SCENES IN THE HIGH SIERRA.

The following interesting article on glaciers, by J. G. Lemmon, is taken from the columns of the *Mining and Scientific Press*:

GLACIERS AND THEIR WORK.

Nowhere else in California are glaciers more fully represented than here around the bases of this Lyell group of half a dozen peaks. It is not so surprising that the much loftier Whitney group to the south, nor the great domes of Dana and Gibbs northward, scarcely retain an active glacier, when we consider the character of their rock, reddish porphyry, greenstone and slates, all good absorbants of solar rays. The cold, gray granite and silvery quartz of Lyell, added to the interior location of the group, condense the moisture out of the over-blowing winds for a longer period of the year, to fall in copious showers of snow on their plateaus, then to crystallize to *neve*, soon hardening to fields of ice, called *Mers de Glace*, from whence glaciers emerge, grinding their way to the plain.

FIRST THE FACTS, THEN THEIR ORIGIN.

These *Mers de Glace* are ribbed from upper to lower side with hard snow, the lowest end the largest between each ridge, in the warmest hours of summer days, there flows the daily melt of snow, filling the cracks that occur always in a mass of ice upon every change of temperature. Down each canyon of every peak, where favored by shade, flows a frozen river, a glacier. On its back, regularly distributed, are rocks of all sizes, some partly covered with the ridges of snow. These glaciers move slowly down the canyons, which they exactly fill, to the level of the melting point at the present time in this region, at an elevation of about 11,500 feet. Arrived at the melting line the glacier abruptly terminates in a sheer precipice, semi-circular in outline. Off from its edge, one after another, fall the rock passengers, forming a curved row of high-piled rocks, a moraine. These moraines are often one to two miles long in their sweeping curve and 50 feet high.

Following down the ravine, it is found to be smooth on the bottom and sides, with no sharp angles in its course, nor yet the short bends peculiar to water courses. At intervals, deep, round or oval lakes are found in or near the center of the ravine.

At every change of level, that is, every precipice down which this ravine-maker continues, just over the brow there is found a moraine.

Farther on, when the plain is reached, the ravine joins with others to form a deep, narrow valley, strangely regular in contour, no sharp angles or bends, but at a few points curving gracefully from side to side, always bending away from a tributary, never *towards* one, as often do rivers.

THE GLACIO-AQUEOUS EPOCH.

Before we attempt to interpret these phenomena, let us recall the glacio-aqueous epoch of the world's history, and note the configuration given to our globe by the universal ice mantle. The waters of the earth then flowed at an elevation far above the tops of the present mountains. In the lapse of time, as condensation of the earth's elements took place, the waters were gradually drawn off into preparing oceans, at the same time ridges or undulating bilges of the earth's crust appeared, constituting the present mountain chains, with their complement of material, now removed.

As the sea, with its immense blocks of ice, driven about by wind and tide, receded, the icebergs began to touch the earth's ribs, and at once the work of grinding and denuding commenced. While age upon age elapsed, lower and lower sank the icy sea, and its ice blocks beat harder and harder upon the ribs. The weakest formed rock gave way first, and, it may be, that between now towering peaks there once existed much higher, but easier denuded rocks. At length the great icy sea receded until it became fenced into basins by the appearing mountain chains. In the weakest places channels were formed, and as differences of level occurred, as respects the basins, the resistance of the sierra barriers caused tremendous pressure upon the sides of these channels, and the ice blocks squeezing through, often wrenched the toughest rocks from their ledges and hurled them upon the distant plain. Other rocks suffered the loss of crowns and angles and remain to-day as domes or bosses upon the flanks of the mountains, notably in the region of Yosemite, where they may be counted by the score, their scratched and polished surfaces recording at once the hight, strength, and direction of the ice currents.

At last the glacio-aqueous epoch was ended. The waters were gathered into their future home, the ocean. The dry land appeared, strewn with debris for hundreds and thousands of miles on each side of the mountain chains, while a warm atmosphere crept from the plains by degrees up the mountains, clothing them with vegetation.

Next succeeded the wonderful phenomena of

GLACIERS.

At first glaciers were developed on a scale so grand as to be scarcely conceived of now. Their work is denuding mountain ranges and sharpening domes into pinnacles, as did their parent, the icy sea, but they toil in a very different manner, slow as the cycles of ages, silent as the mold of the tomb. Their power is equal to the destruction of the highest mountains of the globe, and to the furrowing of the deepest Yosemites of the plateaus.

IT ALL BEGINS WITH THE MERS DE GLACE.

These masses of ice, at first, stranded upon plateaus, afterward formed from snow falling in favoring localities, are fixed to the earth, in winter, thoughout their extent, by freezing. Certain points of greatest cold are developed, coinciding probably with the lowest places. At these points the rocks are clasped firmly by the ice and form a fulcrum for dynamic movements, which will be examined soon.

