THE GALLEYS OF LAKE NEMÍ.

Buried under the waters of Lake Nemi lie two pleasure galleys, which belonged to the Emperors Tiberius and Caligula, and which contain art treasures that have been coveted for five hundred years.

It was Julius Cæsar who first hit upon^cLake Nemi as a summer resort; for on its banks he built a villa, splendid in these days, but later far outdone in brilliancy by the floating residences of his successors.

From pamphlets which have been published by Prof. Emilio Giuria and Signor Eliseo Borghi, it seems that Leon Alberti, an archbishop, made some attempts in the fifteenth century to recover the treasures buried in the lake. A hundred years later a fairly systematic exploration of the bottom of the lake was undertaken by De Marchi, a French engineer, who seems to have been the first to have made a fairly thorough survey for that day. He made a few drawings of the probable appearance of Caligula's galley as he conceived it, and from his designs a Flemish engraver prepared what he conceived to be its original appearance.

Although stray relics were found now and then, no further systematic effort was made to recover the contents of the old hulks until Signor Eliseo Borghi came upon the scene in 1895. Divers were engaged, and the two galleys located, measured, and carefully examined. From both, bronzes, pieces of wood, anchors, and ornaments of all kinds were collected.

Of the two vessels, the larger measures about 230 feet in length and 80 feet in beam, the smaller 200 feet in length by 65 feet in beam. It is because of their unusual size (war galleys were much smaller) that the vessels, it is inferred, must have been used as

LINE OF SIGNOR MALFATTI'S PROPOSED TUNNEL FOR THE TEMPORARY DRAINING OF LAKE NEMI 425. 400 800 RELCEIA 295 OUTLET® TUNNEL Genzanes

IF THIS PLAN IS CARRIED OUT, THE WATER OF THE LAKE WILL FLOOD THE VALLEY OF ARICCIA.

pleasure barges. Among the more interesting relics which have been brought to the surface, and which are herewith pictured, may be mentioned a lion's head, cast in one piece and beautifully worked. A ring is held in the lion's teeth. Clearly, the piece formed the top of a wooden column, because wood is still attached to it. Still other pieces which, like this, were

> intended for the reception of ropes, are wolves' heads, hyenas' heads, and the heads of various animals. A remarkable specimen is a Medusa's head, mounted upon a cap. An interesting rectangular bronze grating, with the two side bars by which it was held in place, is likewise included among the exhibits. The bars have projections at their ends, so that they could be fitted into beams or metal pieces. Inasmuch as there are no holes, it may be inferred that the grating was placed horizontally and held in position by its own weight.

Curiously enough, some pieces of lead pipe were also found, and these bear ample evidence that the galley from which they came had been the scene of the pleasures of Caligula. They bear the inscription C. CAESARIS AUG. GER-MANICI, which was the official name of Caligula. Lead plates were also used in sheathing the vessel. They were held by flat-headed copper nails some two inches long. Why lead should have been used is not very clear; it does not form a



Redrawn from Illustrated London News,

Lead Plate with embedded nalls, and an iron-shod pawl. 2. Diver's Sketch of the Galleys. 3. Moldings of glazed enamel. 4. Mortise and tenon; joint secured by pins (side and plan views). 5. Reconstruction of the Deck Structure; plan and longitudinal section. 6. Ornamental Woodwork. 7. Small Roller and Hinge. 8. Metal-shod Beam. 9 and 10. Diving Bells used during the researches of 1539. (From De Marchi's descriptions.)
Reconstruction of the Galley of Tiberins, from an engraving signed "Del Galle," sixteenth century. 12. Terra Cotta Tube (perspective and sectional views); stanchion and section of same; little latch; joint with nalls and mortise. 13. Relics from the galleys. Augural hand; above it lead pipe. To the left, grating. To the extreme left, fragment of the side of the galley covered with sheet lead. At the bottom, bronze rope-rings held in the mouths of animals. 14. Metal caps. 15. How a diver saw Caligula's Galley. 16. Nalls bent on being driven into knotty wood.

RELICS FROM THE ROMAN GALLEYS IN LAKE NEMI.



