

# SCIENTIFIC AMERICAN

## SUPPLEMENT. No. 1532

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Scientific American, established 1845.  
Scientific American Supplement, Vol. LIX., No. 1532.

NEW YORK, MAY 13, 1905.

Scientific American Supplement, \$5 a year.  
Scientific American and Supplement, \$7 a year.

### RECENT EXPLORATION IN PERU.\*

By ENOS BROWN.

THE University of California has recently acquired one of the largest and most valuable collections of Peruvian antiquities possessed by any institution in the United States. Though surpassed in the number of objects by the collection at Berlin, in comprehensiveness, intrinsic value, and the assistance which it gives archeologists to determine the civilization, manners, habits, and customs of the early races inhabiting the coastal region of Peru prior to the rise of the Inca dynasty, the collection of the California University is unsurpassed.

This valuable archeological data is the result of researches prosecuted by Dr. Max Uhle, as representing the university, at the instance of Mrs. Phoebe A. Hearst, regent, who defrayed all the expenses of the expedition. The explorations were begun in 1901, and conducted in Huamachuco and Trujillo in the Department of De Libertad, Chincha Alta, Chincha Baja, Department of Huancavelica, and Pisco, Huaitara, Ica and Rio de Ica, in the Department of Ica. All these localities are near the coast, between the parallels of 8 deg. and 13 deg. south. Dr. Uhle laid bare the great structures at Pachacamac, Chancay, Huaca del Sol,

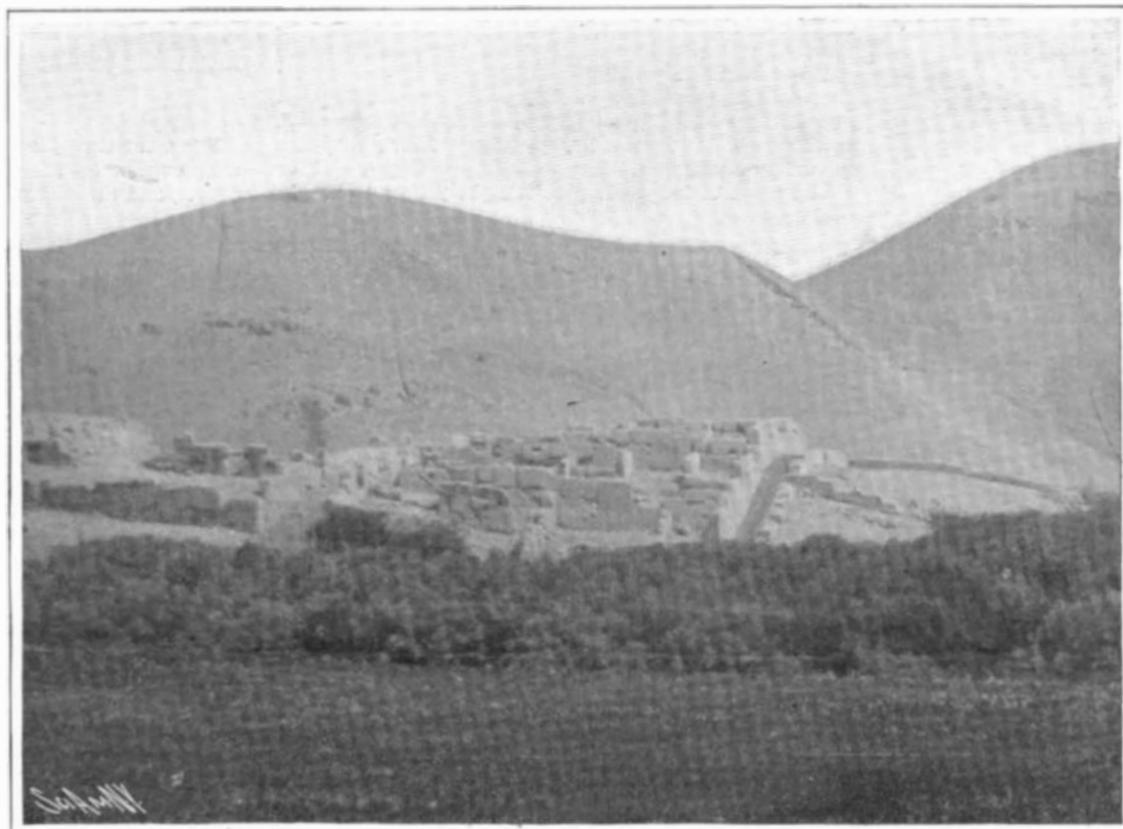
of the scientist being that at least twenty-five hundred years before the rise of the Incas, Peru was inhabited by a highly-civilized race, to whom is to be attributed the fabrication of the most artistic of all the objects secured during his excavations. Assuming the Inca period to begin at 1062 A. D., this would fix the chronology of the objects as early as 1,500 years be-

