Mining and Metallurgical Section.

(Stated Meeting, held Thursday, October 18, 1906.)

Acoma : the Cliff City of New Mexico.*

BY PROF. OSCAR C. S. CARTER.

One of the strangest corners of our country and one of the greatest wonders of the Southwest is Acoma, the Cliff City, built centuries before Columbus' time and to-day occupied by the Pueblo Indians, who are the descendants of those conquered by Coronado's expedition 366 years ago. It is the oldest city in the United States and has been inhabited continuously for centuries. Man in every country on the globe is undoubtedly influenced by his environments; this statement holds true with the Indian, African and Mongolian alike, and to a less degree perhaps with civilized man. The conceptions of the Indian by the English and Spaniards were totally different. The cavaliers who sailed up the broad estuaries of the Delaware and Chesapeake and the Puritains who landed on New England's inhospitable shore met a more or less migratory race of Indians who subsisted by hunting and fishing. Many of them were born warriors. The same may be said of the former Indians of the plains who were migratory and warlike. The buffalo was their food supply, and when the white man, with little foresight and less sense, almost exterminated this animal, the food supply of the Indian was destroyed; starvation stared him in the face, and the Government has been obliged to give him an allowance of flour and meat ever since at his new home on the Indian reservation. How different was the experience of the Spaniards who came from Mexico in 1540 with Coronado's expedition in search of the seven cities

*Read by title.

of Cibola? In their conquering march through the Southwest they met a peaceful and agricultural race of Indians, the Zunis, Acomas and Hopis, who were not migratory and were not hunters, but lived in permanent houses of stone on the mesas and in the canons hundreds of years before the discovery of America. In the valleys and at the base of the mesas they raised melons, pumpkins and corn. They are the Pueblo Indians of to-day. They were not hunters, because in the arid and desert district of the Southwest, where they live, there is little to hunt. They were forced to be agriculturists, notwithstanding a harsh environment and deficient rainfall of but ten or twelve inches per year. The Government did not take their land because nobody wanted it. It is not worth having. So they have remained unmolested for centuries in their isolated desert homes. They were not born warriors, although they defended themselves strenuously and often successfully in their impregnable homes against the terrible Apaches and the warlike Navajos, who were migratory. Farther south, near the Mexican boundary line, the Papagos have a still harsher environment, and even less rainfall, and they are reduced to the extremity of living on mesquite beans, seeds and the pulp of the giant cactus, Saguaro. The first spring shower finds them planting a little corn which often fails to reach maturity. The Pai Utes, near Death Valley, California, do not scorn a meal of lizards and snakes. Man's environment influences his whole life, and the proper way to study man is as influenced by his environment. Acoma is located about three miles south of the enchanted mesa, near the southeast boundary of the plateau country, which was described in the previous article on the Enchanted Mesa by the author. It is in the Pueblo region. The ancient Pueblo region, according to Cosmos Mindeleff (19th Annual Report, Bureau Ethnology, Part II.) "extends from Great Salt Lake to beyond the southern boundary of the United States, and from the Grand Canyon of the Colorado River to the vegas or plains east of the Rio Grande and the Pecos. Within this area of about 150,000 square miles ruins can be numbered almost by the thousands." In other words, the present Pueblo Indians and their ancestors, the so-called Cliff Dwellers, dwelt in Utah, Arizona, New Mexico and Southwest Colorado. They occupied all of the plateau region and the

