

a continuous zone of loess lands covered with grass. From the time when the domestication of the horse and ox made possible the movements of organized bodies of men, these grassy plains have been used as an easy road for the migration of whole populations and for the devastating irruptions of barbarian hordes.

To turn again to the more peaceful side of the subject, southern Russia, Hungary, Austria, and the valley of the Rhine enjoy great profit from this fertile soil; and this is true to an even greater extent in the United States over the loess-covered areas of Iowa, Missouri, and Dakota, where it compensates for the lighter rainfall.

All previous geologists had considered it to be a sedimentary deposit, laid down in still water, and this was the view also of the writer after seeing it in some of the connected basin-like depressions of northern China and Mongolia in 1863. But later Richthofen, in his extensive exploration of China, found it mantling mountains several thousand feet high and containing there only remains of land animals and land snails. He found also that waters eroding this mantle deposited it in basins and on flood-plains, where it then often contained pond and river shells. As a result of his studies he found that the loess had been brought by winds. In developing his theory Richthofen showed that certain widely existing conditions were necessary to the formation of this product, so important to man. These conditions he explained in connection with the broad and fundamental theory, mentioned above, of the effect of climatic conditions in the "central" parts of continents as contrasted with the coastal or "peripheral" zones. All water is brought by winds from the oceans, and, generally speaking, by far the greater part of the moisture that is not precipitated in the coastal regions is condensed on the mountain ranges bordering the interior. The streams that flow from these mountains toward the central area sustain vegetation only where they can be spread over the land, leaving practically the whole vast area in a more or less arid state, excepting where more or less precipitation occurs over a zone near the mountains.

It was in the action of the winds on the unprotected surface of these plains that Richthofen found the source of loess. Wind not only takes up dust, but it wears away slowly and surely all soft, unprotected rocks, and, following lines of weakness, it removes thick strata of harder texture, leaving masses carved into fantastic forms, towers, and pinnacles, often hundreds of feet high, to prove the gigantic scale on which it can work with the aid of time. The products of this action may be classed as dust, sand, and still coarser material. The wind itself makes this classification. Separating the sand and dust from the coarser detritus, it carries the dust afar, while the sand is moved slowly forward, piling up into wave-like dunes, which progress by drifting away from the windward slope to accumulate on the lee side. As long as the dust is borne over a barren surface, it is ever at the mercy of the wind; but in many places near the borders of the arid region, as in northern China and southern Mongolia, there is sufficient precipitation to permit the ground to be covered with grasses adapted to such a climate. Once caught in this grass it remains to nourish the growth that is to continue the process