established themselves by conquest or discovery, introducing there manners, customs, laws, and the arts—a race which, twenty-five centuries after, were overthrown by the Incas and incorporated into the later dynasty. Henceforth the identity of the primitive nation is absorbed in that of their conquerors.

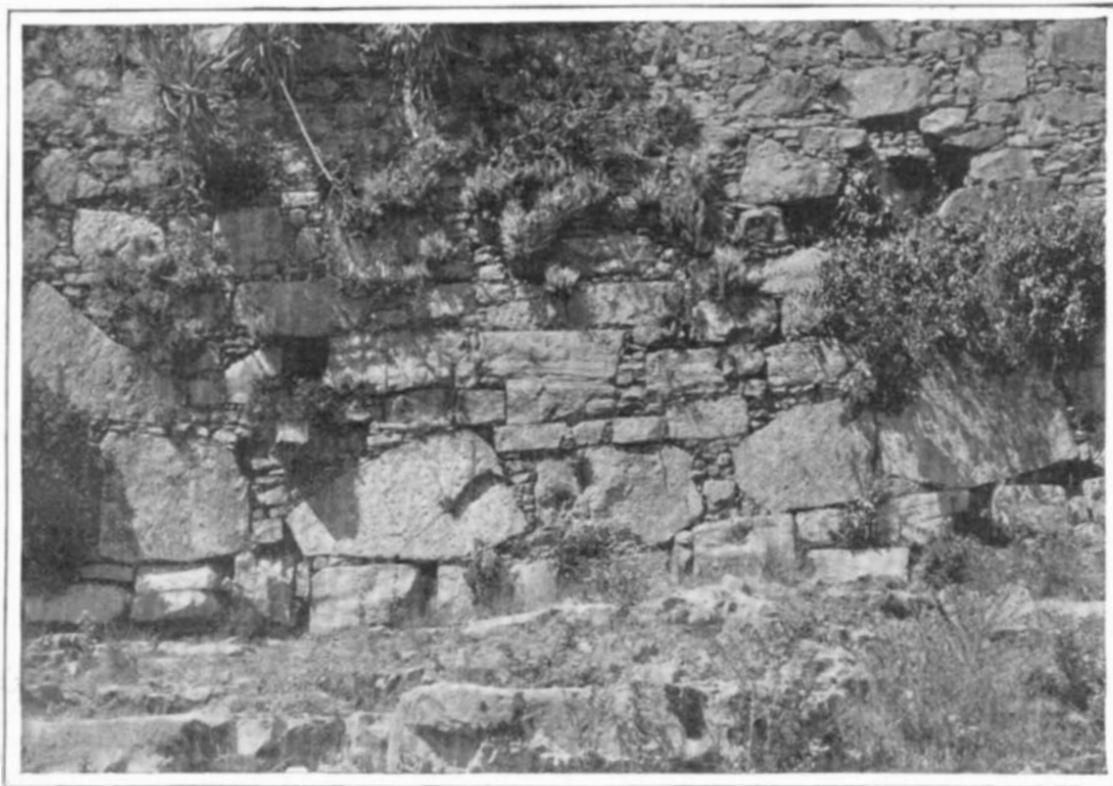
The recent explorations of Dr. Uhle have been conducted with the care of the learned archeologist and with a thoroughness only possible when liberal supplies of money are forthcoming.