country to the south of it, extending over the boundary line into Mexico. Mindeleff states (13th Annual Report, Bureau of Ethnology, page 258,): Before archeological investigation of the Pueblo region commenced and when there was little knowledge extant by which travelers could check their conclusions, the immense number of ruins in that region was commonly attributed to an immense population, some writers placing the number as high as 500,000. Besides this figure the present population, about 9000, is so insignificant that it is hardly surprising that the ancient and modern villages were separated and attributed to different tribal stocks. It is very doubtful whether the total number of Pueblo Indians ever exceeded 30,000. This is the figure stated by Mr. A. F. Bandelier, whose intimate acquaintance with the eastern part of the Pueblo region gives his opinion great weight. The apparently trifling causes which sometimes result in the abandonment of villages has been alluded to. He reconciles the small population to the thousands of ruins as follows: "Migration among the Pueblo Indians means a slow, gradual movement without any definite end in view. A section of a village moves away from the parent village only a few miles; another section moves to another site. These movements are not possible where outside hostile pressure is great, and if such pressure is long continued, it results in a reaggregation of the various scattered settlements into one large village. Such, in brief, is the process which is termed migration and which has covered the Southwest with thousands of village ruins. As a rule the abandonment of villages was a gradual process, often consuming years. Migration, he says, must not be taken in the sense in which it has been applied to European stocks, a movement of people en masse or in several large groups." The present Pueblo Indians, the descendants of these ancient people, are not migratory. The Pueblo villages of Zuni, Acoma and Oraibe have been inhabited for centuries.

Acoma is thirteen miles south of the Pueblo village of Laguna, which is located along the Atlantic and Pacific R. R., now known as the Atchison R. R. It is also about ninety miles west of Albuquerque. We made the start from Laguna where we secured good accommodations with Mr. Marmon. His son, a graduate of Carlisle, drove us to Acoma. The

Acoma mesa in the distance. Only water in the desert, on the road to Acoma.

Where the trail begins at Acoma sand dunes 80 feet high.

(Carter)

A break or reentrant in the mesa near the corral.

Climbing up the steep trail to Acoma.

Valley of Acoma and the Enchanted Mesa were described by the author in a previous article. It was rather a hot journey to make in an open wagon across the desert in July. Our water gave out before reaching Acoma and one of our horses, that had evidently been driven hard the day before, fell over from fatigue; the heat and the journey through the deep sand in places were too much for him. Otherwise the journey was uneventful and fairly comfortable. There is but one water hole on the journey to Acoma where water can be obtained for horses; it is not far from the Enchanted Mesa. It is a circular pond about an acre in extent which looks very like a so-called limestone sink, although the surface rock is sandstone. This water is too alkaline for man, but the horses seemed glad to get it. The cattle and what horses and mules the Acoma Indians possess graze on the gramma grass of the valley. This is a common name for several low grasses found in Arizona, New Mexico, Texas and also on the plains east of the Rockies. Mesquite grass and buffalo grass come under this heading. Cattle and sheep are not particular in the West where many of the ranges have been destroyed by putting too many cattle or sheep on a given area. Sheep will even eat sage brush and seemingly thrive on it. The stock near Acoma always frequent this water hole. On the road near Laguna we crossed one of the numerous tributaries of the Rio Grande, which at that point is merely a sluggish alkaline creek, unfit for man or beast. One writer has called this the Rio Puerco River, which is an error, as this river is in Arizona and is a tributary of the Colorado Chiquito, or Little Colorado. We had better say, perhaps, that it is an error for the geographers to correct, as the maps show two rivers of the name Rio Puerco, one in Arizona and the other in New Mexico. The mesa on which Acoma is built rises from 350 to 400 feet above the desert. The walls are generally vertical. The two trails in general use are the horse trail and a trail the Indians use, which stands at an angle of about 50 degrees and in some places is vertical. This is a very trying and steep climb on a hot day. You first climb up some sand dunes, which are from 70 to 80 feet high. One is astonished at these enormous dunes, which seem out of place at the base of this mesa. The sand is formed by the disintegration of the sandstone rock and

is heaped up by the strong wind. On the vertical trail are some ladders, simply cedar posts with rungs, although in some places pieces of wood are wedged between rocky walls and serve as ladders; in other places steps were cut in the rock which necessitated steep climbing. The Indians told the following story to a writer (in *American Architect*, Vol. 16, page 258): "Several Indians started up the steep trail, each with a live sheep on his back. When they had nearly reached the top, the sheep carried by the foremost man became restless, and the shepherd in his excitement lost not only his hold but also his footing and toppled over, sweeping his companions down on the jagged rocks below where they fell in a lifeless heap. The Indians have carved a representation on the rock near where it occurred, which scarcely serves to steady the nerves."

