The Mexican Volcano Paricutin

Parker D. Trask

Science, New Series, Volume 98, Issue 2554 (Dec. 10, 1943), 501-505.

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Mon Jun 9 12:49:18 2003

SCIENCE

VOL. 98 FRIDAY, DECEMBER 10, 1943 No. 2554

The Mexican Volcano Parícutin: DR. PARKER D. TRASK 501

Presentation of the Sedgwick Memorial Medal 505

Obituary:
Elmer Darwin Ball: DR. CHAS. T. VORHIES. *Deaths and Memorials* 506

Scientific Events:
The Proposed Development of Wayne University; Rare Chemicals; The Sugar Research Foundation; The Alabama Academy of Science; Awards of the American Society of Mechanical Engineers 508

Scientific Notes and News 511

Discussion:
Tryptophan and Phytohormone Precursors: PROFESSOR GEORGE S. AVERY, JR. and DR. JULIUS BERGER. *The Roots of Spinal Nerves:* DR. DONALD DUNCAN. *Taxonomy and Genonomy:* PROFESSOR CARL EPLING. *Isolation of Influenza A by Intra-allantoic Inoculation of Untreated Throat Washings:* MINNIE THIGPEN and JAMES CROWLEY 513

Scientific Books:
Naturalist at Large: PROFESSOR T. D. A. COCKERELL. *Developments in Science:* DR. S. A. KORFF 516

Special Articles:
Retardation of Rancidity by Sulfhydryl Compounds: DR. PAUL GYÖRGY, DR. ERIC T. STILLER and DR. MARTIN B. WILLIAMSON. *Vitamin B_6 Deficiency Anemia in the Dog:* SUSAN GOWER SMITH, ROBERT CURRY and HAROLD HAWFIELD 518

Scientific Apparatus and Laboratory Methods:
Technique for Stroboscopic Studies of Insect Flight: DR. CARROLL M. WILLIAMS and DR. LEIGH E. CHADWICK. *The Coagulum-Contact Technic in Traumatic Rupture of the Liver in Dog and Man:* DR. MACHTELD E. SANO and DR. CLARENCE A. HOLLAND 522

Science News 8

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL; WARE CATTELL, assistant editor. Published every Friday by

THE SCIENCE PRESS

Lancaster, Pennsylvania

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington 25, D. C.

THE MEXICAN VOLCANO PARICUTIN[1]

By Dr. PARKER D. TRASK

U. S. GEOLOGICAL SURVEY

THE new volcano in Mexico, El Parícutin (pronounced Pah-*ree*-koo-teen) is a unique geological phenomenon; for, before our very eyes, it has sprung into existence and has grown to a very respectable height of 1,500 feet, all within a period of 8 months. It lies within a region in which no previous volcanic activity has been known within the memory of man, though in 1759 the volcano El Jorullo, some 50 miles to the southeast, likewise suddenly was born, grew to a height of more than 1,000 feet within 5 months, and then quieted down, never more to erupt violently. Will Parícutin do likewise? That remains to be seen, for at present it is still going strong.

For the first time in their lives geologists have been able to observe in a single volcano all stages of its history. Parícutin exhibits many of the features of other volcanoes; but other volcanoes have been encountered by geologists after they have been in existence for some time, and their early history is unknown. The early history of Parícutin therefore fills important gaps in our understanding of volcanism.

To me the most outstanding aspect of this volcano is the incredible rapidity with which it grew. Within one week it was 550 feet high and within 10 weeks it was 1,100 feet in altitude. Up to this time, all the material in its cone had come from fragments that had been blown into the air from the volcano. No lava came from the cone until nearly four months after the eruption started; and then, contrary to some popular reports, it did not flow over the lip of the crater. Instead, it broke through the sides of the cone, undermining the overlying fragmental material. Lava appeared within two days of the first explosion, but it issued quietly from a fissure about 1,000 feet north of the explosive vent.

[1] Address presented before the Geologic Section of the New York Academy of Sciences in New York, October 4, 1943. Published by permission of The Director, Geological Survey, U. S. Department of the Interior.

Geologists have been observing Parícutin practically from its inception. Dr. Ezéquiel Ordoñez, the grand old man of Mexican geology, despite some eight decades of age, reached the volcano, together with some associates from the Instituto Geológico de Mexico, within two days of its birth; and he has actively been watching its development ever since. Senor Téodor Flores, director of the Instituto Geológico, has devoted all available facilities of his institution to the study of Parícutin, and the passionate interest he has shown in this volcano would gladden the heart of any scientist.

