

EXPLORATION IN PERU.

THE Yale Peruvian Expedition of 1911 made a number of discoveries which, either for lack of time or means, could not at that time be given the attention they deserved. The most important of these

the auspices of Yale University and the National Geographic Society, had for its chief objects the further study of these two discoveries and also the completion of certain topographical work planned for 1911, but not finished at that time.



FIG. 1.—Machu Picchu. Sacred Plaza. Chief temple, east side, interior. Copyright by the National Geographic Society.

finds were the ruins of Machu Picchu, in the Grand Cañon of the Urubamba, below Ollantaytambo, and a small quantity of human bones apparently inter-

The staff of the second expedition included, besides myself as director, Prof. H. E. Gregory, Silliman professor of geology in Yale University, geologist; Dr. G. F. Eaton, of the Peabody Museum of Yale University, osteologist; Mr. A. H. Bumstead, formerly of the United States Geological Survey, chief topographer; Messrs. K. C. Heald and R. Stephenson, assistant topographers; Mr. E. C. Erdis, archaeological engineer; Dr. L. T. Nelson, surgeon; and Messrs. P. Bestor, O. Hardy, and J. P. Little, assistants.

The Cuzco Valley was carefully mapped by Mr. Bumstead and his assistants, and this map will be published in connection with the report on the geology of this valley now being prepared by Prof. Gregory. The geological work undertaken by Prof. Gregory consisted in part of a study of the gravel deposits near Cuzco, and the relation in age and position of these gravels to the remains discovered in 1911. The result of these researches has not confirmed us in the opinion that the human bones found in 1911 are of very great age. It seems probable, on the other hand, that, owing to recent filling and recutting of the valley, the bones may be of recent origin. Prof. Gregory also carried on a general examination of the structure and stratigraphy of the Cuzco Valley with a view of constructing a geological map of the area tributary to the Huatanay River. The region was found to consist chiefly of sedimentary rock of pre-Tertiary, Tertiary, and Pleistocene age. During glacial times a lake occupied the upper part of the valley.

Not far from Cuzco, in the Apurimac Valley, near Ayusbamba, a small amount of vertebrate fossil material was found and collected by Dr. Eaton. His report on these fossils, which include the remains of both ancient horse and deer, will be published in the *American Journal of Science*.

Anthropometric measurements were made of 145 Indian men in the department of Cuzco, and front and side view photographs were taken of each subject. The Indians represented sixteen provinces and sixty towns. Thirty-eight measurements were taken of each subject. Photographs of many Indian women were also taken in Cuzco and vicinity. The anthropological material collected by Dr. Nelson has been placed in the hands of Prof. H. B. Ferris, Hunt professor of anatomy in Yale University, who is preparing a report which will be published in the near future.

The ruins of Choquequirau, which had been visited

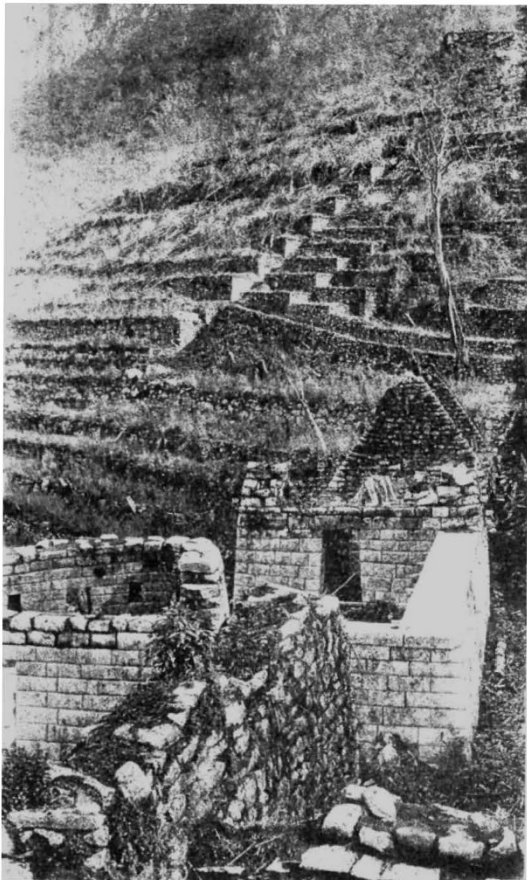


FIG. 2.—Machu Picchu. Princess group. View of round tower and ornamental wall. Shows in distance the agricultural terraces. Copyright by the National Geographic Society.

stratified with what seemed to be glacial gravel near the city of Cuzco.