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THE GORGEOUS GALLEY OF TIBERIUS AS IT PROBABLY APPEARED WHEN AFLOAT ON LAKE NEMI.-[See page 25.]

Signor Borghi recovered many pieces of mosaic, tiles. porphyry, and serpentine, intermixed with colored glass and enameled by fusion. These were probably used for paving the decks.

On the galleys supposed to have been used by Tiberius relics were obtained quite similar to those from Caligula's vessel. One of these has the form of a bronze cap for the end of a beam, and carries a hand, which the Roman navigators always used as a talisman.

From the investigations of the divers we may glean much of the construction of the vessels, even though we may not be able to present an absolutely accurate restoration. Some of the wood which was used was soft, and some hard and resinous. The soft wood, employed mainly for sheathing and deck planking, is white pine, hewn, no doubt, on the shores of Lake Nemi. The harder wood is either red pine or larix. just which it is difficult to determine, because decomposition has set in. Oak pins were employed to hold down the planking. In sheathing the vessels the planks were placed edge to edge and joined by wedges. As the planks swelled, the edges formed a tight joint. Long copper nails were driven through the planks at intervals of four or five feet, the nails passing through one plank down to the next, and the succeeding nail being driven through the second plank to the third. Short copper nails held the planks themselves to the beams of the framework. To render the hull particularly stanch, an outside layer of hard plaster was employed, upon which a woven fabric was laid. Then came the above-mentioned sheathing of lead plates held by flat-headed nails two inches long.

The construction of the beams of the framework is often ingenious. A beam was sometimes formed of a single piece, and in other cases of two superposed pieces nailed together. In order to form a long beam. two pieces were sometimes placed together with a lap joint, and the whole fastened by three large copper nails.

The deck flooring was made of planks nailed to the beams. A method of joining the planks by keys was also employed, the keys running in two rows alongside the beam. Although mostly copper nails were found, it is not unlikely that nails of iron were also employed. At all events, one of iron was found: the others (unless they are still undiscovered) have probably rusted away. The copper nails range in length from twenty inches to one inch; the larger may more properly be called spikes. In driving these soft copper nails it not infrequently happened that a knot or other obstacle was encountered. The result was that they curled into the form of a spiral.

In order to recover these ancient vessels, many projects have been proposed. It is obviously impossible to raise the crumbling hulls bodily. Therefore, Malfatti has suggested the draining of the entire lake by means of a tunnel. Prof. Giuria, however, has suggested the use of the old Roman outlet. According to Malfatti's scheme, the valley of Ariccia would be partially flooded. According to Giuria's scheme, the water will be piped across the valley of Ariccia, and will be made to drive an electric plant. If the bottom of the lake is ever exposed, the bodily removal of the two old galleys will present considerable difficulty. Prof. Giuria has suggested the use of iron cradles built around the barges, upon which cradles the barges will be pulled out upon tracks. -

Geology and Geography at the Ithaca Meeting of the American Association for the Advancement of Science,

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BY EDMUND OTIS HOVEY.

The Ithaca meeting of the American Association for the Advancement of Science, June 28 to July 3, was an experimental return to the old plan, honored by many years' observance, of having a meeting in the summer. It was, however, only a partial return to that plan since this was a "special" meeting without the attractive features of the annual meeting, the addresses of retiring president and vice-presidents and faunas, which have given rise to some confusion in the nomenclature, and the author has devoted much time and thought in laboratory and field to straightening out the order of succession.

The second paper was on "Abyssal Igneous Injection as a Causal Condition and as an Effect of Mountain-building," by Dr. R. A. Daly, geologist of the Canadian International Boundary Commission. In the absence of the author the paper was read by Dr. A. C. Lane. The paper hypothetically extends the contraction theory of mountain-building to cover the explanation of igneous intrusion, geosynclinal downwarps, the location of mountain ranges, and the common association of intense mountain-building with the batholithic (deep-seated) intrusion of liquid igneous magma. Among the chief postulates laid down are two of particular importance: 1. An earth-crust about 25 miles thick, within which is a substratum which, on account of its high temperature, acts as a viscous liquid. 2. The division of the crust into a shell of compression about five miles thick, overlying a shell characterized by cooling tension. The shell of tension extends from the bottom of the shell of compression down to the substratum.