Dr. William F. Foshag, of the U. S. National Museum, in charge of the war-minerals work of the U. S. Geological Survey in Mexico, has been making a systematic study of Parícutin, and I am indebted to him for practically all statements in this paper not based on my own observations. In addition, many other geologists have visited the volcano. Therefore eventually a rather complete record of its history will be available. I saw Parícutin three times: first, a week after its birth; a second time when it was nearly three months old; and once again, a month later, when I flew over it in an airplane during one of the stages when lava was pouring from the cone.

Parícutin is located in the state of Michoacan, 200 miles in airline due west of Mexico City in the Sierra Madre Occidental, which forms the west boundary of the high plateau that occupies the central part of Mexico. The volcano is situated in an area of forested hills and cultivated lowlands, and the base of the cone lies about 7,500 feet above sea level.

Parícutin is readily accessible. In the early stages an automobile could be driven to the front of the advancing lava flow, but now so much ash has fallen that the only practicable approach is by road to San Juan de Parangaricútiro, where horses are available for visitors to the volcano, four miles distant. San Juan is 15 miles by passable dirt road from Uruapan, which in turn is 300 miles by excellent paved road or by rail from Mexico City. Frequent comfortable bus service is maintained between Mexico City and Uruapan, and the ride is one of the most beautiful in the whole world. Good accommodations are to be had in Uruapan and frequent bus service to San Juan is available. Costs are surprisingly low.

Parícutin is located in a region of volcanic rocks consisting of essentially the same andesitic basalt as its own lava. Several hundred volcanic cones lie within a radius of 75 miles of the volcano. These are of all ages; some are so fresh that they can hardly be more than a few hundred or a few thousand years old; others are so dissected by erosion that they must be many tens of thousands of years in age. Most of them are cinder cones—that is, cones composed of debris blown from a vent in the ground; others are composite cones consisting of both lava and fragmental material. They range in height mainly from 200 to 800 feet. The highest rises some 4,000 feet above the surrounding country. The soil is rich and is derived from volcanic ash and interbedded lava. Most of the cones are conical and have small craters, but a few consist of rings of fragmental material, 200 feet or less in height and some hundreds of feet in diameter. One such abortive cone is situated about one mile northwest of Parícutin; another lies some miles to the east. From the air this latter cone seems to be some 3,000 feet in diameter and less than 200 feet in height. It contains within it, but somewhat off center, a similar ring-like ridge about 1,500 feet in diameter.

The first intimation that something was about to happen was an account in the newspapers about February 12, 1943, that 25 to 30 earthquakes had been felt the previous day near the town of San Juan de Parangaricútiro. Each day thereafter increasingly more tremors were reported, and on February 19 some 300 earthquakes occurred. The next day the eruptions started.

Stories of the beginning of the volcano are legion, and as time goes on they probably will become more varied. One of the most colorful is that a farmer while plowing his field turned over a stone, whereupon lava gushed forth and, like the headless horseman in the Legend of Sleepy Hollow, raced down the furrows behind him as he fled. This story of course is fantastic; in the first place, no Mexican would plow a furrow down hill, and in the second place, the Parícutin lava was too viscous to flow rapidly.

The most reliable story is that a farmer, Dionisio Pulido, while plowing noticed a column of smoke about three inches in diameter spiralling upward from a small hole in the middle of the field. Thinking that he had inadvertently started a fire he went over to the smoke and put it out by placing a stone over the hole. He continued plowing and sometime later looked around and saw smoke emerging from the ground in greater force. He went forthwith to inform the Presidente of the town of San Juan, who sent a group to see what was happening. Upon arriving at the spot three hours later these people found a hole some 30 feet in depth from which dense clouds of dark smoke were issuing. About ten that night, February 20, the first explosion occurred, and since that time the volcano has been erupting steadily.

When I first visited the volcano, on February 28, a little over one week after its inception, the explosions were coming at fairly regular intervals of 4 seconds. At times two explosions would come in quick succession; at other times the interval between outbursts was 6 or 8 seconds. In general the explosions were

of about equal force, though occasional loud outbursts occurred. One was strong enough to knock me off balance while walking some 3,000 feet from the crater.

