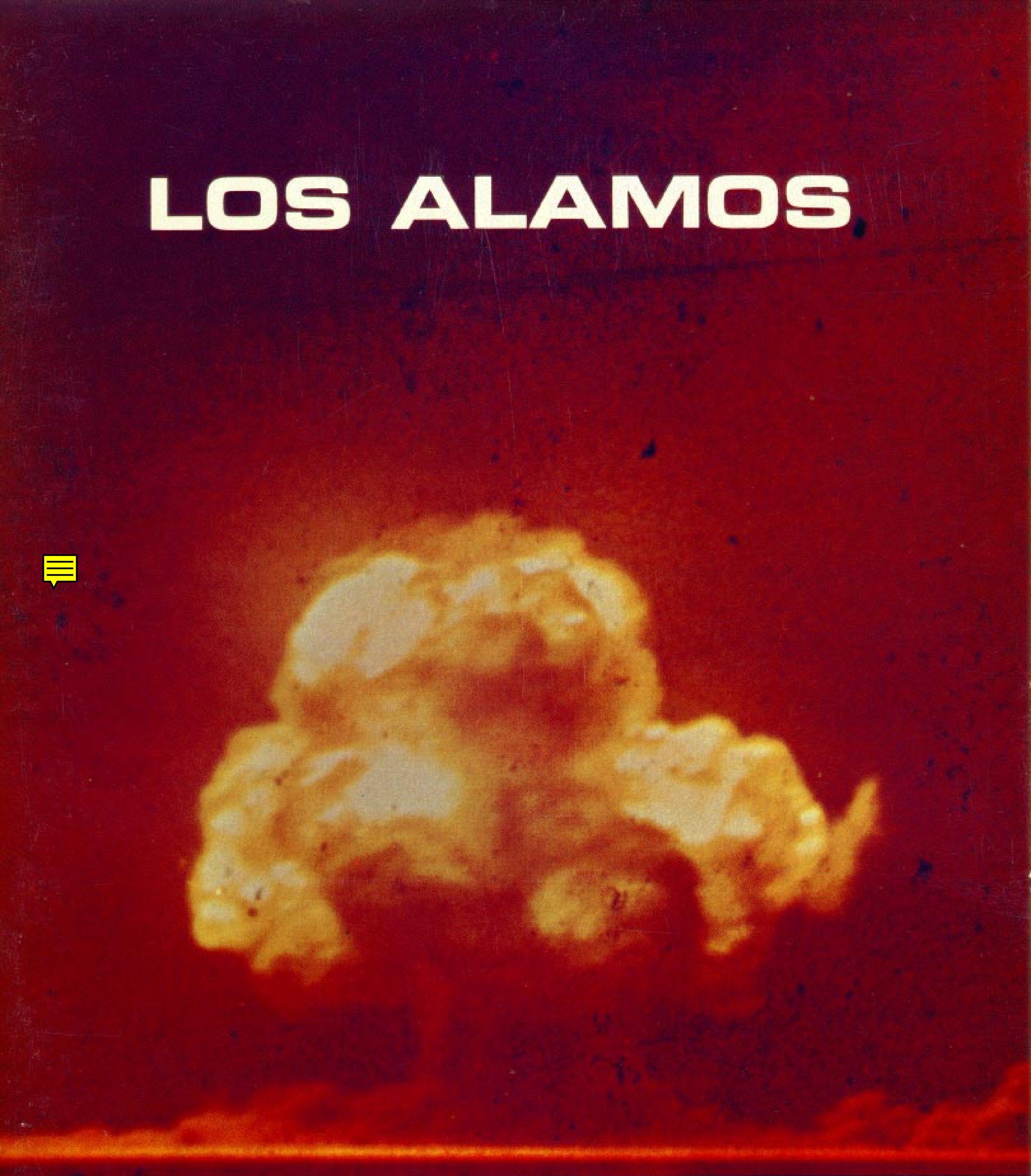
LOS ALAMOS



beginning of an era 1943-1945

ON THE COVER:

Although colored movies were taken of the Trinity test, they were of poor quality and have since deteriorated. This cover photograph, also showing the ravages of time, is the only existing color shot of the test. It was taken, surprisingly enough, by an amateur using his own camera. Jack Aeby, now of H-6, was working at Trinity with Emilio Segre studying delayed gamma rays. Segre secured permission for Aeby to carry his camera to the site to record the group's activities. Came the test and, as Aeby says, "It was there so I shot it." The picture was taken from just outside Base Camp with a Perfex 33 camera using 35 mm film. The photograph provided the basis for the Theoretical Division's earliest calculations of the Trinity weapon's yield and was shortly confiscated by the Army and first published after the announcement was made of the bombing of Japan.

