

the administrative system, which prevent effective expansion beyond the area actually irrigated¹⁴.

An ample supply of water for irrigation, the presence of fertile loess soil, and a sufficient population are, no doubt, the essential conditions without which it is impossible to assume a greater expansion of the oasis either in the past or in the future. It would, however, be a mistake to believe that the limits of cultivation in a territory situated like Khotan could ever in historical times have depended upon these factors alone. Wherever my search for ancient sites took me within the Taklamakān desert, I found evidence that by far the greater portion of the area over which its dunes move is formed by beds of naturally fertile loess. But it was equally clear that what cultivation had once existed there, or was still proceeding on the edges of the desert, could be carried on only in constant struggle with a formidable opponent, the drift-sand of the desert. It will probably take long years of painstaking study and observation on the spot, before all the physical facts connected with the gradual changes and movements of the desert dunes in different parts of the Taklamakān are elucidated with some approach to scientific accuracy. And as these movements are mainly influenced by the prevailing winds, which themselves, like other phenomena dependent on climatic conditions, may have undergone material changes in the course of long centuries, it appears very doubtful whether even the results of such observations could be relied upon to give in all respects a true view of the conditions prevailing at earlier periods.

Cultivation threatened by drift-sand.

Notwithstanding this reservation, which applies particularly to the assumed rate of progress in the general advance of the desert southwards, it seems highly probable that the edges of the oasis presented in ancient times the same abrupt transition between cultivated ground and desert which we note there at present. Wherever on my tours I moved northward beyond the limits of the Khotan oasis, I invariably found dunes, often of respectable dimensions, fringing in closest proximity the last irrigated fields. The drifting sand is thus ever at hand to overrun any ground from which for one reason or another cultivation recedes, and under special conditions it may even prove a successful aggressor in the face of human resistance. The causes for the abandonment of once cultivated ground may vary greatly, but are always easy to understand. Inadequate supply of water, due to neglect of the irrigation canals or to natural changes affecting them; shrinkage of the population and of the available labour; reduced cultivation, owing to political troubles or maladministration—are all sure to make their effect felt first on the outskirts of the oasis, where the struggle of the agriculturists must always be most severe.

Abandonment of cultivated ground.

In the absence of detailed and prolonged observations, it seems less safe to express an opinion as to cases where the intrusion of the desert within the former limits of the oasis may have been the result of purely natural causes. Yet one important fact at least can be clearly established. The careful microscopical examination which Prof. L. Lóczy was kind enough to undertake of the sand specimens brought back by me from localities once included in the Khotan oasis, but buried under dunes for probably close on fifteen hundred years (Ak-sipil, Rawak), proves that the constitution of this sand differs in no essential respect from that of the alluvial loess which forms the fertile soil of the oasis. Like the latter, it consists mainly of distinctly angular quartz-grains, plentifully mixed with mica-flakes and to a less extent with fine dust, all manifestly products of the detritus which forms through disintegration in the Kun-lun Mountains, and which the rivers of Khotan wash down. The entire absence of

Drift-sand composed of loess.

¹⁴ This point has been noticed already by a number of earlier travellers, with regard to Khotan as well as other

oases; comp. e. g. Grenard, *Mission D. de Rhins*, ii. p. 180; Johnson, *J. R. Geogr. Soc.*, 1867, p. 6.