Temples, fortresses, and shrines have yielded many secrets, and their fine proportions and, in many instances, beautifully carved façades, attested the architectural ability of the builders and the skill of the sculptors, who displayed the highest talent in adornment. The walls of the temples are massively constructed and of cyclopean proportions. The stones are fitted to their positions with admirable skill, and in no case has mortar been employed, yet they retain their original positions, and to the present have bid defiance to the assaults of time. The era to which the construction of these wonderful edifices may be assigned can only be conjectured.

It is to the graves of the dead that the archeologist turns for whatever knowledge of the ancient races of Peru the world possesses. These receptacles yield certain infor-



RIGHT-HAND END OF PANORAMA OF HUACHA TAMBOINGA.



CONSTRUCTION OF THE SOUTHWESTERN FORTRESS WALL FROM THE SOUTH, HUAMACHUCO.



EASTERN PILLAR OF THE GRAND GATEWAY, HUAMACHUCO.

### RECENT EXPLORATION IN PERU.

and many other places, besides excavating altogether hundreds of graves and bringing to light a vast number of objects illustrating the manners of a primitive age. In an effort to determine somewhat of the chronological period to which most of the objects were to be attributed, Dr. Uhle advances a theory which may or may not be accepted by archeologists, the conclusions

\* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

fore the Christian era. The theory of Dr. Uhle, while highly interesting, remains to be established by later explorations. As yet no traces of a race existing prior to the date assigned have been discovered. Peru is a vast country, and the area explored up to the present time is comparatively limited. The future may disclose the secret. The conclusion, however, is admissible that about 1500 B. C. a strong and enterprising people did invade the country from the north, and

mation of the high stage of civilization to which they aspired. The ruins could have been built by no race without a definite knowledge of architecture and building construction. They domesticated the llama and alpaca, using the fleece for fabrication into clothing and blankets. In the plastic arts they excelled. Many centuries must have elapsed before the natives of the Andes could have produced cultivated varieties of maize and potatoes. Considerable progress is attested

in metallurgic, ceramic, and textile arts. In the numerous utensils fashioned from clay, instances are found of attempts at portraiture. Gold, silver, and copper ornaments of decorative and personal adornment are found, and indicate considerable progress and refinement in their manufacture and design. Cotton cloths, woven in complicated colors and graceful patterns, prove a high degree of skill in the fabrication of textiles. The painted vases and pottery are proofs of considerable talent, while the many articles of utility used in the household witness to the great ingenuity and invention of the people. Battles between the Peruvians and their enemies are depicted upon some of the larger specimens of pottery, with representations of the weapons in use, and are executed with much power and graphic delineation. A system of enumeration and accounting by means of variously colored threads was invented, and they were familiar with the curative properties of plants.

The dead were mummified by burial in a soil impregnated with chemicals or preserved by the intense dryness of a region where rain never falls. It is not believed that the preservation of the body after death was designed, but the custom of interring in the graves the most valued possessions of the dead seems to have been universal. It is to this custom that the archeologist is able to declare with some degree of certainty the standard of civilization attained at different periods, together with the probable time at which interments were made. In all the excavations of Dr. Uhle, the classification of the different cultures was observed. Several layers appear to have been superimposed, each with essential differences. In his opinion, formed after observation of numberless instances and at separate stations, the lowest and earliest of the layers exhibited a higher degree of artistic skill in the fabrication of the objects exposed than the one just above, and so on until the last, or fifth, which exhibited a great deterioration over all its predecessors. Five cultures were thus superimposed, and Dr. Uhle's conclusion is that each represented a definite period of five hundred years. Thus Schliemann at Troy and archeologists in many other instances were enabled to identify dynasties, and to trace periods and catastrophes in ancient localities; even in the absence of historical data.

