk, and it waved me like a fan on a hot night in New Orleans. The tug seemed very small struggling away at our dead weight. Got to thinking—the first importance of Project Mohole is that it is being done at all. We spend treasures daily on fantastical sky rockets aimed feebly toward space. Our lustful eyes turn to the moon, not as the Queen of the Night but as real estate. We spend and devise and dream toward the nearest star unreachable in a lifetime of travel. And meanwhile we know practically nothing of far the greater part of our home planet covered by the sea. The suboceanic terrain is a dark mystery to us in its nature, its

components, its history and its riches. This expedition will cost less than one single glittering missile blasting from the launching pads at Canaveral, and yet this project is as surely an adventure toward the discovery of a new world as were the three little lumbering ships of Columbus. And this new world is here—not a million miles away.

The wind played on the tower like a harp so that it throbbed like plucked strings.

At 12:30 Willard Bascom, the director, gave a lecture on the geology and geophysics of the project and everyone attended: cooks, seamen off sentry, drillers and scientists. Their attention was complete and afterward there were many questions. This lecture pulled the group together into a unit. Now the drillers know what they are drilling to find out: to read the world's history as you would read the rings of a tree and in an area undisturbed for millions of years. The radio brought bad news and good. Bob Nold's mother died and Pete Johnson's wife had an 8½-pound boy. The wind is at 20 knots and we're making four knots still due west.

Saturday March 25—Heavy seas and a big roll. At 0800 we changed course from 230° to 145°. Rolled like a barrel on the turn but now we have following seas and a little better speed, but we are behind time and the men are getting restless. There was a lecture today on the engineering of the project.

I have an assistant writer, a driller named Keith, ex-shepherd, ex-miner, a jovial soul with a long and lugubrious face. Besides being a first-rate driller Keith is a character. Come to think of it, there's no one on board who isn't a character. Being ignorant in the complicated field of drilling, I need Keith to instruct me. He tells me the names of things and their functions. There's a whole language in this specialized profession.

We should reach our station tomorrow.

If, as seems probable, the greatest part of the world's material wealth is under the sea, there will have to be a re-examination of international spheres of ownership and controls. Twelve miles off almost any coast now belongs to anyone who can get there. The only reason the seas have been free is because no one wanted them except for transportation and defense. Available riches may change all that.

If we can seriously plan and design stations in space and on the moon, we are surely capable of mining a few thousand feet under water. The engineering problems are far simpler.

Sunday March 26—Guadalupe Island in sight at dawn, a high waterless mountain, the top fringed with some kind of conifers. It is inhabited by goats and a herd of sea elephants and a small Mexican military radio crew. We should be on our drilling station tonight. The oceanographic ship *Baird* is standing by there guarding our positioning buoys. We hear by radio that rumors are flying in the more nervous newspapers. We are suspected of 1) mining for diamonds, 2) surveying for future caissons in the sea bottom for permanent guided missiles, 3) looking for sunken treasure. They haven't yet found a way to tie us to sex but they will.

The men are getting restless. They wander about from bow to stern,

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TEAM SPIRIT in which oldtime oil drillers worked intimately with the scientists finds Oceanographer Roger Revelle explaining the significance of basalt chunk to roughneck Dean McCurdy who helped drill the hole.

MOHOLE CONTINUED

nervous as cats. The weather is getting worse: wind at 25 knots, waves and swell 12 to 14 feet.

We arrived on station about midnight. The tug dropped us, and our four giant outboards pushed us between the anchored buoys and held position by radar and sonar. No waiting. The drilling crews were on the rotary table before we were on our spot, and the moment we were positioned the string of drill pipes was prepared. The big mushroom-shaped drill bit with \$8,000 worth of commercial diamonds first, then bumper subs, and then the drill string started down. Wonderful to watch these drillers work. They are big powerful men. They carry their shoulders forward and their arms swing in unison. This is always true of men who lift and push at heavy things.

The deck is heaving and pitching. The men step like cats. There is nothing clumsy about them, and as the steel sections of pipe rise and are screwed together and lowered, the drillers move with the timing and precision of a corps de ballet. They would throw me overboard if they knew I said this or thought it. But it has to be. If one man makes a clumsy or ill-timed move, someone may be killed by the swinging steel. They depend on one another for their lives. Also they have enormous pride in their work.