The Peruvian Expedition of 1912, sent out under

by the present writer in 1909, were reached from the north side by Messrs. Heald, Eaton, and Nelson, of the expedition. A few boxes of bones and potsherds were collected. This party had great difficulty in carrying out its undertaking owing to the fact that no guides could be procured, and the way lay through a very

Spanish conquerors. But the ruins of Machu Picchu do not appear to have been connected with the later history of the Incas. These ruins are located on top of a ridge in the most inaccessible part of the Urubamba Cañon some 2000 ft. above the rapids, and some 8000 or 9000 ft. above sea-level.



FIG. 3.—Machu Picchu. Sacred plaza and Intihuatana Hill from boulder caves. Copyright by the National Geographic Society

rough country, where scarcity of water and a plague of flies were added to the many other difficulties.

Interesting but not highly important ruins were discovered by the writer near Palcay, in the Aobamba Valley, in the vicinity of an impressive group of glaciers hitherto unmapped and not reported. An interesting feature of one of the groups of ruins in this valley is that it appears to be exactly oriented; its two cross streets seem to run on the true, not on the magnetic, cardinal points.

The topographic cross section of the Andes along the 73rd meridian, begun by Mr. Kai Hendriksen in 1911, was completed in the face of great difficulties by Messrs. Bumstead, Hardy, and Little, and will be published in connection with the report of Prof. Isaiah Bowman, the geographer-geologist of the 1911 expedition.

The most interesting, and in many ways the most satisfactory, results of the 1912 expedition were in connection with the ruins of Machu Picchu. In 1911 the present writer, while engaged in a search for Vitcos, the last Inca capital, discovered a number of hitherto unreported groups of ruins in the valley of the Urubamba and its tributaries. The group known as Rosaspata, near Puquiura, in Vilcabamba, is believed to be that which the chroniclers called Vitcos, the capital where the young Inca Manco, set up by Pizarro, fortified himself after his revolt against the

The presence here, in a wonderfully picturesque position, of a remarkably large and well-preserved abandoned city practically untouched by the hands of the spoiler, and apparently unknown to the Spanish chroniclers, led us to undertake to clear the city of its

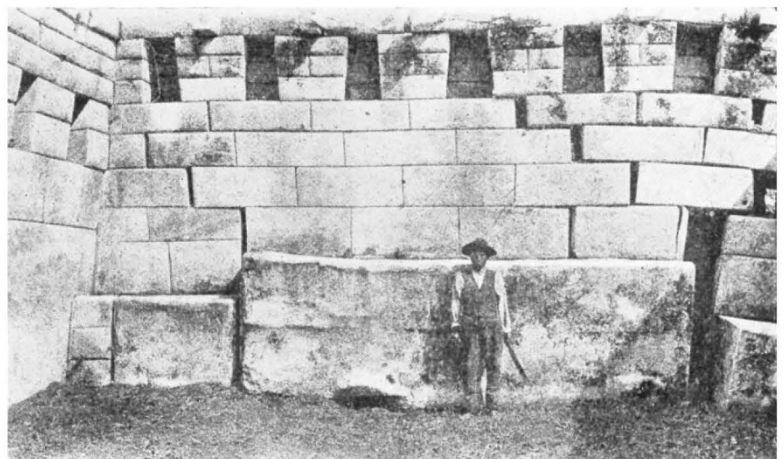


FIG. 4.—Machu Picchu. Sacred plaza. Chief temple, north wall, interior, showing the cracking caused by the settling of the east wall. Notice the care with which the size of the stones is made to decrease gradually in each ascending tier. The main altar stone is 14 ft. in length. Copyright by the National Geographic Society.

extensive jungles and to excavate the ruins. Many difficulties had to be overcome, but we were eventually successful in locating more than one hundred burial caves. The excavation yielded a considerable amount of anthropological material, including human and

animal bones, a large number of potsherds and a few stone, silver, and bronze implements. Nothing of gold was found, and only half a dozen small silver pins and pendant discs.

