

kettles are drained. On the outer edges are valleys where streams probably flowed along the two sides of the glacier, as they often do. The inner slopes of these two portions of an old moraine are very steep, as they are now being undercut by the ice, C, on which lies part of the present moraine, D. The slopes show that the material of the old moraine is truly glacial in its angularity and irregularity of size, but utterly different from the present moraine in that it is well weathered and that the soil produced by weathering fills all the interstices. In fact, the slopes seem to contain decidedly more soil than rock. At present the modern moraine lies 50 feet more or less below the top of the older ridge, but there are many places where it formerly rose to the top and overflowed, as at D.

These facts seem to lead to the conclusion that between the deposition of moraine No. 3, or 4, as the case may be—it is quite immaterial which—and the deposition of the present moraine, the ice retreated to a position farther up the valley than that which it now occupies, as the following considerations will show. It may, perhaps, be taken as beyond question that a moraine such as B can not have become thoroughly weathered, graded, and covered with grass without long exposure to the air; nor does it require discussion to show that where graded slopes, such as those of B, are being undercut, they must once have extended farther in the direction of the agency which undercuts them. Therefore the ice must for a long time have occupied a smaller space than at present, and since that time it must have widened. But this could not have been possible with a continuously retreating glacier, for it should have suffered a continuous narrowing. Moreover, on the supposition of continuous retreat, with or without pauses, but without readvances, each moraine ought to lie above the one that preceded it, and this seems to be the crux of the whole question. A portion of the third or fourth moraine—let us say the fourth for convenience—lies from 1,000 to 2,000 feet above the rest of that moraine, and from $1\frac{1}{2}$ to 3 miles farther upstream. Between the two portions of the fourth moraine lies the whole of the fifth and most of the sixth moraine. It seems impossible to explain the facts on the theory of one retreat whether at a uniform rate or with pauses.

If, on the other hand, each moraine represents an advance and retreat of the ice, the difficulty disappears. The old glaciers were probably covered with moraine stuff just as the present one is, and as each retreated it would leave a trail of moraine behind it. The glacial stream would carve a valley in the abandoned moraine during the interglacial epoch. The next glacier would follow this valley at first, though it would widen it greatly, and in most cases utterly obliterate it. But each succeeding ice sheet was smaller than its predecessor, and where the valley was wide it might happen that portions of the older moraine would be preserved. This is what appears to have taken place at Kan Su. If this interpretation is correct it means that after the formation of the main portion of the fourth or possibly the third moraine, the ice retreated so far as to end at least 1,200 feet above the level of its moraine, and so reached a point 700 feet above the present level of the glacier front; that is, the fourth glacial epoch was followed by an interglacial epoch decidedly warmer than the present epoch.