The trail is steep enough, but we don't want to give the impression it is too bad, because the Indian boys run up and down like squirrels, and my chief concern was the fear of starting a loose boulder down the trail after them. When you reach the flat summit of the mesa you are astonished to find three parallel rows of houses extending for a distance of from 800 to 1000 feet across the mesa. There are two fairly wide streets between the rows. These long unbroken walls of stone and adobe extending across the mesa are divided by partition walls at right angles into separate homes. Imagine a sheer wall of solid masonry on one side of the street and terraced house three stories high, like a series of steps, on the other. These terraces are reached by ladders and the highest roof or terrace is about 35 feet from the ground. The wall of the first row of houses rises sheer from the cliff and is a continuation of its face. This wall faces the north and the terraced part of the houses faces south. It would not be safe for a man giving to sleep-walking to wrap himself in a Navajo blanket and lie down near the wall, because if he should fall it would be a sheer drop of nearly 400 feet. We climbed up the ladder to the terraces and entered one of the rooms. It was clean and smooth like a plastered room. A stocky built, heavy featured Indian was reclining on the floor; a middle-aged, bare-footed Pueblo woman, who was standing near by, grunted welcome. A white-haired, feeble old Indian, who was nearing the century mark, rose slightly from a reclining position and held out

The old Spanish church at Acoma; walls seven feet thick.

A young man of the Acoma tribe in front of his terraced home.

(Carter)

A street in Acoma.

Bargaining for a necklace of beads.

his hand in welcome. He was either a former governor or else the cacique, who is the oldest man in the tribe, whose duty it is to treasure in memory's storehouse all the traditions, lore and history of the tribe. He is, in fact, the official historian, and to the young man who is to succeed him he tells everything he knows concerning the history and tradition of the tribe.

They have store rooms and living rooms in which you will find jerked meat, dried peaches, muskmelons and peppers, skins of animals and some silver filagree work and their wearing apparel. The walls and fire-place are adobe and the chimney made of earthenware pots or tinajas from which the bottoms have been removed.

In 1540 Coronado's expedition started in search of the seven cities of Cibola and later saw and conquered Acoma, and the Spanish padres or priests sought to convert the Pueblo people. The Pueblo Indians are a patient people and after years of patient toil they built an adobe church on the summit of the mesa. Every pound of clay was brought up the steep trail from the valley below on the backs of the Indians. The mesa was bare of soil. This was a herculean task when we consider the church is about 150 feet long and 50 to 60 feet high and the adobe walls are said to be from 7 to 10 feet thick. The timbers are 40 feet long and about 1 foot square, and there is no wood of this size nearer than Mt. Taylor, which is 20 miles distant. It was necessary to push these timbers up the trail after they had been carried for miles on the backs of the Indians.

The old church, which was slowly going to ruin and decay, was recently repaired by the Indians, the same year, in fact, that Prof. Libbey scaled the Enchanted Mesa, 1897. One is indeed fortunate to catch a glimpse of the inside of this church with its curious decorations and paintings. A writer in the *Catholic World*, for January, 1873, 16-703, says: "On one side of the altar was a painting of the Virgin and Child, on the other side was a painting of St. Joseph. On the ceiling above the altar were large paintings of the sun and moon, and here we got a chronological glimmer, the last we found. It was an inscription which stated that the church was renovated in 1802. The Indians said it was done by some artist priest who

came from far away, probably Spain or Italy. There are a pair of bells in the belfry. The Acoma tradition is these bells were a gift to the Pueblo from the Queen of Spain. They say they were given some time before the renovation of the church.

"The estufa at Acoma is an underground apartment descended through a trap door, which serves as a chimney. The smoke-begrimed ladder reaches to the bottom. The chamber is 30 feet in length and 15 feet wide and is used as a general place of meeting or public hall or club room. He found four Indians sitting around a fire, each wearing a blanket, the only other covering being a breech clout. It was the duty of these men to watch the fire, that was always kept burning, waiting for the coming of Montezuma. They were finally relieved by others. Francisco, a Pueblo Indian, unlocked a vast trunk of antique form and solidity and took out a pile of manuscript which he handed with solemnity. The first was a missal; the office of the Mass was copied in Latin, in a fair, plain hand, the work of a Spanish missionary. The ink was turned yellow, but the text was clear and legible; but there was no date. It also contained a register, in Spanish, of births and marriages. The earliest record of the Pueblo they found in the trunk was the record of a baptism in 1725. They then put the papers in the chest and locked it with a padlock nearly as large as a traveling satchel. He then sat down to a dinner of chicken stew made intensely hot by chile (red pepper).