The differences in the stratifications referred to have been noticed by other explorers in the same regions, who ascribed the changed conditions to the work of widely separated tribes, some exhibiting superiority over others.

This theory of Dr. Uhle, if well founded, proves that no account of the succession of time, as suggested in the stylistic strata, had been thought of. Dr. Uhle is the first, probably, to advance the proposition that each stratum, or culture, represents a definite period, which he conjectures to be five hundred years, the total being twenty-five hundred years for the five cultures. As no traces of former inhabitants have been found, and as it would appear impossible for the original race to have at once developed so high a stage of civilization without having left some indications of graduated progress, the conclusion is irresistible that the first culture represents an invasion of a powerful and well-developed people, somewhere about 1,500 years before the Christian era. In commenting upon this feature of Peruvian history, Dr. Uhle remarks: "It will now be easier to give the correct chronological position to each new Peruvian culture which may be discovered. Moreover, the results are of importance in investigating the connection between the cultures of Central and South America, for it is not improbable that if connection existed between the north and south, it took place during the earliest period. As the Peruvian cultures are now being classified according to age, it would be important to know by similar means the relative ages of Central America and other South American cultures; for connection can have existed only between contemporaneous cultures, and only such, therefore, should be compared if fruitful results are to be expected."

The explorations are now being conducted at Cuzco.

#### LOGGEPOLE PINE.

The lodgepole pine, which is known in the Sierras of California as tamarack pine, and in Colorado and Montana is sometimes called white pine, jack pine, pinyon, and scrub pine, bears the common name of "lodgepole" from the fact that the Indians used its long slender trunks as supports for their wigwams or lodges. Its geographical range is along the Rocky Mountains from Alaska to New Mexico and westward to the Pacific coast. In the United States it is found in merchantable quantity and dimensions on the spurs and eastern slopes of the Rocky Mountains throughout southern Montana, Wyoming, and Colorado, in the Bitter Root Mountains of Idaho, the Uintah Range in Utah, and in the Big Horn Mountains of Wyoming. The Bureau of Forestry is studying the species throughout this range of its best commercial distribution.

Lodgepole pine grows at all altitudes between 3,000 and 10,500 feet above sea level. In the Gallatin Mountains of Montana, and in the mountainous country south and east of Yellowstone Park it reaches its largest size at elevations between 4,500 and 8,000 feet. In Colorado, however, toward the southern limit of its range, the conditions which are necessary to its best growth are found between 9,000 and 10,500 feet elevation.

Lodgepole pine is valuable, for one reason, because it grows on high mountain slopes, and also on old "burns," where other trees find difficulty in obtaining

a foothold. It readily adapts itself to most diverse soil conditions, but thrives best where there is considerable moisture. Its roots accommodate themselves to the shallow soil common in the localities where it grows. At a very early age this tree produces cones in large quantities, and after it is ten years old the seeds are generally fertile. The cones sometimes open and distribute the seeds as soon as they are ripe, though more commonly they remain on the trees for years with their seeds carefully preserved beneath the scales. In many cases squirrels cut off the closed cones and hide them away in the ground. If a fire occurs before the seeds are eaten, it will cause the cones to open and set them free. As a rule, however, the cones of many seasons remain on the trees until a fire comes along, and, by heating them, liberates the seeds, when a dense growth of seedlings follows.

In many localities where lodgepole pine now grows, the ground was originally covered with Engelmann spruce in mixture with red fir and other species. Repeated fires laid waste these forests, and prevented their reproduction by destroying the seed and the thick forest floor of decaying leaves and litter, which is absolutely essential for the seed germination of these species. Lodgepole pine, however, thrives on an impoverished soil, and its great seeding capacity and the ability of the cones to withstand fire cause it to spread quickly over burned areas. In places where the pine has carpeted the ground again with a quantity of forest litter, and where lumbering has thinned the forest sufficiently for the light requirements of Engelmann spruce and red fir, these more valuable trees are found taking the place of lodgepole pine. Thus if fires can be kept out of the woods of this region, these more important trees can be produced in many places where they are now virtually extinct.