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LOS ALAMOS

beginning of an era 1943-1945

This is the story of one of the greatest scientific achievements of all time. It is the story of the founding of the Los Alamos Scientific Laboratory and its successful secret mission to create the first atomic bomb, the weapon that ended World War II.

Information for this story was compiled and edited from previously published articles and brochures on Los Alamos history written by the staff of LASL's Public Relations Office.

PART I

starting point

military & scientific realities of '1943

Military considerations had government the decision, by 1943, that an atomic bomb was desirable, as a means for bringing World War II to an end. Scientific considerations had governed the decision that an atomic bomb was probably feasible. Technological considerations (already being worried about, though they were almost entirely in the realm of the unknown) had made it obvious that the atomic bomb would not be built in a day or a month or a year.

The military picture was grim. The USA was at war with Japan, Germany, and Italy. American naval power had not yet recovered from the disaster at Pearl Harbor. The Japanese had conquered the Philippines, and Japanese naval power was at its height. American' soldiers were heavily engaged in North Africa and elsewhere. The Germans had barely begun to suffer the reverses that would turn the tide of war against them. (They surrendered El Alamein late in 1942 and Stalingrad in 1943.) Gel--man scientists were working-no American knew how ineffectively-toward an atomic bomb.

The scientific picture was exciting. The phenomenon of uranium fission had been observed several years earlier and had been correctly interpreted before 1940. It was known that at least one kind of uranium nucleus would divide (roughly in half') upon absorption of a neutron, and that this react ion liberated energy plus more neutrons. In December, 1942, a Chicago group under Enrico Fermi had succeeded in bringing about the world's first man-made nuclear chain reaction-a reaction in which the neutrons from fission caused further fission at a sustained level.

The technological picture was wry nearly a blank, so far as atomic bombs were concerned. This was true not only because no one had ever tried to build an atomic bomb, but because so much fundamental scientific research remained to be done before anyone ever could.

Enough was known already, to suggest the magnitude of' the task, both scientifically and technologically. It was known, for instance, that the essential fissionable material-the heart of the bomb-would be hard to prepare.

Fermi's historic "pile" consisted of graphite

The military picture was grim in 1943. Right: Anti-aircraft gunners on USS Sangamon fight off burning Japanese Kamikaze plane. Opposite: As one American scout falls in Italy, his comrades dart into a doorway for temporary shelter from the barrage.

blocks and lumps of natural uranium. Natural uranium is more than 99% U-238, a heavy isotope unfit for use in a bomb because of its tendency to capture neutrons without fissioning. Uranium-235, the lighter isotope needed for a weapon, makes up about seven-tenths of one per cent of naturally-occurring uranium, Separating U-235 from the more abundant isotopes is extremely difficult, since the chemical behavior of the two isotopes offers no differences great enough to form the basis of an efficient chemical separation process.

Slight differences in physical behavior include the fact that atoms of U-235 diffuse through porous material at a somewhat faster rate than atoms of U-238, and also the fact that the trajectory of a fast-moving U-235 ion (an atom lacking one or more of its natural electrons) will bend slightly more, in a given transverse magnetic field, than the trajectory of any accompanying ions of U-238. Both of these slight behavioral differences (as well as others, even less promising) were under intensive study by 1941.

In 1943 a separation plant based on the different diffusion rates was built at Oak Ridge, Tennessee, to produce enriched uranium (uranium containing more than the natural proportion of U-235) for possible use in a weapon. At the time of the founding of the Los A1amos Laboratory, construction of the Tennessee plant had not yet begun. There was not enough enriched uranium in the world for a single bomb, or even for satisfactory laboratory investigations of U-235 behavior. Material for the first uranium bomb would not be ready for more than a year.