"The women wore dark woolen robes made of two pieces about 5 feet long and 3 feet broad, sewed together at one of the narrow ends with an aperture for the head to pass through. The robe is then gathered round the waist and tied with a string. The arms are bare and encircled at the wrist by brass rings. The feet are bare and there is a thick swathing of buckskin to wrap the lower limbs."

The dead at Acoma are buried in a graveyard, but probably there is not another one like this on the continent. The mesa has a bare rocky floor, not an inch of natural soil produced by erosion; so these patient people built a stone wall about 200 feet square and filled it with soil brought with infinite toil from the desert plain below. The soil was brought in baskets or in earthenware vessels. It is stated that at the outer edge

there is a depth of 40 feet of soil. The priests have said that it took 40 years to complete it. Lummis says: "In the graveyard the dead of centuries sleep. The still form is swathed in the costliest blanket and lowered into their narrow bed and upon the earthen coverlet is broken the symbolic jar of water. From the belfry has pealed the last silver clang when they file to the houses where the shamans are blinding the eyes of the ghost that they may not find the trails of the vanished soul upon the four days' journey to Shipaipu. You may see brought forth jars, hand mills, weapons, ornaments and clothing to be broken and rent that they may go with the departed owner."

In an arid region the great desideratum is water, and the Acoma people are extremely fortunate in having a bountiful supply. There is a great natural tank or reservoir, which is really a depression or hollow in the sandstone rock. Here accumulates the water from the melting snows and the summer cloudbursts, for in the plateau region what rain does fall often comes down in torrents accompanied with a most vivid and startling display of lightning and a fearful cannonading. Although evaporation is rapid in this unusually dry atmosphere, still it is a source of perennial supply without which they could never have defied the Navajos and Apaches in their impregnable home. There is also a spring in the base of the mesa and the Acoma women make constant journey to both sources of supply, carrying the water in their earthenware vessels or tinajas securely poised on the head, which doubtless helps to insure an erect and graceful carriage.

On the occasion of our visit to Acoma quite a number of the men were at the summer pueblo, known as Acomita, which is from 12 to 15 miles distant. There is more water at this village and agriculture can be conducted more successfully, because they can irrigate in a small way and raise peaches, melons, beans and peppers. Agriculture cannot be successfully conducted and good crops raised where the rainfall is less than 20 inches a year without irrigation. At Acoma the rainfall is about 12 inches, yet they succeed in filling their storehouses with sufficient food to last them over winter.

At Acoma there is a very interesting estufa or underground chamber. You descend through a trap door and then down

a ladder and you find yourself in a room about 30 feet long and 15 feet wide. This underground room is a council chamber where matters of state are discussed. The Indians, wrapped in blankets, sit around a sacred fire which is never allowed to go out. It is always replenished with fuel. There they await the coming of Montezuma.

In 1598 Juan de Onate conquered Acoma. The Indians wanted him to scale the cliff and descend into the estufa, but he wisely declined, which was fortunate, as the estufa was full of armed Indians.

The population of Acoma at the present time is between 500 and 600 peaceful Indians who never gave the Government any trouble. They have defended themselves against their enemies, the Navajos and Apaches, in the past. The Apaches, led by Geronimo, have been chased time and again over the border line into Mexico by the United States troops, but the Acoma Indians have been peaceful towards the United States and have never been moved to reservations.