The wood of lodgepole pine is light yellow to nearly

other advantage to the forest in that it offers a means of utilizing the upper parts of trees cut for lumber, which in the ordinary way of logging are left on the ground to become dry and increase the danger of fire. It also makes possible the thinning of pole stands which contain few or no trees large enough for ties, but which are so dense that the trees have almost stopped growing.

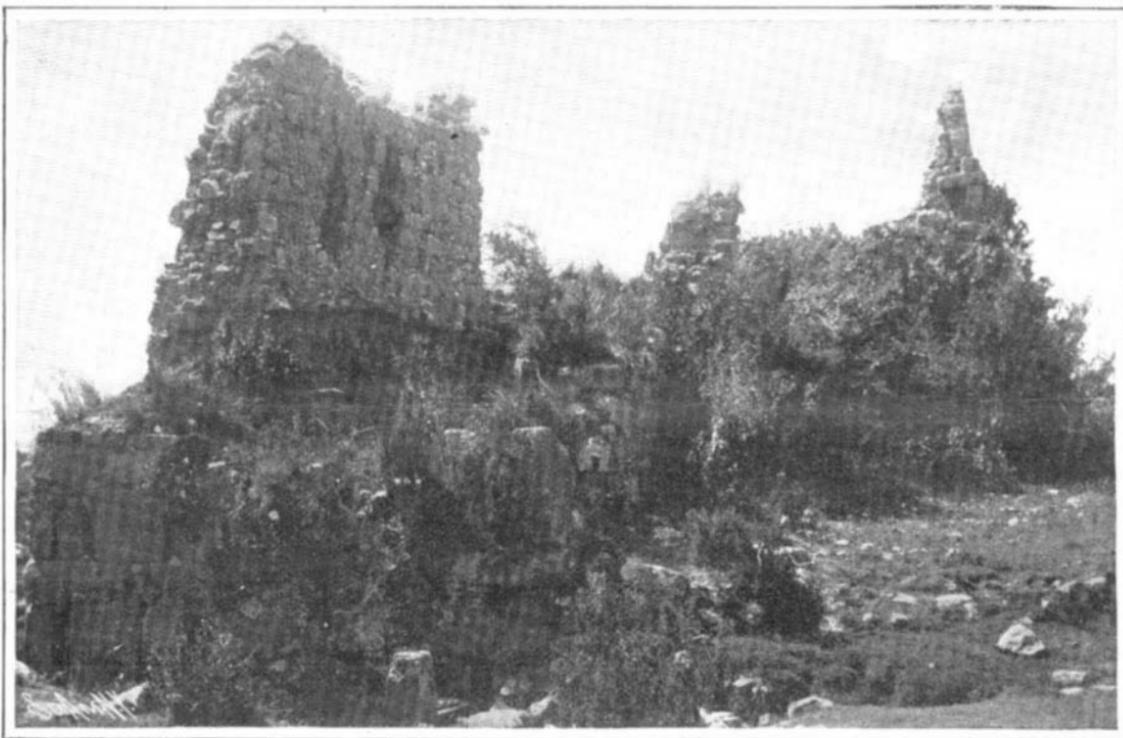
By far the larger part of the merchantable lodgepole area is within existing or proposed Federal forest reserves, where the lumbering regulations which the government put into effect some time ago will protect and benefit the forests.

Other objects of the Bureau of Forestry in this study are to ascertain the rate of growth of the tree, and how it may be increased; to better existing lumbering regulations; to devise a system of fire protection; and to extend the commercial uses of the wood. A controlling consideration is the need of maintaining the forests on all the mountains they now cover, and of causing them to spread more widely, if possible, since the most important function they can perform is to safeguard the watersheds they include. This study will enable the Bureau to carry out more effectively the work of forest reserve management lately intrusted to it by Congress. The results of the study should also prove of large value to railroads and private owners, who hold a great many odd sections of land all through the lodgepole pine region.