The city itself contains about two hundred edifices. Most of the walls are standing and many of the terraces are in good repair. The roofs of the houses disappeared long since, and a large part of the city was completely overgrown with a tropical forest. Trees 2 ft. in diameter were found growing on top of the walls of the houses, and in some cases on the very peaks of the gables. A majority of the houses are of a storey and a half in height with gable ends.



FIG. 5.—Machu Picchu. City gate, interior. Notice the lock hole containing granite cylinder on left and projecting ring stone over the lintel of the doorway. The gate, probably of wood, was either swung from the ring stone or fastened to it and balanced by a log fastened to the stone cylinders in the lock hole on either side of the gateway. A similar device was used also in the entrance doors to each isolated group of houses. Copyright by the National Geographic Society.

Perhaps the most conspicuous features of Machu Picchu are the number of stairways and the large number of windows in the houses. There are more than a hundred stairways, large and small, within the city. Some of them have more than 150 steps. In some cases the entire stairway of from six to ten steps was cut out of a single granite boulder. The water supply must always have been very scarce. We were there during the dry season, and with forty workmen found the available springs only barely sufficient for cooking and drinking purposes. The town may have had a population of two thousand people on occasion.

In the four months of field season, the ruins were

practically cleared of all forest growth, and a large part of the débris was burned and removed. From twenty to forty workmen were kept continuously at work under the direction of Mr. Erdis.

One of the most interesting facts brought out as a result of the clearing was that the city was at one time divided into wards, or clan groups, each of which had but one entrance, a gateway furnished with the means of being solidly fastened on the inside. Each one of the clan groups has certain distinctive features, one having its own private gardens, another being distinguished by the ingenuity of the stone work, while still another is marked by having monolithic lintels over the doorways, and unusually steep gables. Machu Picchu contains examples of nearly every variety of architecture known to the Incas and their predecessors on the Peruvian highlands, including fine specimens of the most exquisite stone cutting that can be found anywhere in the New World. One of the most interesting structures is a temple containing three conspicuously large windows. Another is composed of several large blocks of granite, three of them being more than 12 ft. in length. These are shown in the accompanying photographs.

Machu Picchu is in a remarkably good state of preservation, and its architecture has not become confused by Spanish efforts to build churches and villas. The people who lived here were masters of the art of stone cutting. They know how to make bronzes, and they had considerable artistic sense. Their pottery is characteristically Inca in form and ornamentation, but some of the patterns and shapes are practically unknown in European museums.

Just where Machu Picchu comes in the history of the Incas is still a puzzle. It is too early to speak definitely. In many ways it appears to be closely related to Cuzco. One of the buildings bears a strong resemblance to the famous Temple of the Sun, now the Dominican Monastery. It is safe to say that Machu Picchu was essentially a city of refuge. There is no part of the Andes better defended by nature than this Grand Canon of the Urubamba. Granite precipices, frequently more than 1000 ft. sheer, present difficulties of attack and facilities for defence which cannot be excelled. Furthermore, the natural defences were strengthened by the construction of high walls and a dry moat.

A careful survey of the ruins and the neighbouring cañon was made by Mr. Stephenson. More than seven hundred photographs of the ruins were taken by the writer, who has in hand the preparation of a complete report on the ruins and the material collected at Machu Picchu.

HIRAM BINGHAM.

CIVIL SERVICE ESTIMATES FOR SCIENCE AND EDUCATION.

THE Estimates for Civil Services for the year ending March 31, 1915, are being issued as a series of Parliamentary Papers. The following particulars referring to the money under this heading to be devoted to scientific work and to higher education are taken from the paper entitled, "Class IV.—Education, Science, and Art."

Under the heading, "Scientific Investigation, etc.," we find that the grants in aid for 1914-15 amount to 100,697*l.*, which represents a net decrease of 11*l.* on the amount voted in 1913-14.

The grants enumerated under the heading of the Royal Society amount for 1914-15 to 25,550*l.*, as compared with 27,150*l.* in 1913-14. This grant includes the usual 4000*l.* in aid of scientific investigation and 1000*l.* for scientific publications; the remainder of the amount is for the expenses of the Magnetic Ob-