The sound from the explosions seemed to originate within the crater at about the level of the ground, though occasional explosions took place in the ash cloud 500 feet above the top of the cone. Each explosion from the crater acted like a giant gun-burst. The material was ejected from the throat of the volcano in a cylindrical column to a height of 400 to 800 feet above the top of the volcano, and at this point, like water in hydraulic jump, suddenly formed dark expanding cumulus clouds of ash that billowed upward to a height of 6,000 to 8,000 feet above the ground, where steam would begin to condense. With increasing altitude the ash cloud became progressively whiter with water vapor until some 10,000 to 12,000 feet above the ground, where it was nearly pure white. The column of vapor continued upward to about 15,000 feet and was carried eastward in a horizontal cloud bank from which columns or large puffs of vapor curled upward for another 2,000 or 3,000 feet, like ostrich plumes sewed tandem on an ermine scarf.

At this time the material ejected from the crater was thrown upward at an angle deviating from the vertical by 10°, much as if it were coming from a sharply defined conduit. As a result of this inclined direction of outburst, more material fell on the west side of the cone than on the east, thus causing the top of the cone to be lopsided. In the course of four hours the angle of ejection changed gradually back to vertical and two hours later was deviating 5 degrees to the east, thus causing the east side of the cone to build up faster than the west side.

The column of ash ascended nearly vertically but was deflected slightly eastward by the wind. Trains of cinders, one-eighth to one-half inch in diameter, rained down from the ash clouds on the lee side of the cone. They were cool, light and very porous, and they sounded like sleet as they fell on one's hat. Few cinders were falling more than two miles from the volcano. At this distance the ground was just barely covered by them. Fine particles of ash were transported greater distances than cinders, and covered the country side in delicate films for as much as 15 miles away on the leeward side. The ash and cinders were 18 inches thick 500 feet from the edge of the cone, which was the closest to the volcano my courage permitted me to approach.

At this point the ground was pock-marked with pits three to five feet in diameter where large fragments or bombs had buried themselves in the ground. The average distance between bomb-pits at this point was about 20 feet. During some 30 minutes while I was standing there, two bombs fell within 300 feet. One bomb more than four feet in diameter landed 25 feet away. For awhile as it was coming down it looked as though it might make a direct hit, and the problem was which way to run, but eventually it veered slightly and the next moment it came down with a large whoosh and whistle, and buried itself. The top was about one foot beneath the surface of the ground. A piece broken from it was hot enough to light cigarettes. Another bomb two feet in diameter, landed 50 feet to the rear, breaking an oak limb eight inches in diameter, much as if it were a cleaver cutting a bone. This bomb buried itself three feet in the ground. It came down five feet from some girls, who immediately retired to a more discreet distance.

Most of the fragmental material ejected from the volcano in this stage of its history consisted of bombs, rather than of ash or cinders. With each explosion the bombs were blown 2,000 to 3,000 feet into the air. Most of them landed on the cone; the greatest distance at which I found a bomb was 3,500 feet from the center of the volcano. The bombs went so high that it took from 10 to 15 seconds for most of them to fall, after they had reached their greatest height. They were roughly spherical and ranged in size from a walnut to a big house. Most of them were between three and five feet in diameter. The largest I saw was a block 50 feet in diameter, which was blown 300 feet above the top of the crater; that is, 850 feet above the ground. Nearly all the bombs when they landed were so thoroughly solidified as not to change in shape, though many when they struck the sides of the cone, broke into pieces. A few were still liquid when they landed and splattered out like pancakes on the ground. Bombs of this type did not penetrate the earth for more than three inches. Others rotated slowly in the air, gradually thinning in the middle, and before they fell separated into two tear-shaped bodies. Some, after coming to rest on the cone, smoked for a considerable time, certainly for as long as 15 minutes. Most of the bombs consisted of highly vesicular basalt, but a very small proportion were composed of a light medium-grained granitic rock that looked like diorite. These granitic rocks were angular, and not vesicular. They evidently were blown from the conduit through which the lava was coming.

Most of the bombs landed upon the sides of the cone, ricocheting down the side until they came to rest. The sides of the cone were remarkably even and were at an angle of 33° with the horizontal. The volcano at this time was 550 feet high and 1,700 feet in diameter at the base. The diameter of the crater at the top of the cone was 250 feet, and the orifice from which the material was ejected seemingly was about 75 feet in diameter.

