

"And God said, 'Let the waters under the heavens be gathered together into one place, and let the dry land appear . . . ' And there was evening and there was morning, a third day."

Genesis 1:9 and 13

"THE THIRD DAY CONTINUES"

(No theological implications intended)

Franklin A. Nash, Jr., Ph.D.

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Dionisio Pulido lived in a small village in Central Mexico, about 125 miles west of Mexico City. It was on the twentieth day of February, 1943, that he went out into his field to pasture his sheep, just as he had done many times before. Just an ordinary day in many ways, but not so in others. The day before, while in Europe and on Pacific islands the big guns were roaring and bombs were falling, the earth had also been rumbling around Señor Pulido. Some 300 minor earthquakes had been recorded on February 19 in the region where he lived, but today all was relatively quiet--at least at first. It was about noon, according to his account, when he looked across a corn field and, all too close for comfort, saw thin white columns of smoke beginning to rise from the flat ground. He watched, no doubt with a great deal of amazement and fear, as the smoke columns grew in size. He continued to watch, backing away to what he considered a safe distance. Then suddenly, about four o'clock in the afternoon, flames burst out of the ground, accompanied by clouds of dense smoke, explosions, and loud roaring noises. And that was just the beginning. The violent activity got worse and continued into the next day; and the next. By the fifth day, where there had been a flat corn field there was now a mound of hot rock and cinders 300 feet high! A young, lusty volcano had been born and was now exploding continuously at the rate of 17 explosions a minute. Ten days later it was 722 feet high, and by its first birthday it was 1,410 feet high. Spectacular effects were common, especially at night. Incandescent lava bombs 3 to 5 feet in diameter, and occasionally 15 feet in diameter, would glow red and orange as they fell back onto the

cone and rolled down its flanks, illuminating the whole volcano in a mass of fire. What a spectacular display of fireworks--certainly greater than any Señor Pulido had ever seen before.

But there was more than just awe and beauty. Early in the life of the volcano basic lava began to flow from the base of the cone, with other flows following. The temperature of these lavas near the base was 2,192°F; and they were moving, moving toward the villages of Parícutin and San Juan. Fortunately, they were moving slowly enough that the people of the villages could be evacuated, but before it was over both villages were completely engulfed by lava. Only the church steeples remained above the surface. Eruptions continued violently for the first year, but then were rather small during the next eight years until they suddenly ended all together on March 4, 1952.

When my wife and I, and two friends visited there in 1969, it was an awesome sight to look across a black sea of now quiet and cool lava, and see the church steeples standing in the middle of it--a memorial to a village that is no more. In the background, where there was once a flat corn field, Parícutin volcano, the world's youngest, stood about 1,500 feet above the surrounding terrain, with small columns of steam still rising from the top.

Of all the Earth's natural phenomena, active volcanoes are certainly among the most fascinating. Observing one is somewhat like stepping back in geologic time, yet active volcanoes are really not that uncommon even today. In the world there are more than 500 known "active" volcanoes (defined as those that have erupted at least once within recorded history), 50 of which are

in the United States--in Hawaii, Alaska, Washington, Oregon, and California. Many more may be hidden beneath the seas. More than 80 percent of the Earth's surface, above and below the sea, is of volcanic origin. Throughout the geologic ages countless volcanic eruptions of all kinds have resulted in mountains, plateaus, and plains; and with the forces of erosion and weathering have yielded beautiful landscapes and fertile soils. The beauty of often-snow-covered peaks and the value of the rich soils have always, and still do attract people to live very near, or even on the slopes of volcanoes that are thought to be inactive; and sometimes those that are known to be active. But people have often failed to realize the potential dangers through ignorance of the geologic time frame and volcanic activity, or have chosen to take the risks. Perhaps statistically the risks of living near a volcanic peak are quite small, but when the conditions are met, the results can be devastating.

In the most widely known case history the volcano had been quiet for hundreds of years. Green vegetation covered the surface and it was thought to be "extinct." The succession of relatively large earthquakes about 16 years before, and a few minor ones later, had done some damage but had certainly not been understood as a warning sign. But then on August 24, AD 79, Vesuvius Volcano suddenly exploded and within a few hours hot volcanic ash and dust so thoroughly buried the Roman city of Pompeii, and streams of lava and mud flow the city of Herculaneum that their ruins were not uncovered for nearly 1,700 years. The city of Stabiae was also destroyed. So sudden was the event that in Pompeii at least

2,000 victims out of a population of about 20,000 were trapped in their homes; killed by the hot ashes or from breathing poisonous fumes. Pumice, ash, and dust were later wet by heavy rains and cemented into a hard layer called "tuff."

