

## CHAPTER VIII.

### SECTION I.

*A brief account of the geological structure of the Hill-ranges between the Indus Valley in Ladak and Shahidula on the frontier of Yarkand territory, by DR. F. STOLICZKA, Geological Survey of India, Naturalist attached to the Yarkand Embassy.*

THE following brief notes on the general geological structure of the hill-ranges alluded to, are based upon observations made by myself on a tour from Leh *via* Changchenmo, the high plains of Lingzi-thang, Karatagh, Aktagh to Shah-i dula, and upon corresponding observations made by Dr. H. W. Bellew, accompanying Mr. Forsyth's camp along the Korakorum route to this place.

Before proceeding with my account, I will only notice that our journey from Leh (or Ladak) was undertaken during the second half of September and in October, and that we found the greater portion of the country north of the Changchenmo valley covered with snow, the greatest obstacle a geologist can meet on his survey. While on our journey the thermometer very rarely rose during the day above the freezing point, and hammer operations were *not easily* carried out. At night the thermometer sank as a rule to zero, or even to 8° below zero in our tents, and to 26° below zero in the open air. Adding to this the natural difficulties of the ground we had to pass through, it was occasionally not an easy matter to keep the health up to the required standard of working power.

Near Leh, and for a few miles east and west of it, the Indus flows on the boundary between crystalline rocks on the north and eocene rocks on the south. The latter consist chiefly of grey and reddish sandstones and shales, and more or less coarse conglomerates, containing an occasional *nummulite* and casts of *pelecypods*. These tertiary rocks extend from eastward south of the Pangkong lake, following the Indus either along one or both banks of the river, as far west as Kargil, where they terminate with a kind of brackish and fresh-water deposit, containing *melanice*.

Nearly the entire ridge north of the Indus, separating this river from the Shayok, and continuing in a south-easterly direction to the mouth of the Hanle river (and crossing here the Indus, extending to my knowledge as far as Demchock), consists of syenitic gneiss, an extremely variable rock as regards its mineralogical composition. The typical rock is a moderately fine grained syenite, crossed by veins which are somewhat richer in hornblende, while other portions contain a large quantity of schorl. Both about Leh and further eastward, extensive beds of dark, almost black, fine-grained syenite occur in the other rock. The felspar often almost entirely disappears from this fine-grained variety, and quartz remains very sparingly disseminated, so that gradually the rock passes into a hornblendic schist; and when schorl replaces hornblende, the same rock changes into layers which are almost entirely composed of needles of schorl. Again, the syenite loses in places all its hornblende, the crystals of felspar increase in size, biotite (or sometimes chlorite) becomes more or less abundant, and with the addition of quartz we have before us a typical gneiss (or protogine gneiss) without being able to draw a boundary between it and typical syenite. However, the gneissic portions, many of which appear to be regularly bedded, are decidedly subordinate to the syenitic ones. As already mentioned, the rock often has a porphyritic structure, and the felspar becomes pink instead of white, as, for instance, on the top of the Kardung pass and on the southern slope of the Chang-la, where large fragments are often met without the slightest trace of hornblende. To the north of the last mentioned pass the syenitic gneiss gradually passes into thick beds of syenite-schist, and this again into chloritic schist, by the hornblende becoming replaced by chlorite, while the other mineral constituents are gradually almost entirely suppressed. The syenitic and chloritic beds alternate with quartzose schists of great thickness. This schistose series of rocks continues from north of the Chang-la to the western end of the Pangkong lake