The volcano at night is a magnificent, never-to-be-

forgotten sight. Nearly all the bombs that are blown from the crater are red hot, and they shower up like a gigantic Fourth-of-July flower-pot. The floral effect is complicated by the fact that four or five subsequent explosions have taken place before the bombs from any one explosion have all landed. Thus some bombs are going up, some are just arching over at their highest point, and others are falling. After the bombs strike the sides of the cone they cascade down in great fiery arcs. Some come to rest on the sides; others roll to the bottom. The glow from the cone comes and goes, depending upon the number of bombs that fall and the interval between explosions. Big outbursts cover the whole volcano, and the cone progressively lightens up in an ever larger descending curtain of fiery red, as the fragments land progressively down the sides of the cone. Then, as the bombs cool, the red gradually darkens. Yet before the color finally vanishes another crop of bombs falls and the scene is repeated. Even though parts of the cone may fade into darkness before a succeeding increment of glowing bombs descends, a ring of red always remains around the edge of the cone where the rocks that roll completely down the sides come to rest.

A flow of lava first appeared in a plowed field about 1,000 feet north of the crater about two days after the birth of the volcano. In five days it had attained a length of 2,000 feet, a width of 600 feet and a thickness of 20 feet at the sides and front. It continued to grow for about 6 weeks until it was about 6,000 feet long, 3,000 feet wide and more than 100 feet high. The front and sides were steeply inclined; the top was nearly flat and consisted of blocks of congealed scraggly aa lava 3 to 15 feet in diameter.

At the time I saw the lava, five days after it first appeared, it was flowing westward down a gently sloping field at a rate of about three feet an hour in front and one foot an hour on the sides. Like a glacier the lava moved most rapidly in direction of greatest slope, and like a glacier it also developed pressure ridges as it flowed. It advanced by pushing large blocks of solidified lava, three to five feet in diameter, off the front and sides. These blocks fell down the edges of the flow, and in turn were covered by other blocks similarly spalled by the advancing lava. Gradually the molten rock inside the flow passed over the fallen blocks and incorporated them within itself, forming a volcanic flow breccia. At all times the surface of the lava was congealed, except for places from which blocks had broken off at the edges of the flow as the lava advanced. These freshly exposed places consisted of red, pasty, dense lava that solidified within a few minutes to hard rock.

Fumaroles came out of vents 6 inches to a foot in diameter and gave off dense clouds of white smoke, which, according to Foshag, is largely ammonium chloride. The ammonium chloride also condenses in a white powder around the orifices of the fumaroles, and in places a fringe of bright-orange iron chloride is also formed. Few poisonous gases seemingly are given off.

When I visited Parícutin the second time, about the middle of May, nearly three months after its birth, it was still erupting at about the same rate, but the explosions were less forceful and a much larger proportion of ash was coming out. The cone had doubled in height and the orifice from which the material was being ejected seemed to be about 150 feet in diameter. Ash was everywhere, and most of the trees within 5 miles of the volcano had been killed. The lava flow had stopped moving and was covered by 6 to 8 feet of ash. Even at Uruapan, 15 miles east of the volcano, the ash was 6 to 8 inches thick, and at San Juan, four miles to the west, it was 15 inches thick. A large part of this ash fell in one period of 36 hours early in April. Electrical discharges or lightning strokes were flashing at irregular intervals, sometimes as frequently as 30 an hour. These flashes were vertical in the cloud of ash, and generally started within a few hundred feet of the top of the cone. They ranged in length mainly from 500 to 1,500 feet, and produced sharp cracks but no loud thunder.

About four weeks after this visit, a phase of lava actively ensued. In the course of a week, 8 flows appeared, all from within the cone. Prior to this time, that is, for almost four months, no lava had come from the cone itself and there had been just the one flow. According to Foshag, each flow was preceded by a period of violent explosive activity, which terminated shortly before the lava came. While the lava was issuing from the volcano relatively few explosions took place. All these flows ruptured the sides of the cone, and those that came from the upper part of the volcano undermined the fragmental material above, leaving a large gap in the side of the cone. These gaps were rapidly filled by material blown from the crater after the lava ceased to move. One flow advanced in three days as far as the town of Parícutin, three miles to the west. When it approached Parícutin it was moving at a rate of about 100 feet an hour. Another flow on the east side of the cone spread out like a large fan at the base of the volcano. According to Foshag, this one went 1,500 feet in 15 minutes.