Minute quantities of a second fissionable element, plutonium, had been created at Berkeley in the winter of 1940-41. Plutonium does not occur in nature, but can be formed from uranium-238 through a complicated series of events beginning with the capture of neutrons by the uranium. The construction of nuclear reactors to furnish neutrons for this process began in 1943 at Oak Ridge, Tennessee (on a small scale) and Hanford, Washington (on a large scale). At the time of the founding of Los Alamos Laboratory, all the world's plutonium could still have been piled on a pinhead, with room to spare.

Thus in January, 1943, not only was there no fissionable material for bomb-making; construction of the Tennessee and Washington plants from which the material would come had not even begun.

Methods of devising a bomb deriving its explosive energy from the fission of U-235 or Pu-239 were purely specculative. The engineering effort was entirely in the future, and it would depend heavily on the results of physical, chemical, and metallurgical studies of the two possible core materials. These studies would have to be made on extremely small quantities of uranium and plutonium, so that the necessary knowledge would be gained by the time larger quantities should become available.

Thus it was that the Los Alamos Laboratory, or Project Y as it was called, became the crucial part of a super-secret nationwide research and development program known as the Manhattan Engineer District of the War Department. While other groups worked toward development and production of materials, the mission of the Laboratory, under the direction of J. Robert Oppenheimer, was to pet-form the necessary research, develop the technology and then to produce the actual bombs in time to affect the outcome of the war. The story of how this was done, in the face of the problems just suggested and other problems soon to be encountered, has already become a classic of science and engineering. It begins with the choice of a site for the laboratory that was to become, in the words of Dr. L I. Rabi, "the first line of defense of the United States."

As the following chapter will show, geology and geography played a remote but finite part in the selection of the location on the Pajarito Plateau in New Mexico's Jemez Mountains-an isolated school for boys with "adequate quarters for the 30 scientists" who were all the project would need, or so the founding fathers thought.

the place

Early map makers, looking at the rectangular block of the Jemez Mountain range in northern New Mexico, apparently noted with only passing interest the circular shape formed by a series of peaks near the center.

The great circle, if they noted it at all, must have appeared to them to be merely a curious set of connected mountain valleys, 8,500 feet above sea level, separated by conical hills ranging in size from knobs to 11,000-foot mountains. On their maps they gave these lovely alpine valleys their collective Spanish name: Los Valles del Monte. The eastern rim of the circular range, overlooking present-day Los Alamos, still bears the name of Sierra de los Valles. Early geological reports refer to the region as "the Vanes Mountain volcanic center, " or something equally non-committal.

It was not until sometime in the 1920's that the idea that this unusual geographic feature might actually be the rim of an ancient and extinct volcano began to gain acceptance. There never was any question of the volcanic origin of the Jemez range. Even to the untrained eye thick layers of volcanic ash, heaps of burned rock, cone-shaped hills and fumeroles, and bubbling hot sulfur springs, all give unmistakable evidence of an open passage to the underworld in the not-too-distant past.

The Indian name "Jemez" means "Place of the Boiling Springs. "

Relief maps and aerial photography clearly said that here was once a huge volcano, but only served to start another argument. One group of geologists claimed the big hole really was a crater, the top of a volcano. If this were true, it would be the largest known in the world, some 50 miles around and encompassing nearly 200 square miles. The other group insisted it was a caldera, the huge saucer left when a volcano collapses upon itself after having spewed all its insides out. There are lots of big calderas, some even bigger than this one. Clarence S. Ross of the U.S. Geological Survey, who has devoted 30 years to studying this region, is now certain it is a caldera.

The caldera and the surrounding peaks arc the final result of a series of upheavals dating back perhaps ten million years and continuing down to a few tens of thousands of years ago. Cone-shaped peaks of varied size rising within the caldera, including 11,250-foot Redondo peak, are known to be secondary volcanic upthrusts. They came into existence after the original volcano collapsed to form the great basin. The basin itself once was a lake which left wave terraces visible today along the high rim. Ages ago the lake cut through the rim and drained away down what is now the Jemez river gorge.