One effect of cooling tension is to produce cracks in the lower shell. These are only partly closed by the shearing of mass against mass. These cracks permit the dike-like injection of the substratum into the crust. The hydrostatic and expansional pressures normal to the walls of such dikes cause lateral creep and special condensation of matter in the shell of tension. A down-warp of the earth's surface results, and the sedimentary filling of the surface depression prepares the way for mountain-building. Mountain-building is accomplished through the shearing of the shell of compression over the shell of tension, breaking the solid continuity between the two shells, permitting the injection of vast bodies of magma from the substratum into the shell of tension, and relieving all the accumulated stresses. From the discussion which followed the reading of the paper it was evident that the geologists of the country would not return without protest to the theory of a fluid interior of the earth.

"Brewster's Neck, Connecticut," was the subject of a geographical paper by Dr. F. P. Gulliver, of Norwich Town, Conn., which in the absence of the author was read in abstract by the secretary of the section. Brewster's Neck is a delta which was formed in a glacial lake and is a form for which the author proposes the name "delta-terrace." A new point in regard to the theory of the formation of waterlaid glacial deposits is believed to be the following: When the margin of the ice-sheet was retreating by the annual summer melting faster than ice was supplied from Labrador, the ice remained longest in the valleys. Some of these valley tongues of ice would stand higher than the surrounding hills, and between the tongues standing water would occur, in which the streams from the melting ice would deposit their sand and gravel. Where the supply of rock waste was sufficient to fill up the space between these ice-blocks and the surrounding hills or other ice-blocks, a flat-topped delta-terrace would be formed; where the supply was not sufficient to fill up the body of water, lobes would occur. The author believes that the Brewster's Neck delta-terrace was formed between a block of ice occupying the vallev of the glacial Thames River and a block occupying the tributary glacial Poquetanock Valley.

The next paper on the programme was by Dr. E. O. Hovey, of the American Museum of Natural History, and was entitled "Notes on the Geology of the Guaynopita, Chihuahua, Mexico, Mining District." The Guaynopita district lies in the heart of the western Sierra Madre in northern Mexico. Here are shown cretaceous limestone, schist, and gneiss overlain by volcanic rocks (andesites) and invaded by granite intrusions. Later volcanics (basalts, andesites, and rhyotites) have supervened, great inclosed basins have been formed and filled with wash from the surrounding hills, resulting in the making of local sandstones and conglomerates. The whole region has been deeply dissected by the Aros and its tributaries. Several lantern slides were shown in illustration of this namer

of débris on the divide between the Santa Clara and Pajaro valleys, and probably had a variable channel, which may have allowed the fishes of the Sacramento-San Joaquin River system to pass around into the Lorenzo, Pajaro, and Salinas rivers, accounting for the present range of species.

"The Geology of Coon Butte, Arizona," as worked out by D. M. Barringer and B. C. Tilghman, of Coon Butte, was presented by Prof. Branner.

Coon Butte is a strange, crater-like hole with raised rim in the plain about six miles east of Flagstaff. Arizona, which has attracted much attention on account of its form in the midst of otherwise horizontal beds of sandstone and limestone. The nearest volcanoes are in the San Francisco Mountains, several miles distant. Coon Butte is the place from which have come the hundreds of large and small fragments of what is known as the Canyon Diablo meteorite. The authors have made extensive excavations and borings here, and they consider the evidence as all pointing to the impact of a great meteorite as the cause of the hole, although they have not yet found the main mass.

The field meeting of the section consisted of three excursions. Saturday the party went to the vicinity of Union Springs for a stratigraphic study of the Upper Silurian strata. Monday was devoted to the examination of the Ithaca delta and the upper (southern) end of Cayuga Lake, the Devonian rocks exposed along both shores and the Taughanock gorge and falls. These two excursions were conducted by Prof. Gilbert D. Harris, of Cornell University. On Tuesday the section visited Enfield Glen under the guidance of Mr. R. H. Whitbeck, of the State Normal School, Trenton, N. J. This was a study in glacial and post-glacial geology, observing the moraines of the Cayuga Valley, old and new, and hanging valleys, and the great new gorge which has been carved out of the strongly jointed Devonian shales since the last retreat of the ice-sheet. A feature of this excursion was an address by Mr. C. R. Dryer, of the State Normal School, Terre Haute, Indiana, upon the geography of the Finger Lake region of Central New York.

