

## COMPARISON OF GLACIATION OF ASIA WITH THAT OF AMERICA AND EUROPE.

When the glacial history of Asia is compared with that of America and Europe there is found to be an essential agreement of the main facts. In all three continents there seem to have been cold glacial and warm interglacial epochs. American geologists usually recognize three advances of the ice, while many European geologists recognize a larger number, and in Asia, as we have seen, there seem to have been five. In so far as these facts agree, they indicate that the cause of the glacial period must have been of widespread influence, since it has produced similar effects in many parts of the northern hemisphere. The present discrepancy in the number of glacial epochs detected in different regions may yet be reconciled; but there is another discrepancy which can not as yet be explained. It has been already stated that the glaciation of Central Asia was much less severe than that of Europe and America. A specific comparison will make this clearer. The only European mountains that are at all comparable in height to the Alai and the Tian Shan ranges are the Alps; but the Alps lie so much farther north than the Tian Shan and in a region of so much greater precipitation that a direct comparison as to glaciation can not be made between them. In America, however, the Uinta and Wasatch ranges, although somewhat lower than the Asiatic ranges, are in other respects very similar to them. In both cases the mountains lie at a latitude of from  $40^{\circ}$  to  $42^{\circ}$  N., in the center of a continent far from the sea, and therefore in a region of slight rainfall. Close by are extensive desert plains, along the border of which are numerous piedmont villages dependent entirely on irrigation by mountain streams. The Asiatic mountains are higher than the American ranges above named by an average of fully 3,000 feet; they seem also to have at present a greater precipitation, if we may draw such a conclusion from the number of summer storms, the height of the snowline, the number of perennial streams, and the amount of vegetation. From these considerations it is clear that if during the glacial period there was an equal climatic change in both countries the Asiatic glaciers ought to have descended lower than the American; but this was not the case. Let us compare the figures in the two regions.

In order to avoid all possibility of exaggerating the unlikeness between the Asiatic and the American ranges, let us say that the average lower limit of permanent snow is 13,000 feet in both cases, although in America it is above this, and in Asia decidedly below. Let us also suppose that the greater height of the Asiatic mountains had no effect on the descent of their more protected northern glaciers. Even with these concessions we find that the Uinta Mountains were covered by glaciers which locally merged into something of an ice sheet near their western end, while those of the Alai and Tian Shan were all confined to the valleys. The average descent of the ice in the twenty-four valleys listed in Table III, from the assumed snow-line of 13,000 feet, places the base of the lowest old moraine at 9,740 feet; while in the Uinta and Wasatch mountains the average altitude of the moraines on the northern slope is 8,055 feet and on the southern slope 7,033 feet, as determined by Dr. W. W. Atwood. If we compare the extreme points to which the lowest glaciers descended below the present snow line in either region it appears