The lush, grassy valleys between the secondary peaks inside the basin have Spanish names, like most places in New Mexico—Vallc Grande, Vane Jaramillo, Valle de los Pesos, Vane Santa Rosa, Vane San Antonio. One of' the valleys, the Vane Grande, is best known because it is the only one alongside a public road, State Highway 4. It is the largest valley in the group, but it is only a fraction of the caldera. However, its name oftcn appears on maps and is popularly ascribed to the entire basin. The error probably will stic:k.

The error is understandable. The Vane Grande itself is huge enough, a vast sea of grass on which great herds of cattle and sheep appear as ants. Intermediate forested hills block the view, of distant adjoining valleys, so that only from an airplane up 15,000 feet or more is it possible to see the whole caldera. In winter, when the main peaks stand starkly around the blanket of snow that fills the valleys, the circular shape is particularly evident from the air. But planes have been flying over the range only a short time—actually since World War 11. The place names were established long before people could view the whole magnificent panorama. So if' you call it all the Vane Grande, not many will argue the point.

In the 1880's the Vane Grande was used for maneuvers by soldiers from Santa Fe's Fort Marcy, who built a log fort on East Jcmez Creek. Navajo hogans were standing along a ridge bordering Vane Toledo, in the northeast section, until recent times. Apaches and Utes also passed this way in ancient times.

Somewhere in this period also a sawyer named Buckman started a mill, one of several in the region, and hauled lumber to the narrow-gauge railroad station across the Rio Grande from White Rock at what came to be known as Buckman's station. Logging operations have continued off and on down to the present-day in the caldera and around it.

High altitude view shows rugged canyon-pierced Pajarito Plateau below the rim of the Jemez Caldera; part of the Vane Grande is visible upper right.

The Valle Grande, part of a giant volcanic caldera in the Jemez Mountains is 8,500 feet above sea level.

Next to the great Jemez caldera, the Valle Grande, and the high peaks, probably the most prominent geological feature of the region is the long, narrow plateau that extends along and halfway up the eastern slope of the Jemez range, overlooking the Rio Grande.

Edgar L. Hewett, early-day archaeologist, named it Pajarito (Little Bird) Plateau. Lying at an altitude of between 6,300 and 7,300 feet above sea level, this wooded, volcanic bench averages a mile or two or three in width. It is severely indented along its eastern edge by a series of deep vertical canyons, where multi-colored layers of volcanic deposits are exposed by erosion. Backed up against 10,000-foot peaks, the plateau is covered thickly with pinons, juniper, and many varieties of scrub on its lower slopes, and with ponderosa pine, fir, spruce, oak, and aspen on its upper levels. It supports numerous small streams, a few of which are permanent. The few clearings arc man-made.

Nomads probably wandered over the plateau for centuries, as they did along the Rio Grande, but they left no dates. There is no may yet to date with any precision the countless pctroglyphs that decorate the rocks of the region. Most of these crude symbols are associated with adjacent ruins, which can be dated somewhat by tree rings and by pottery and other relics. Other "picture rocks" arc near nothing and seemingly relate to nothing, They could be of any age.

At Bandelicr and at Puye, Tsirege, Tsiping, and Tsankawi, from Abiquiu to Cochiti, south-facing cliffs and adjoining mesa tops are the sites of countless ruins. It is difficult for a trained observer to get out of sight of a telltale mound or cliff-opening that speaks of early Pueblo occupancy, anywhere along the length of the plateau. Pottery sherds and obsidian flakes literally pave the ground in many places. (In central Los Alamos, between the shopping center and the Lodge, a fenced area encloses a partially excavated ruin of the 12th century, black-on-white pottery period, believed to be associated with the large Otowi Pueblo ruin in Pueblo Canyon. Local archaeologists plan to restore the ruin as a public museum.)

There is no visible evidence in all these memorabilia, however, of any residence on the plateau prior to about 1150 A.D. Between that time and the Spanish occupation, many thousands of Indians evidently lived and died on the plateau, farming the valleys by day for squash and beans and corn, retreating by night to the relative security of their cliff dwellings. They were harrassed by Apaches from the south, Navajos and Utes from the north, Comanches from the east, and by a changing climate. About the only factor in their favor was the ease of digging holes in the soft pumice cliffs for storerooms behind their talus dwellings. Housing was cheap and plentiful and natural defenses were at hand. Nothing else could have been easy.