During a much later eruption of Vesuvius in 1631, streams of lava and boiling water fell on the villages at the foot of the mountain killing about 18,000 persons. Other destructive eruptions of Vesuvius have occurred in 1794, 1822, 1855, 1872, 1880, 1895, 1906, 1929, and 1944. Many times villages and towns have been destroyed and people killed, but still others return and live at the foot of the mountain.

Mount Etna is another of the world's most famous volcanoes. It rises 11,122 feet on the eastern coast of the island of Sicily, and presents quite a picture with its snow covered peak, forested slopes, and with orchards, vineyards, and orange groves around its base. There are two cities and 63 villages around it creating the most thickly populated area of Sicily. Yet Mount Etna, too, has a long history of destruction. The first recorded eruption occurred about 700 BC, and there have been more than 80 eruptions since then with some of them being extremely violent. During the 1669 eruption and earthquake about 20,000 persons were killed. Several towns were destroyed in the 1950 and 1951 eruptions. Violent eruptions ripped a new hole in the mountain in 1960, and other eruptions occurred in 1971 and 1975; but still the people come back to rebuild and to tend the vineyards.

In Indonesia, Mount Tambora erupted in 1815 releasing 6 million times more energy than that of an atomic bomb and killed

over 12,000 persons. This was probably the largest volume eruption in recorded history.

Krakatoa is a volcanic island in the Sunda Strait, between Sumatra and Java. In late May, 1883, relatively small eruptions started in one of Krakatoa's three cones. People came by boat from nearby islands to watch. The activity died down for a while, then started up again, and shortly after noon on August 26, a catastrophic, explosive eruption occurred, followed by others through the night. The next morning another catastrophic explosion blew two-thirds of the island away, leaving only half of one cone above water. The noise of this blast was so great that it was heard more than 3,000 miles away! Ash, pumice, and a dark cloud stretched 17 miles high. Fine dust drifted three times around the world, causing temperatures to drop for the next two years. But worse than that, a huge tidal wave washed over the shores of nearby islands, killing about 36,000 persons. This has been called one of the world's greatest disasters, but a worse volcanic disaster, in terms of the toll on human life, was yet to come.

On the northern end of the island of Martinique in the French West Indies is Mont Pelée (Mawn puh Lay), an active volcano. It had been dormant since 1851 when in the spring of 1902 it began to stir with life, but no one in the town of St. Pierre some five miles away seemed worried. Throughout April the mountain smoked and dropped ash on St. Pierre, and there were some mild earthquakes. In early May some explosions began and some of the population of St. Pierre fled the city, but most stayed on. On May 5, a mudflow destroyed a sugar mill outside the city. Ash

and other debris mix with the suddenly melting snow and/or rain creating the massive rivers of mud known as mudflows. On May 6 and 7, there were some loud explosions from the mountain that sent clouds of ash into the sky; but still most of the people remained in St. Pierre along with about 2,000 who had fled to the city from areas closer to the mountain. At dawn on May 8, steam was rising from the mountain but it was otherwise quiet. Two ships arrived in the harbor and docked beside 17 others already there. Then it happened. At exactly 7:52 a.m., Mont Pelée exploded violently from its flank blowing out an enormous, dense, black cloud of superheated steam, heavily laden with fragments of extremely hot gas-charged lava that sped down the slopes to the sea at the rate of more than a mile a minute. Within two minutes St. Pierre was ablaze and as many as 38,000 people were killed. Only two people, one a prisoner in a dungeon, are known to have escaped.

This massive, unusual kind of eruption called attention to a phenomenon previously unknown. French investigators called the remarkable clouds, "glowing clouds" or "glowing avalanche." Today they are referred to as "peléan clouds." The extraordinary features of a peléan cloud are: it is ejected horizontally from beneath the lava plug in the summit of the volcano rather than blasting the plug vertically upward; it is extremely hot; it travels at great speed; it carries with it an enormous quantity of highly gas-charged lava fragments, including blocks many yards in diameter. These fragments are surrounded with gas such that there is almost no friction, allowing the tremendous speed.