The 60-foot sections go down one a minute. The brake that holds and lowers the string cries with a curious tone—two notes an octave apart and a third sound cuts in, I think it's a ninth but will have to check—a strange harmonic sequence of sound. CUSS I roars with noise, the motors, the great engines, the whining dynamos. Huge floodlights on the drill rig make us look like a great seagoing Christmas tree. We must be visible for miles.

Monday March 27—All day the drill string went down, 60 feet at a time. Echo and sounding tells us the bottom is about 12,000 feet down and the area a great plain of undulating low hills. The drillers work 12 hours a day seven days a week and then have a week off. Shifts change at noon and midnight. Food four times a day: morning, noon, evening and midnight. The wind is still high, 20-25 knots with 8-10 foot waves, but CUSS I holds position perfectly and the drill string drops section by section with a crying brake. It is too exciting to go to bed. Now and then an hour's nap and then back on the rig. The drillers are instructing me in watching the dials, indicating weight, torque and pressure of mud in the pipe. Instruments have gone down to measure the deep currents, never before known. Everything is new about this, everything a discovery. We find that the deep currents are moving at less than one knot and in a slow circle. Why? No one knows yet. It would be so

much easier if the wind would moderate and the swell level off. The wind out of the north is bitterly cold. We wear hard hats to protect our heads from falling and swinging steel but put hoods over them to keep ears warm. All night the string whines down.

Tuesday March 28—The drill touched bottom at 12:15 and bit into the ocean sediment. From now on everything is new, everything unknown. A hundred and ten feet beneath the bottom we dropped a cable and brought up the center bit, then dropped the corer. The first core is 53 centimeters of sediment—gray-green clay full of tiny fossils. The general rule for the age of sediments in deep sea is 100 years to a millimeter or about 30,000 years to a foot. That would make this core 3.3 million years old. The head scientist guesses this is much older, and later his guess proves true. This first core is Miocene, about 20 million years old. The rule does not hold—but what happened to the top sediments? No one knows. All new. A lot of textbooks will have to be rewritten.

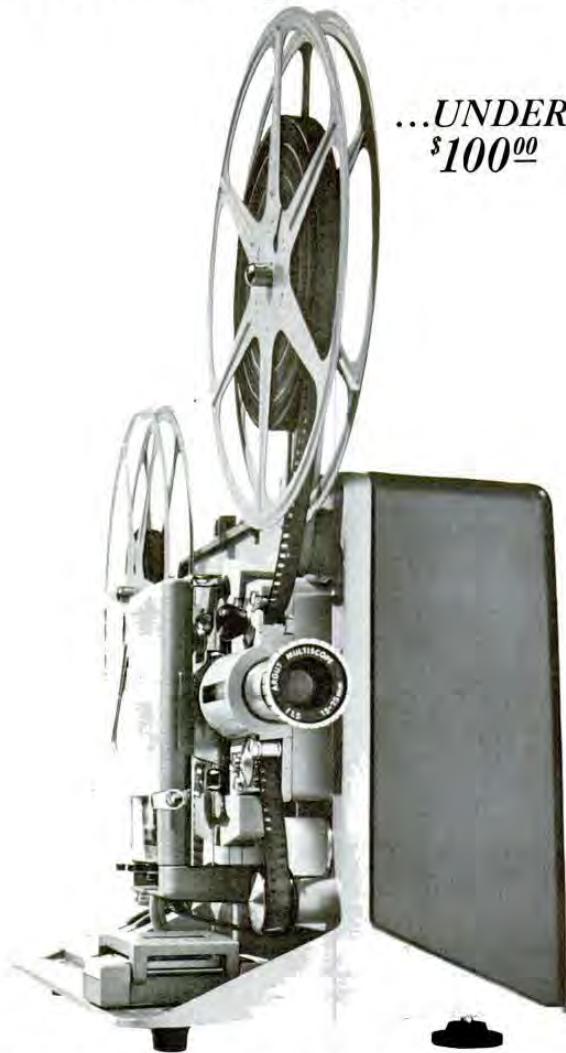
When the core comes up and is pushed out into plastic cases, the whole crew crowds around—cooks, seamen, drillers, off-duty engineers, scientists. Everyone aboard has a frantic interest. I've never seen such concentration of interest. The scientists have trouble working because of the crush of bodies. I take a small sample for myself and draw a scowl from the chief scientist. He flutters and worries over his cores like a setting hen on a clutch of eggs.