Indians existed here, in some fashion, for perhaps four hundred years, when drought apparently drove them to the Rio Grande bottom lands. They arrived just in time to meet the Spanish Conquistadors, who jerked them in short order from stone age freedom to slavery and near-extermination. Had they known what was in store for them, probably they would have stayed in the hills and starved.

Some caves along lower Frijoles creek in Bandelier National Monument are believed to have been a refuge, perhaps as late as 1700, for Indians fleeing the returning Spaniards after the Pueblo revolt of 1680. But after that there is a blank in the history of the whole Pajarito Plateau, until the arrival of the first homesteaders in the late 1880's.

(At Puye Cliffs, on the Santa Clara Indian reservation, Indians from the nearby Pueblo celebrate annually a fiesta at the site of a partially restored ruin which they insist is their ancient homesite. But the celebration is obviously just good clean fun, as it is of very recent origin. The Santa Clara Indians also maintain picnic, fishing, and recreation areas in beautiful Santa Clara Canyon.)

There can be little doubt that early hunters ventured into the forests of the Jemez for the deer, bear, elk and turkey that still abound there. Sheepherders and drovers from the haciendas of the Rio Grande valley doubtless grazed their flocks in the high meadows and in the great caldera. But they left no record that the passage of a century has not obliterated.

The mountain men of the fur trade who opened the West late in the 18th century may have trapped the Jemez streams—there are still beaver in the larger ones–but there is no mention of these mountains in their scanty journals. It is known that they trapped the Rio Grande and the Chama, and it is likely therefore that they trapped the tributaries of both.

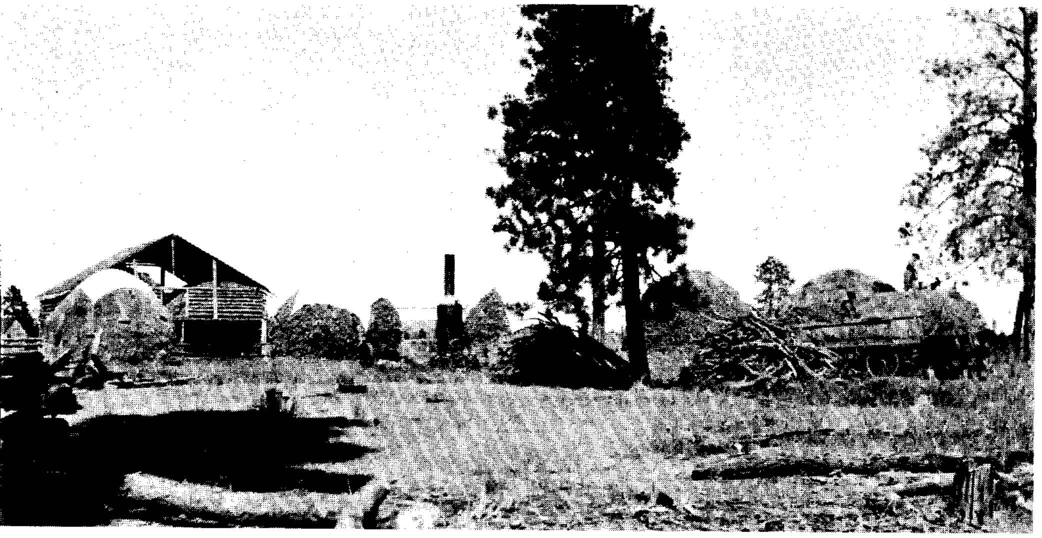
The archaeological wonders of the plateau were first reported in the 1880's by Adolf Bandelier, for whom the present-day national monument is named, as a result of his explorations here between 1880 and 1886. For a short time he lived with the Cochiti Indians, who claim Frijoles Canyon as one of their ancestral homes. He camped in Frijoles also, probably in one of the larger caves. From these experiences he obtained the material for his romantic historical novel "The Delight Makers," which seeks to reconstruct the lives of prehistoric dwellers in Frijoles Canyon, now headquarters for the Monument.

Not only is the archaeological record of the plateau best preserved in Bandelier National Monument, with its museum, guided tours and partially restored prehistoric dwellings, but it is also the locale for some of the earliest permanent settlements on the plateau.

A Boston judge named A. J. Abbott homesteaded Frijoles (Bean) Canyon about 1907. Abbott built a stone and log house and planted an orchard. Some of his peach trees still bloom every spring across from the upper campground.