First, let it be remembered that ice expands when forming, about one-ninth of its volume.

Second, when crushed at a temperature below 22° it re-congeals, over and over again.

Third, that the force of ice-expansion is one of the most powerful known, utterly irresistible.

Now from the point of greatest cold under an ice-field, this fulcrum firmly clasped, the ice expands by congealing, thawing, crushing and regelation, and pressed in every direction, wrenching off and taking the contiguous rocks with it, and rasping them upon those left in the matrix.

The result is a spreading outward and upward of the mass of ice and consequently the excavating of the crater-like amphitheaters that are found, some of them now empty, on the sides of the mountains. This accounts also, for the holes along the glacier's track, once ice-womba now filled with water-forming.

GLACIERS AT WORK.

The upper edge of this powerful excavator impinges against the mountain, undermining rocks and earth, causing them to fall upon its back, to be carried slowly down the frozen river, as seen.

When glaciers are in operation on both sides of a mountain rim, they remove all the material between, and thus isolated peaks are formed at the side.

The greatest amount of pressure will be successful in the direction of least resistance, hence the final downward flow of the frozen river.

GLACIER LAKES.

The *Modus operandi* of lake-forming is so interesting that a few words of detail may be apropos. Anywhere that ice forms upon a plateau or mountain side, the work of excavating a basin may commence, so soon as the conditions are favorable, *i. e.*, frequent thawings and freezings, which, as shown, are attended by expansion, crushing of ice and regelation, the latter of course attended with renewed expansion. The fulcrum or fixed point would change from side to side of the bottom seeking the lowest place, from season to season, or rather from age to age. The result would be the scooping out of a crater of more or less depth, stopped only by the condition of unchanged, low temperature reached at the bottom, generally several feet. When a change to warmer temperature occurs (which rise will soon show is sudden, and by several degrees at once), the ice is melted, and the ice-womb or fountain, becomes a deep clear glacier lake, or often, if in loose soil easily drained, remains empty.

These lakes distributed along a ravine, show where glaciers had their origin, or where portions of a flowing stream fastened on the bottom, for a period, and proceeded to digging wells upon the most gigantic scale, and with the most powerful yet simple of mechanical agents, ice-expansion.

The warmth of the atmosphere in a distinct stratum at the melting limit, causes an abrupt termination of the glacier, while its flow being unhindered in the center, is faster there and causes the outward curve to its front, and this rain-bow curve determines the shape of the moraine of rocks dropped from its brow, added to those disgorged from its mouth below.

The regularity of form of the glacier bed results from the power of ice to remove obstructions, like an immense furrowing flow, and its graceful curves *away* from the entering tributary glacier shows by the degree of deflection the size of the tributary—a phenomenon never exhibited by water currents.

Trains of rocks often seen, longitudinally disposed upon a glacier, show the union of two or more such tributaries. Their rocks deposited upon the terminal moraine form nodules or heaps in the latter. When left *in situ* by the sudden melting of the glacier, they form medial moraines; while those rocks carried outward to the side of the glacier form the third kind, lateral moraines.

Terminal moraines being found deposited at the brow of every precipice in the glacier's course, prove that the heat of the atmosphere has increased by intervals of several degrees at a time, not gradually—a most important deduction from the study of glaciers, bearing upon the subject of climatology, the sudden withdrawal and introduction of different species of animals, and plants, etc. If the increase of temperature was gradual no terminal moraines of immense size as now seen, would be formed, but the rocks would be scattered along the track of the receding glacier.

The few rocks found on the back of a glacier, its very slow movement, the bottom of it only moving in summer, the swiftest recorded motion being a Swiss glacier that only traveled 4,400 feet in nine years, together with the often, immense hight of the terminal moraines, 50 feet or more, all prove the necessity of vast periods of time required for their formation.

Finally the long, deep, glacier-carved valleys, like the famous Yosemite, prove the prevalence of glaciers of prodigous size and power, plowing the plateaus of the middle region of the Sierra, down to a low point near the foothills, the melting line being met at their mouths at an elevation of only about 3,000 or 4,000 feet.

CLIMATE BECOMING WARMED.

From this brief study of glaciers may be deduced a theory of the positive increase of the earth's atmosphere as the ages have rolled by; an increase which has advanced the melting point—33° Fah.—up the Sierra, 7,000 or 8,000 feet, since the day of the great glaciers. At that period, such valleys as Sierra and its sisters, now decorating the flanks of the Sierra north and south, were either lakes imprisoned with ice, or complete ice-womba, the source of glaciers whose moraines have been scattered since by floods from higher basins as their contents were feed; while the great valley of California, and the great basin of Nevada were cold, fresh