#### RECEPTACLES OF QUARTZ AND THEIR USES IN CHEMISTRY.

By M. BERTHELOT.

For some time past we find in commerce a variety of recipients or tubes of a new material known as fused quartz, and these are distinguished by special qualities,



GREAT SOUTHWESTERN GATE OF FORTRESS EL CASTILLO, HUAMACHUCO.  
RECENT EXPLORATION IN PERU.

white in color, with a coarse but straight grain. It is more resinous than the eastern white pine, but less so than the yellow pines of the South. It is soft and easily worked, and would make excellent finishing lumber were it not for the abundance of small though hard knots, and for its tendency to warp and check with seasoning. Without doubt the best use of lodgepole pine at present, and the one to which it is most largely put, is for railroad ties and mine props; but to be utilized with the greatest profit for these purposes the timber must first be subjected to preservative treatment. The Bureau of Forestry has for some time been conducting, in Montana and Wyoming, exhaustive tests in seasoning and in preservative treatment of this pine, and a comprehensive bulletin on the subject is now in preparation.

During the season of 1903-4 between 1,300,000 and 1,400,000 lodgepole ties were cut, most of which were treated with preservatives. The cut of this season will exceed this number, and without doubt the use of lodgepole pine for ties will increase yearly. Trees between 11 and 14½ inches in diameter breasthigh are hewed; those larger are logged and sawed, as the hewers refuse to work them. When a tree reaches 11 inches in diameter it is mature for ties; this makes it possible to remove a quantity of material from the dense natural forests as soon as a number of the trees have reached that size, and thereby to stimulate the smaller ones to a more active growth. At the same time a new generation may be started in the openings from the seed of the felled trees.

Great quantities of lodgepole pine are also used for props in the numerous mines of the region where this tree grows. The timber is cheap, and in its natural condition answers for temporary purposes in mine development; when well seasoned or treated with preservatives it may be used for permanent construction. Miners use poles as small as 5 inches in diameter at the top, and this demand for small timber works an-

such as their infusibility at temperatures as high as 1,400 degrees C., their resistance to acids, as well as sudden cooling, etc. I recently undertook some experiments with this material analogous to those which I made upon glass vessels and tubes sealed by the blow-pipe. The latter were designed to be used for different researches, notably those relating to slow reactions carried out at constant temperatures and under pressures as high as 200 atmospheres. But the applications of this method are limited by the temperature of softening and fusion of the glass, and I could scarcely work higher than 550 degrees C.

By the use of vessels made of fused silica, it is possible to reach temperatures as high as 1,500 degrees. Some precautions must, however, be taken with the use of such vessels, and it seems useful to make some general observations in this case, before describing some of the new experiments made in my laboratory and the new problem I attempted to solve by their use.

The quartz tubes of small size may be worked by the oxyhydrogen blowpipe or more easily by the oxygen-acetylene blowpipe, which gives much higher temperatures. They can be drawn out or welded like glass tubes, but care must be taken against the cooling, which is quicker. The tubes which I generally employed are those of 10 millimeters (0.4 inch) diameter, some 100 millimeters (4 inches) long. Their capacity after sealing varies between 4 and 5 cubic centimeters. The thickness, which is about uniform, is some 0.7 millimeter. The resistance to internal pressure is near 3 atmospheres and this lasts up to the commencement of the softening point, between 1,300 and 1,400 deg. C. If need be, we introduce solid bodies in definite weight into the tube before drawing out the end. Then the latter is drawn, and can be fused to a capillary tube which is thicker and more convenient to join to a mercury pump. The mercury of the latter should never be allowed to come into the quartz tube. The pump serves to make the vacuum and then to introduce, by the