In 1925 George and Evelyn Frey took over the place, known as Ten Elders Ranch, and started a guest ranch resort, about a quarter-mile west of the present visitor's center. They brought supplies in by cableway from the cliff top. Guests had to ride in on burro-back, down a dizzy zig-zag trail, after boarding a buckboard at Buckman on the two-day journey from Santa Fe, crossing the Rio Grande on a rickety plank bridge that washed out almost every spring. There was no road down into the canyon until 1933.

Ruins of the ancient pueblo of Tyuonyi, as well as many prehistoric cliff dwellings, are included in Bandelier National monument, 14 miles from Los Alamos.



Scene on a ranching homestead of the Pajarito Plateau, photographed before the founding of the Los Alamos Ranch School in 1917.

The old ranch buildings were torn down in 1938 by the CCC when it built the present lodge and visitor's center. Mrs. Frey, a widow, has managed the lodge since it was built.

Around Los Alamos, the earliest known occupancy was by summer bean farmers who came up from the valley. Bences Gonzales, who retired from his Laboratory employment in 1959 at the age of 66, recalls spending summers near Anchor Ranch (now GT Site) where his father had been the first settler in 1891. His wife's grandfather, Antonio Sanchez, was the first homesteader on Pajarito Mesa (above present Pajarito site) in 1885, he recalls. Some scraggly peach trees and a tumbledown log cabin are all that are left of the old ranch. Because of usually heavy snow the ranch was never occupied in the winter, Gonzales recalls.

In dry years, the farmers hauled water to the mesa top up an old trail still visible on the south side of Los Alamos canyon, just under Fire Station No. 1. It was known for years as Dead Man's Trail, because Sanchez was killed by a falling rock while building it.

The first permanent settlers in Los Alamos, who dug in for the winter with log cabins, frame houses and fireplaces, apparently arrived about 1911. The mesa was homesteaded by a man named Harold Hemingway Brook, who with a fellow lumberjack named Mack Hooper, filed on 160 acres of land each in 1911. They called it Alamos Ranch, built homes near the present Lodge building, and raised beans and wheat. Other ranchers settled on the mesas and in nearby canyons.

Alamos Ranch also was a convalescent camp, and just before the Los Alamos Ranch School opened many people who came to Santa Fe from the industrial areas of' the East to recover from tuberculosis, finished up the rest cure in the pine groves of Los Alamos.

Two long-ago incidents involving water, the Southwest's most precious and unpredictable commodity, were important in the chain of events that led to the establishment of' Los Alamos Ranch School.

The first occurred in 1904 in the small, foothills town of Valmora, N. M., on the cast side of the Sangre de Cristo Mountains. A sudden flood washed away the buildings of a new private school, only weeks before it was to have opened.

The second was a dozen years later, more than 100 miles away in the grassy depths of Pajarito Canyon, when a stream chose to disappear suddenly.

Affected by both unrelated outbreaks of nature was a former Detroit, Mich., businessman, Ashley Pond, who possessed an unremitting determination to establish a school in New Mexico.

Pond's Valmora catastrophe, during which he carried his two-year old daughter, Peggy, to safety through the swirling waters, sent him back to Detroit until an inheritance made it possible to return.

Presence of the stream in Pajarito Canyon, colorful cliff country containing Indian reminders similar to those at nearby Frijolcs, inspired Pond to choose that site for, instead of a school, a rather selective dude ranch. His Pajarito Club catered to a specific clientele,, the newly, affluent motorcar manufacturers of hometown Detroit, and enjoyed considerable popularity what with the abundance of hunting, fishing and exhilarating climate.

When the stream departed (investigation showed it had gone underground at the head of' the canyon), Pond visited a neighbor to the north, H. H. Brook, who operated Alamos Ranch.

Pond bought out Brook's interest and incorporated at the Los Alamos Ranch School,

Pond's isolated school consisted of a conglommate of buildings, some of rough-hewn lumber but most of logs. There was a trim main house with a circling porch much like the farmhouses of the Midwest. There was a boggy area that alternately filled and drained, Near stood a large barn. To the east, reaching almost to the tip of the mesa, was a large field that was part pasture and part cropland. West of the main buildings were service huts and cabins for the ranch hands. A dense forest of pines slipped west down a gentle slope to a 200-acre clearing that extended to the rock base of the Jemez hills. This was range land, and had barns and stables.