G. W. James states in an article (Scientific American Supplement, Vol. 47-19488,) that Juan de Onate, who conquered Acoma, estimated the population in his epic as 3000, and says when Vincente attacked it the population was 6000 and that only 600 remained after the conflict. The author believes this estimate is entirely too high and greatly exaggerated. As before stated, that eminent authority, Bandelier, states the population of all the Pueblos of the entire Southwest never exceeded 30,000, and the population to-day of all the Pueblo villages is about 9000, so that it is not likely that the population of Acoma at any time in its history ever reached 6000 or that any expedition of the Spaniards ever slew so many. As a matter of fact, one of the most popular and wide-spread errors is the grossly exaggerated statement that the former Indian population of the United States was enormous, some writers' estimates reaching 16,000,000, and that the whites are responsible for their extermination. Major Powell, formerly head of the Bureau of Ethnology, scouts this idea, and Garrick Mallery, of the same Bureau, gives the results of a census taken in 1877, which puts the Indian population of the United States at about 300,000. In many of the tribes a decided increase in population was noticed, and in those tribes in which

a decrease was noticed the cause was sometimes due to absorption by marriage or the ravages of some contagious disease like small-pox. The Indian population of the United States has probably always been small as compared to the vast extent of country over which they roamed. Nevertheless there are reasons why many have the erroneous idea that the former Indian population of the United States numbered millions. The early settlers who sailed up the broad estuaries of the Delaware and Chesapeake and took up their abode on the coastal plain of sands, marls and clay, saw many Indians, because they settled where there was an abundant food supply of ordinary fish and shell fish as well. When, however, the coastal plain was peopled they then settled the Piedmont Plateau, the rocky, rolling country to the westwards, between the coastal plain and the Appalachians; but when the mountains were reached the Indians were not so abundant, and long journeys might be taken and very few met with, the reason being the food supply was not so abundant there. The settlers took home to England exaggerated notions of the total Indian population. Then again, many of the tribes were migratory and changed camps often, which made them seem more abundant to the whites. The Appalachians were just as effectual a barrier to the Indians as to the whites, and our history proves that many of the settlers went south to Georgia where the Appalachians end and came round them to settle on the other side rather than cross them with their belongings. This is not to be wondered at, as the two principal ranges, the Blue Ridge and Allegheny Mountains, are 75 miles apart and were then covered with almost impenetrable forests on account of absence of roads. Then again the French voyageurs and trappers could never have made such long journeys up the Missouri and other rivers and return in safety to civilization if the Indians were as thick as flies. The West is a country of magnificent distances and the present white population has not crowded it as yet and will not for many years to come. There is no doubt that some tribes were almost exterminated by the whites, but as a rule they generally moved to another part of the country or were taken in by another tribe.

The Digger Indians occupied the region roughly between the Sacramento River and the State of Nevada. The Hunting-

ton Expedition, 1899-1903, estimates the present number at from 200 to 250; before association with the whites it is supposed they numbered about 4000. Why they have dwindled down to the present number is a question. They have no tradition of living elsewhere.

Coronado's expedition left Mexico in 1540 in search of gold and the seven cities of Cibola; they traveled through what is now Arizona and New Mexico and it is supposed they came as far east as Kansas. Probably from the Spanish manuscript of Castaneda's narrative most of the information we possess of this intensely interesting expedition is obtained. The following brief account of what part of the expedition thought of Acoma is taken from (the 14th Annual Report of the Bureau of Ethnology, Part I, page 490.) It is a translation of Castaneda's narrative, Chapter 12, of how the people came from Ciyuye to Cibola to see the Christians, and how Hernando de Alvarado went to see the cows: "While they were making these discoveries some Indians came to Cibola from a village which was 70 leagues east of this province, called Ciyuye. Among them was a captain who was called Bigotes (Whiskers) by our men because he wore a long mustache. He was a tall, well-built young fellow with a fine figure. He told the general that they had come in response to the notice which had been given to offer themselves as friends, and that if we wanted to go through their country, they would consider us as their friends. They brought a present of tanned hides and shields and head pieces which were very gladly received, and the general gave them some glass dishes and a number of pearls and little bells, which they prized highly, because these were things they had never seen. They described some cows (buffalos), which from a picture that one of them had painted on his skin, seemed to be cows, although from the hides this did not seem possible, because the hair was woolly and snarled, so that we could not tell what sort of skins they had. The general ordered Hernando de Alvarado to take twenty companions and go with them and gave him a commission for eighty days, after which he should return to give an account of what he had found. Captain Alvarado started on his journey and in five days reached a village which was on a rock called Acuco (Acoma), having a population of about 200 men.