Wednesday March 29—At 300 feet we pulled the center bit again and sent down the corer. The cable went down to retrieve it and the thing stuck. Keith was on the brake. He tried to work it free but the cable kinked and then parted. Keith wanted to cut his throat. A fishing spear was sent down and pulled up a spaghetti of tortured wire, but the corer was lost. Nothing to do but pull up the whole string and start fresh.

Thursday March 30—Ten hours pulling up the string and ten hours dropping it again. Everyone edgy and nervous. A kind of violent despondency. Louie the cook burned the meat.

Friday March 31—Wind and swell up. Winds 30-35 knots with gusts of 40. The CUSS jumping like a steeplechaser. The tower lurching and swaying. The drillers all in great danger now. If a section of steel string should break free and pendulum, it could rip the whole tower off and kill everyone on the derrick floor. But they're mad now and they muscle the string down to the bottom at 11,700 feet. The bit goes in. We core at 130 feet. The same gray-green clay, full of fossils. Drilling goes on. At 490 feet a

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MOHOLE CONTINUED

darker, denser clay but with strange lighter colored veins. The echo says we should reach rock very soon and we do. The drill has been going down fast but just under 600 feet we strike hard bottom and penetration slows to two feet an hour. Excitement increases. Drilling with great care now. The brake man never takes his eyes off the torque dial and when torque increases, he eases off and holds the quarter of a million pounds of drill string, lest it snap in two.

Saturday April 1—Some kind of celestial celebration. The wind moderates, the swell begins to flatten. With infinite care the core is lowered and grinds its way into the hard rock. The ship is on fire with expectation. This may be the second layer forecast by the echo instruments. We have slept very little, only short naps. Any change of sound from engines or drill rig perks us wide awake.

Easter Sunday, April 2—Delight on the CUSS. We brought up a great core of basalt, stark blue and very hard with extrusions of crystals exuding in lines—beautiful under a magnifying glass. The scientists are guarding this core like tigers. Everyone wants a fragment as a memento. We have broken drilling records every day but now we have broken through to the second layer which no one has ever seen before. We figure this core cost about \$5,000 a pound. I asked for a piece and got a scowling refusal and so I stole a small piece. And then that damned chief scientist gave me a piece secretly. Made me feel terrible. I had to sneak in and replace the piece I had stolen.

Sunday afternoon—The drill broke through the second layer into softer material. There were guesses as to what would come up—made bets. Would it be earlier Miocene sediment, older clays? I haven't had my clothes off for five days—afraid I might miss something. We are all so weary with excitement that we seem to be floating.

The core comes up about midnight. We pile on it like starving men on a pork roast. Soft mud, maybe made softer by pumped sea water, pieces of basalt imbedded in it and some volcanic ash. The gray mud turned out to be mixed with dolomite, a substance no longer formed on the ocean bottom. A sigh of delight goes over the ship. The drill goes back into action. I have to leave early in the morning. I will have to get the end of the story from reports. But enough new things in the world have been snared to investigate for months. Every test will be given these cores, and from the findings of this first experimental drilling a whole new history of our earth may be written. Project Mohole has barely been started but CUSS I has proved it can be done. And even so far as we have gone, it justifies the building and equipping of a ship for deep sea drilling on entirely new lines.

CUSS I was a makeshift but even so proved the contentions of the scientists that the work can be done. CUSS I's drilling has about the same emphasis as Columbus' first feeble voyage of discovery: on this first touching of a new world the way to discovery lies open. And the men who have dreamed this plan and fought it through have tight smiles of deepest satisfaction. I think they can go to sleep now. They have opened the way to the exploration and eventual development of the greatest part of our home planet. And I feel a joy like a bright light at having been there to see. My little piece of the second layer is more precious to me than any jewel could be. And what a hell of a bunch of men are that motley crew of CUSS I, Project Mohole, National Research Council, National Academy of Sciences. We'll be all right, Jack, with men like these. And I hope I may be invited back when the new ship sails toward new wonders in about two years.



AUTHOR IN HIS "OFFICE," a corner of gyrocompass room, discusses the venture with Dr. Jack McLelland, project's indispensable chief engineer.