For director, Pond solicited the services of a forest ranger named A. J. Connell, and by January 1918, the Los Alamos Ranch School was ready for business. The first pupil, enrolled on a tutoring basis, was the son of a British consul with the unlikely but magnificent name of Lancelot Inglesby Pelly.

The school grew, Faculty members were added and new buildings went up. There was a hulking timber pile called the "Big House" to the north of the home. In 1924 another big log building was erected and named Fuller Lodge for one of the instructors, Edward J. Fuller, whose father bought a major interest in the school and helped finance it through a crucial period. It was a dining and recreation hall. Rooms upstairs were used as an infirmary and for putting up visiting parents.

A young man from Connecticut had been recruited to teach science—the first physicist on the Hill. He was Fermor Church, who married Peggy Pond a few years later.

Ashley Pond, his dream at last realized, retired to Santa Fe.

Enrollment in the school was first limited to 25, but success and expansion made it possible to accommodate 45 boys as the 1930's arrived. A six-year study program was offered. Classes were small and conducted informally.

Pond was a great believer in the vigorous life. Boys wore shorts the year round. They slept in unheated sleeping porches but had a heated interior study room in each of the residence cabins. Each lad was assigned a horse, and pack trips into the Jemez were common.

The bog at the south side of the mesa was worked over and became a 23-acre lake, a place for ice skating in the winter, for swimming and even boating in the summer. Its cracked-tufa bottom frequently sprung leaks and the water dripped away, reappearing far out on the mesa. Adobe was packed on the bottom and eventually a six-inch pipe was run two and a half miles from far up Los Alamos canyon to provide a surer water supply.

Inevitably, the pool was known as Ashley Pond.

Commencement was a spectacular outdoor affair with special guests seated on the log-columned porch. Invited Indians performed dances, then spread their craftwork on blankets for sale to the goggle-eyed visitors.

During these years an incident occurred that had great portent for the future. A visitor rode over the mesas on a pack trip. His summer home was across the valley, in the high mountains at the headwaters of the Pecos river, cast of Santa Fe. His name was J. Robert Oppenheimer.

Hc admired the setting, and thereafter often visited the school. He remembered the place upon

Rows of crops of the Los Alamos Ranch School, growing on the site of the present Community Center. The rich volcanic soil of Los Alamos is still producing good crops of vegetables for backyard gardeners.

being confronted with a momentous decision a few years later, when he was asked to advise the Corps of Engineers on the selection of a secret laboratory site with the following specifications:

1. It had to have adequate housing for 30 scientists.

2. The land had to be owned by the government or to be easily acquired in secrecy.

3. It had to be large enough and uninhabited so as to permit safe separation of sites for experiments.

4. It had to afford easy control of access for security and safety reasons.

5. It had to have enough cleared land, free of timber, to locate the main buildings at once.

Los Alamos fitted these qualifications to a T. All the land around the school was national forest or cheap grazing land. The nearest town was 16 or 18 miles away. And it had "plenty" of housing-for 30 scientists.

Until the spring and summer of 1942, the Pajarito plateau seemed about as far from war as was possible to get. Then, just as the annual summer program was in progress, school officials noticed a frequency of low-flying aircraft seemed to study the area. Cars and military vehicles appeared on the crest of the road that led up from the valley.

In autumn school officials were enlightened: the War Department was interested in the property. On December 7, 1942, the first anniversary of Pearl Harbor, (and five days after Fermi achieved the first nuclear chain reaction) notice was received in a brief communication from Secretary of War Stimson that the school was being taken over. The Government used condemnation proceedings but decreed all records scaled immediately. They were not released until 1961.

Parents were notified that the school was being closed, but were not told why. The Army allowed' until mid-February for the property to be vacated. In a final spurt of academic fire, class work was accelerated and by the time the boys left they had completed the full year's courses and had passed New Mexico tests to prove it.

Graduation at the Los Alamos Ranch School. This building is the main part of Fuller Lodge, used as a hotel from the war years until 1966. Dancing by Indians from nearby pueblos was a feature of the exercises.