Section E can claim, too, one of the principal lectures of the convention, which was delivered by Prof. Branner upon the scientific aspects of the recent California earthquake. showing that the principal cause of the quake was lateral and nearly horizontal displacement amounting to sixteen feet at maximum along an old fault plane. The members of Section E feel that the Ithaca meeting of the association was a genuine success. The officers of the section are Dr. A. C. Lane, State Geologist of Michigan, chairman, and E. O. Hovey, of the American Museum of Natural History, secretary. The next meeting of the section will be with the association at large in New York city during the week after Christmas of this year.

A New Design in Electric Elevators.

A new and extremely simple design of electric elevator has been recently called to the attention of the public, and the new system is said to combine absolute safety, economy of power, and economy of space. In the latter particular at least it represents a great advance over the present types. All the driving mechanism in this case is bolted to the under side of the car platform, and consists entirely of a horizontal drum revolved by an electric motor. On the periphery of the drum is fitted a spiral track, which engages and travels in two series of rollers set in the guide posts supporting the car. The motor being started, the drum revolves, and the car ascends or descends as desired. As to its economy, this system has the advantage enjoyed by all electrically-driven machinery, in that it consumes power only when in actual use, and another recommendation is that all the machinery being contained in the elevator shaft, much valuable floor space is saved. It is claimed to be absolutely safe, and requires no safety devices of any character. The electric elevator of this design is particularly valuable where there is an intermittent demand for its use and where great speed is not required.

the prestige of such a gathering.

Section E, the section comprising the geologists and geographers of the association, held most of its meetings in the field in the shape of excursions to points of geologic and geographic interest in the vicinity of Ithaca. The first business day of the convention, Friday, was, however, devoted to the reading of set papers, after the passage of suitable resolutions referring to the recent sudden death by pneumonia of former vicepresident and chairman Prof. Israel C. Russell, of the University of Michigan.

The first paper read was by Prof. Henry S. Williams, of Cornell University, and was entitled "Revision of the Geological Section Passing Through Ithaca, N. Y." The paper, which had been prepared for the United States Geological Survey, considered in detail the subdivision and classification of the Devonian beds, which are typically and strongly exposed in the vicinity of Ithaca. The beds show intrusions and overlaps of

In a paper on "The Relations of the Drainage of the Santa Clara Valley, California, to That of the Pajaro River," Prof. J. C Branner, of Stanford University, discussed the theory advanced by Leconte many years ago that the Golden Gate was closed by elevation not long ago, and the waters of the Great Valley were discharged through the Santa Clara Valley and the Pajaro River. The author's investigations show that the divide between the Pajaro and Santa Clara valleys is too high to agree with this theory; and that the submerged canyons off the mouths of the rivers point to recent submergence after previous great elevation. There is no canyon outside the Golden Gate, but there probably was one which has been filled up by the vast amount of sediment brought down by the streams discharging that way. The elevation amounted to 3.000 feet or more, and must have caused climatic changes, with greater precipitation and larger rivers. One of the rivers discharged a vast amount

The current SUPPLEMENT, No. 1593, opens with an article on some recent excavations of Roman ruins in North Africa, described and illustrated by our Paris correspondent. Walter J. May writes on the position of patterns in the molds. Some interesting facts about brakes are recounted. To one who sojourns for a few months in the valley of the Nile, new interests are constantly springing up. T. C. Mendenhall tells just what the engineer finds to absorb his attention in the Nile Valley. Joseph H. Painter discusses "Flowers that Feel." Interesting in these days of legion breakfast foods is the article on the "Place of Cereal Breakfast Foods in the Diet." John M. Thomson has taken for his topic the "Chemistry of Artists' Colors in Relation to Their Position and Permanency." Concrete is discussed from the standp int of a fireproofing material. Dugald Clerk's article on Internal Combustion Motors is continued. Some figures are given of steam and producer-gas tests of coal.