While one of these flows was in progress, I had the good fortune to fly over the volcano. At this time the crater was nearly full; lava extending to within 50 feet of the lip. The top of the lava in the crater was congealed, and was broken in large blocks. Ashes were issuing from a vent estimated to be 75 to 100 feet

in diameter in the northwest part of the lava field within the crater, but relatively few explosions were seen. Lava was flowing from an opening on the east side of the cone. This vent was 50 to 75 feet in width and 200 to 300 feet in height. The upper limit was 100 to 150 feet beneath the lip of the crater. The lava coming through the opening was red hot, but it soon cooled and congealed while flowing down the sides of the volcano. The cone was intact above the point of escape of lava, but according to Foshag it subsequently was undermined by the flow.

At this time, June 19th, Parícutin was 1,200 feet in altitude. By late September it had reached a height of 1,500 feet. At that time it was still exploding at about the same rate as when it started, and was showing no signs of dying. In the meantime several other flows of lava had appeared, mostly from within the cone. Parícutin truly is now a full-fledged volcano.

PRESENTATION OF THE SEDGWICK MEMORIAL MEDAL

THE Sedgwick Memorial Medal of the American Public Health Association was presented at the seventy-second annual meeting on October 12 to Brigadier General James Stevens Simmons, U. S. A., director of the Preventive Medicine Division of the Office of the Surgeon General, U. S. Army.

The medal was established in memory of William T. Sedgwick, of the Massachusetts Institute of Technology, pioneer teacher of public health in the United States. It is awarded for distinguished service in public health. The following have received the award in the past:

1929	Charles V. Chapin
1930	Theobald Smith
1931	George W. McCoy
1932	William H. Park
1933	Milton J. Rosenau
1934	Edwin O. Jordan
1935	Haven Emerson
1936	Frederick F. Russell
1938	Wade H. Frost
1939	Thomas Parran
1940	Hans Zinsser
1941	Charles Armstrong
1942	C.-E. A. Winslow

Dr. C.-E. A. Winslow, of the School of Medicine of Yale University, made the presentation address, which was followed by an address of acceptance by Brigadier General Simmons.

PRESENTATION ADDRESS OF DR. C.-E. A. WINSLOW

SHORTLY after the close of the first World War a distinguished British orthopedist was presented for an honorary degree at Yale with the statement that "no man has contributed more than he to the upright position of Britain during the recent war." The Sedgwick Medal is this year awarded for somewhat similar reasons. The 1943 recipient of this medal has done more than any other single individual to make the science of public health effective in maintaining the manpower which our nation has mobilized for the defense of freedom.

James Stevens Simmons was born at Newton, N. C., in 1890. He took his M.D. at Pennsylvania in 1915 and in 1916 entered the Medical Corps as a first lieutenant. For more than a quarter of a century he has devoted his life to the upbuilding of public health laboratory service in the military establishment. In an Overseas Unit in 1918, at the Walter Reed Hospital, in Honolulu and Manila, on the Canal Zone and in the Army Medical School he contributed materially to sound laboratory practice and in 1935 edited a valuable volume on "Laboratory Methods of the U. S. Army." He has made significant original contributions to our knowledge of malaria, and encephalomyelitis and other insect-borne and virus diseases.

With the outbreak of the present war, Colonel Simmons (now Brigadier General Simmons) was entrusted with the organization of a Division of Preventive Medicine in the Office of the Surgeon General. To his energy and vision, to the inspiration of his open and generous and affectionate personality, goes the chief credit for an astounding record of creative initiative and administrative efficiency. The creation of a Board for the Investigation and Control of Influenza and other Epidemic Diseases in the Army (including the most eminent experts in all related fields); the appointment of a distinguished headquarters staff; and the despatch of highly qualified commissions to points of danger all over the world—these have been the instruments in planning a health program of global extent with a record of phenomenal achievement. Operating in some of the most deadly swamps of the world, in regions where malaria and typhus fever and dysentery have for centuries reigned supreme, our army has functioned with a relative freedom from disease unprecedented in military history. At home, the success with which venereal infections have been held in check is equally notable; and, so far, the Army has suffered no serious disability from any of the upper respiratory diseases.

The record to date has constituted one of the finest chapters of achievement in the whole glorious century of modern public health. We do well to honor General Simmons as the central inspiration of this achievement; and in honoring him we pay tribute to the Army of the United States, which has proved itself as effi-