

CALIFORNIA AT DIFFERENT EPOCHS.

At the meeting of the California Academy of Sciences held at the beginning of the month, Dr. J. G. Cooper, formerly of the State Geological Survey made some interesting remarks on California. After exhibiting on a map of California and Nevada, the portions now land, but covered by salt or brackish water during the epoch just preceding the age of man, Dr. Cooper said that probably much of the coast range was also under water, of which no evidence from fossil remains is left, the strata, if any were deposited, having been washed away. Numerous small fresh water lakes also existed, which have left deposits, especially on the slope of the Sierra Nevada, but not yet surveyed enough to define their limits. The Sierra must then have been much lower to allow these lakes to stand where they would now drain out completely. Most of the States of Nevada and Utah were covered by large fresh-water lakes, filling what is now called the "Great Basin," and which have since evaporated so as to form the salt lakes now existing, by combination of the salts always contained in lakes and rivers. This is shown by the deposits of freshwater shells at high levels above the present salt lakes, and the absence of salt-water fossils later than the Cretaceous in the Great Basin.

In California, the whole great interior basin of the Sacramento and San Joaquin valleys was occupied by brackish water, as proved by the remains of sharks and porpoises found by Professor Blake and others near Kern river. All the principal level valleys now forming the best agricultural lands were also occupied by arms of this inland sea or of the ocean. The gulf of California extended over the desert a hundred miles or more north of its present limits.

The Sacramento basin had other outlets besides the Golden Gate (if that existed at all) through an inlet opening at Russian river, and another through Santa Clara valley into Monterey bay. Thus many islands probably existed which are now joined to the main land, among them the peninsula of San Francisco. Some of the inlets near the coast were occupied by marshes, through which the animals of that period reached the nearest islands, as shown by the remains of the fossil elephant found near San Francisco, near this city. Similar remains found by Blunt and Harford, of the Coast Survey, on Santa Rosa island, show that it was then either joined to the main land by dry ground or marshes, as were probably the whole main row of islands now forming the south shore of the Santa Barbara channel. The evidence of all these changes is in the remains of marine, land, and freshwater animals now found in the valleys mentioned, which have become more or less filled up by deposits from the adjoining hills. The following are the most striking forms, described by Professor Ledy in the "Report of the United States Geological Survey of the Territories," issued last year. A tiger (*Felis imperialis*) as large as the Bengal tiger, found in or near Lavermore valley. Wolf (*Canis indianus*) larger than the existing kinds, from same deposit; also found in the tertiary of Indiana, &c. Llama (*Lamauchenia californica*) from the foothills of Merced county, larger than the existing camel; also remains of perhaps another species from Alameda county. Buffalo (*Bison latifrons*) found in several parts of California and the eastern States, larger and differing from the living form. Horse (*Equus occidentalis*) of which remains are common in most of the States, though no horses existed on this continent when it was discovered by Europeans. Rhinoceros (*R. hesperus*), of which teeth were obtained by Professor Whitney, in Sierra Nevada. Elephant (*E. americanus*), one of the commonest of the great fossil animals throughout the United States. Mastodon (*M. americanus*), more rare, but also found in many localities. Another species (*M. obscurus*) first found in the Gulf States, and since in the foothills of the Sierra, Alameda county, &c. A great tortoise, equal to the Galapagos species in size, but probably of fresh water, from a lake deposit of Nevada county. Remains of palms and other tropical trees, chiefly from the lake basins of the Sierra.

From these evidences we perceive that the climate of that day was tropical. The country consisted of peninsulas and islands like those of the present East Indies, resembling them also in climate and productions. From the extent of water surrounding them, there was abundant rainfall and luxuriant vegetation, suitable for the animals mentioned. It is not unlikely that some of these animals may have existed before the pliocene epoch as well as in it, but the explanations are still insufficient to decide this.

The termination of this tropical epoch in California was marked by enormous volcanic outbursts, which poured out great streams of lava on the slope of the Sierra Nevada covering entirely large tracts towards the north. At the same time the whole country was apparently raised by the elevation of new mountain ranges, and increase of old ones, causing the lakes to be drained, and their beds filled by washings from the hills, mixed with volcanic materials. This great convulsion no doubt exterminated most of the tropical flora and fauna of California, although some of its representatives might have existed later in neighbouring regions, and their descendants may still be found in tropical America. That all are not extinct is probable from the analogy of tertiary species elsewhere, and from the fact that most of the marine and freshwater shells of the strata deposited at that time are still living, some however, only south of California. Many extinct land animals have been found to have lived in Europe since the appearance of man on the earth, and there is strong evidence in the Calaveras skull and others that the same fact is true of California. It does not, however, necessarily prove that man existed in the pliocene epoch, as his remains may have been buried under volcanic outflows of later date, together with post-pliocene animals, or even bones of pliocene species mixed with them by aid of volcanic convulsions.

The immense period of time that has elapsed since the pliocene epoch is shown by the vast accumulations of volcanic materials poured out by Mount Vesuvius on the top of marine strata of shells, every one of the species still living in the Mediterranean and therefore of late post-pliocene date. Yet history and the evidence of human remains go back through only a thin portion of these volcanic strata of California, before the end of the pliocene, was certainly badly suited for the existence of man. The deposits formed during the convulsive age, to the thickness of hundreds of feet are themselves almost destitute of all fossils, although burying such a rich collection.

While this was going on in California, there was probably a great geological change taking place in other parts of the world, followed by the glacial age. In this, the northern hemisphere down to about lat. 38 deg., was mostly covered by ice, and the great deposit called the "Drift," found in Europe and the Eastern States.

The Geological Survey proved convulsively that this deposit of erratic boulders did not reach over California, and it is doubtful if even as far as Vancouver's Island. Still the influence of the frozen period was no doubt exerted here in the form of extensive glaciers covering the Sierra, at least half way down their western slope, and probably the highest parts of the coast range. Now we have in summer a mere remnant of that great ice-field, which no doubt did a great part in the excavation of the tremendous canons now cut deep below the previous volcanic deposits of the Sierra. There is evidence also in the present existence of far northern land-shells along the whole length of the Sierra Nevada, that the glacial period progresses slowly, allowing them to spread southward before its advance, without being exterminated. In Europe, it has been found that man existed both before and after this period, living, like the present Esquimaux, on the edge of the perpetual snow, and advancing north again as it receded.

The end of the reign of ice brings us to the present epoch, in which there has been very little change in the outlines of the land in California, although some changes in the fauna and flora, as well as climate, which are yet undetermined. The volcanic disturbances have continued with decreasing intensity since the advent of man in the post-pliocene epoch, and may have elevated considerable portions of land, especially southward, followed by increase of dryness, and probably greater extremes of temperature. A rising of land near the Arctic Sea would further decrease the temperature. Judging from the continual discoveries still being made in the study of these latest formations of the earth's surface in Europe and the Eastern States, we may safely say that a vast field still remains open for the investigation of science in California.

The Locomotives of the World.—Dr. Engel, director of the Prussian Statistical Bureau, estimates the number of locomotives in the world at 45,467. Their aggregate force is calculated at 10,000,000 horse power. Such estimates are, however, necessarily rather vague.