These people were robbers feared by the whole country round about. The village was very strong, because it was up on a rock out of reach, having steep sides in every direction, and so high that it was a very good musket that could throw a ball as high. There was only one entrance, by a stairway built by hand, which began at the top of a slope which is around the foot of the rock. There was a broad stairway for about 200 steps, then a stretch of about 100 narrower steps, and at the top they had to go up about three times as high as a man by means of holes in the rock in which they put the points of their feet, holding on at the same time by their hands. There was a wall of large and small stones at the top which they could roll down without showing themselves, so that no army could possibly be strong enough to capture the village. On the top they had room to sow (?) and store a large amount of corn, and cisterns to collect snow and water. These people came down from the plain ready to fight, and would not listen to any arguments. They drew lines on the ground and determined to prevent our men from crossing these, but when they saw that they would have to fight, they offered to make peace before any harm had been done. They went through their forms of making peace, which is to touch the horses and take their sweat and rub themselves with it, and to make crosses with the fingers of the hands. But to make the most secure peace they put their hands across each other, and they keep this peace inviolably. They made a present of a large number of (turkey) cocks with very big wattles, much bread, tanned deerskins, pine (pinon) nuts, flour (corn meal) and corn."

It is interesting to recall that this quaint account of a visit to Acoma was written about eighty years before the Pilgrims landed on Plymouth Rock.

We who live in Pennsylvania, where the rainfall reaches forty-five inches per year, can scarcely realize how important even a slight rain is in the desert regions of the Southwest; a muddy reservoir means a great deal to the Indians. In the *Extra Census Bulletin of the 11th Census* it is stated: "A great deal of bad feeling existed between Laguna and Acoma on account of a storage reservoir which they had built together for mutual benefit. Many Laguna families own and hold fields in the Valley of Acoma up to a line separating their

territory from that of their neighbors, which had been agreed upon in years long gone by, and their rights recognized down to the present time; but last summer the people of Acoma denied them water from the reservoir, in consequence of which their corn crops were very poor. Laguna sent a delegation of their principal men to confer with a similar body at Acoma and demand their rights. Acoma claimed that there was not sufficient water for their own use, which statement Laguna denied, charging that Acoma was carelessly or intentionally wasting the water. They came to no settlement. The Governor of Laguna then appealed to the Indian Agent at Santa Fe, who paid no attention to his grievances. Finally, through another source, word was sent impressing upon the agent the urgency of the matter and the necessity of its immediate attention and settlement. He came down and went over to Acoma and was not well received. He went back to Santa Fe and the cornfields of the Lagunians in the Valley of Acoma went dry."

EFFECT OF MOISTURE ON THE STRENGTH AND STIFFNESS OF WOOD.

Very little is definitely known about the influence of moisture on the strength of wood, even by those experienced in handling the material. Since the whole subject is one of great importance, the Forest Service has been making a thorough study of it during the past three years and is about to publish the results of its investigation in an exhaustive technical bulletin entitled, "Effect of Moisture upon the Strength and Stiffness of Wood."

The chief points presented by the study are:

1. The relation of moisture to strength follows a definite law which can be graphically expressed. Proper drying very greatly increases the strength of all kinds of wood, the amount of increase in strength depending upon the species and the dryness. The increased strength given to green wood by thoroughly drying it is so great that it will surprise many. For example, the strength of a piece of unseasoned red spruce may be increased over 400 per cent. by a thorough drying at the temperature of boiling water. Strength decreases again, however, as the wood reabsorbs moisture. Air-dried wood, protected from the weather, and containing 12 per cent. of moisture, is from 1.7 to 2.4 times stronger than when green, varying with the species. Stiffness is also increased by drying. These conclusions, however, are drawn from small-sized pieces, not exceeding four by four inches in cross-section, such as are used in vehicle work, tools, etc. Large timbers require years of drying before the moisture is re-