Later investigations suggest that such pelean clouds were ejected in immense numbers and extreme magnitude from the volcano that once stood at Crater Lake, Oregon. One also blew out at Mount Lassen, California, in 1915, destroying a forest, and another in 1951 at Mount Lamington in New Guinea, killing 2,000 people.

In great contrast to such violent eruptions are the relatively calm and quiet eruptions of the Hawaiian islands. Mauna Loa on the island of Hawaii, locally known as "the big island," is the world's largest active volcano and probably the largest single mountain of any sort on earth, rising approximately 30,000 feet above its base at the ocean floor. Its volume is in the order of 10,000 cubic miles, as compared to 80 cubic miles for the big cone of Mount Shasta in California. Mauna Loa along with nearby Kilauea have during the past century been among the most active volcanoes in the world; yet they are accessible and safe to visit during eruptions. Hawaii is perhaps the only place in the world where spectators rush toward the scene of an eruption instead of away from it. The reason Hawaiian volcanoes erupt so quietly as compared to others is the greater fluidity of the Hawaiian lavas and their lower gas content. In other, more highly viscous lavas the gas enclosed in them has difficulty in escaping, and must build up a high pressure before it is able to force its way out. Many of the Hawaiian eruptions are quite spectacular and beautiful. Great fountains of red hot lava at times shoot as much as a few hundred feet high; and often create rivers of lava that can flow down the mountain side as fast as 35 miles per hour. At other times a lava lake is formed in one of the craters in which waves

like those on the sea can sometimes be observed and lava fountains put on a fantastic show. In September, 1972, my wife and I were in Hawaii and had the opportunity to see one of the smaller lava lake eruptions in the Mauna Ulu crater near Kilauea. Along with others, we climbed about a quarter of a mile up a slope that had been covered with new lava in February of that year. From the top of the rim we could look right down into the crater and watch the red hot lava lake play about with occasional fountains and rapid movements that appeared as fast as the wind as some of the lava flowed out an opening on one side of the crater. The temperature of these lavas is usually in the range of $2,000^{\circ}$ to $2,150^{\circ}$ F, and in the lake were of extremely low viscosity. From the opening in the crater the lava was flowing down the mountain and over to the sea. When we left the crater we were not able to drive what had been the most direct route to where the lava was flowing into the sea because the earlier lava flows had covered the highway. But we were quite willing to drive the longer distance to see such a sight. I was amazed to find that in this age of "OSHAitis" and similar super precautions for public safety, there were no restrictions at all with regard to how close one got to the flowing lava. In fact, we walked right beside the now slowly moving, but still red hot lava as we went all the way to the place where it entered the sea, creating clouds of steam. At one point I held my camera at a hole in the older lava and took a picture of brilliant red flowing lava that was less than two feet away. I was also able to pick up a small piece of the new lava that had

cooled to a dark gray but was still warm--a prize piece for my rock collection!

Coming a lot closer to home the cloud of one volcanic explosion could even be seen here in Hopkinsville. You are all at least somewhat familiar with the explosion 3 1/2 years ago of Mt. St. Helens in Washington. Geologists have long recognized Mt. St. Helens as one of the youngest of the Cascade Range volcanoes, and as having a complex history. The present cone, or what is left of it, overlies and partially conceals the eroded remnants of an older volcano with a pumice layer dated at 37,000 years, and a weathered mudflow about 36,000 years old. About 2,500 years ago the character of the volcano changed from being explosive with frequent avalanches of hot rock debris and gas, much like the *peléan* clouds mentioned earlier, to more calm lava flows and ash. The eruptions during the past 2,500 years produced most of the part of the mountain we can see today, with the largest part being formed during the past 500 years. The eruption 3 1/2 years ago may have heralded another change of character, returning to its older explosive nature.

On March 27, 1980, Mt. St. Helens, one of the most beautiful snowcapped peaks in the country, belched a little steam and ash, and made a dirty smudge on top of the white snow, waking up after 123 years. In the weeks following there were numerous earthquakes recorded, and a large bulge developed on the north side of the mountain. Scientists, reporters, and some interested on-lookers came to the mountain to study it, watch, and take pictures. Most of them had no realistic idea of the danger involved. In fact,

not many people in Washington believed that Mt. St. Helens would erupt. Active volcanoes were something in far away places and on the late late show.

David Johnston was one of the geologists on the mountain in mid May. He was alone in the camp when he got up about sunrise on Sunday, May 18, and everything was quiet. He had just radioed fellow scientists in Vancouver, Washington, 40 miles away, that there was nothing new to report as he looked in front of him at the bulge on the north side that was now half a mile long and stuck out "like a 500-foot boil." Suddenly the ground shook, and shook again. He held tightly to his radio transmitter as he shouted, but somehow the transmission was blocked and Vancouver never heard him. A ham radio operator, the only one to hear him, said he didn't sound frightened, but excited when at 8:32 a.m., Johnston shouted, "Vancouver! Vancouver! This is it . . .". Moments later David Johnston vanished in a storm of hurricane winds and hot ash.

The blast was said to have been 500 times greater than the 20-kiloton atomic bomb that fell on Hiroshima. The hot ash, gas, and debris roared down the slopes at 100 to 200 miles an hour. The once graceful, snow-covered cone was now pulverized, with the top 1,300 feet of it being blasted into the stratosphere. In addition to the blast a boiling mudflow as much as 40 feet deep raced to the lowlands, destroying everything in its path before finally stopping over 17 miles from the mountain. At least 70 people died, with the exact number probably never to be known. Many of these died instantly, suffocating ash forced into their

throats and lungs by the explosion; some burned to death; and others were buried by ash, mud, and falling trees. In moments the blast had covered 150 square miles, leveling everything in its way. Along with the mudflows, floods, and ash fall, an incalculable amount of damage was done.

The ash fallout covered the city of Yakima, 85 miles to the east, with 800,000 tons of ash. In the Richland, Washington, area, where some of my family live, 140 miles east of Mt. St. Helens, the bright sunny morning became like midnight as an unbelievable cloud rolled low overhead. By the end of the second day and into the third, the ash cloud could be seen overhead here in Hopkinsville, and eventually it encircled the world. There have been a few fairly large eruptions at St. Helens since then and many small ones. When I saw it just over a year ago, she was just pouring out a little steam. But no one knows if the eruptions have stopped for now or not. In the past they have occurred off and on for as much as 18 to 20 years. Another could occur at any time, even worse than that of May 18.

There are several other volcanoes in the Cascade Range also. Mt. Hood in Oregon experienced several earthquakes during the early months of the St. Helens eruption; and years ago I saw a picture of the top of Mt. Rainier with small amounts of steam coming through the deep snow cap. Which one is next?

There are many stories to be told from the hundreds of awesome volcanic eruptions within the span of recorded history. These have been a few of them. An interesting footnote is the photograph made in July, 1979, by Voyager 2, of a volcanic

eruption rising some 60 to 100 miles above the surface of one of the moons of Jupiter. There is also the Mariner 9 image of a shield volcano on Mars, like those in Hawaii, with a diameter at its base wider than the length of the entire chain of Hawaiian islands.

From the catastrophic, violent, sudden death pe^{le}éan clouds to the dancing lava fountain "stage shows" of Hawaii, volcanoes are vivid demonstrations that the Earth is still forming.

B I B L I O G R A P H Y

Combined staffs of The Daily News, Longview, Washington, and The Journal-American, Bellevue, Washington. Volcano, The Eruption of Mount St. Helens. Longview, Washington: Longview Publishing Company, 1980.

Forest Service USDA, Pacific Northwest Region, Gifford Pinchot National Forest. Eruptions of Mt. St. Helens. Leaflet, 1980. Lauber, Patricia. Science Book of Volcanoes. New York: Scholastic Book Services, 1980.

Longwell, Chester R.; Knopf, Adolph; and Flint, Richard F. Physical Geology, Third Edition. New York: John Wiley & Sons, Inc., 1952.

Macdonald, Gordon A., and Hubbard, Douglass H. Volcanoes of the National Parks in Hawaii. Honolulu: Tongg Publishing Company, Inc., 1970.

Personal Experience.

The World Book Encyclopedia, Vols. 6, 11, 13, 15, & 20. Chicago, Illinois: World Book-Childcraft International, Inc., 1979.

Tilling, Robert I. Volcanoes. Denver: U.S. Department of the Interior/Geological Survey, U.S. Government Printing Office, 1982.