

LATE PRE-CAMBRIAN GLACIATION IN CENTRAL INDIA

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IT is a well-known fact that at the end of the late Pre-Cambrian period there occurred a widespread ice age. Nantow Tillite of China, the extraordinarily thick glacial series of Adelaide System in Australia, and the extensive tillite of Numees Series in South Africa are eloquent proof of glaciation in the immediate vicinity of India while later Pre-Cambrian tillites are quite as well developed and have been reported from Norway, Scotland, Spitzbergen and from many localities in North America. In India, Sir Thomas Holland suggested in 1908 that Blaini conglomerate as found near Simla may be much older than the Permo-Carboniferous and may belong to Late Pre-Cambrian glaciation. The Blaini conglomerate is now relegated to the Permo-Carboniferous age by most people in spite of the fact that the succeeding Krol Series is totally devoid of fossils.

The senior author, while mapping the Son Valley in 1948 observed that the basal bed which marks the lowermost horizon of Lower Vindhya and overlies the Bijawar Series, was composed of a fine-grained siliceous rock, in which are distributed angular and sub-angular boulders of vein quartz varying in size upto a maximum of 9", as well as subordinate amounts of jasper and trap pebbles. This horizon extends for nearly 100 miles between River Banas and River Gopath, the two tributaries of River Son. It was thought that such boulders might have been the result of torrential action. But the unsorted assemblage, combined with great extension, suggested the possibility of glacial action. This boulder bed merges into a coarse-grained quartzite at the top. The matrix on examination under a microscope reveals the presence of abundant flesh-coloured fresh feldspars. The presence of feldspar strengthened the belief that ice has led to the formation of such a deposit. It is interesting to note that Oldham¹ also has described a similar rock occurring between River Banas and Gopath which he thinks 'is in fact an indurated boulder clay of a structure similar to the glacial boulder clays of Europe and the Talchir boulder clays'.

The junior author while working in Bundelkhand in Ken Valley in 1950 (Map Ref. No. 54.P/14) found that just below the Semri Series and overlying the Bijawars, there is a remarkable formation of 150' thickness which forms the most prominent scarp in the locality.

It consists of a totally unstratified clay of chocolate brown colour in which are embedded pieces of varied lithology—sandstones, quartzites, conglomerates, cherts and traps, representing the Bijawar Series and granite pieces



FIG. 1. Angular and sub-angular rock fragments of all grade embedded in a dark argillaceous matrix (Unsorted breccia of sporadic fragments). Note the unstratified nature of the deposit. Locality Ken Valley



FIG. 2. Big boulders, angular and subangular, embedded in a dominant dark matrix. The boulder (block) in the fore-ground is of quartzite and measures 3 feet across. Field photo of the Tillite occurring in Ken Valley.

derived from Bundelkhand granite. These sparsely enclosed constituents display most remarkable variation in size and shape. Boulders and blocks measuring 3' across are not uncommon, while every grade down to silt size is represented. They are angular and sub-angular in shape. Under the microscope, angular fragments of rock types mentioned earlier are seen embedded in a ferruginous matrix. This formation with its peculiar characters extends to 20 miles towards west.

The extreme variation in grain-size, the dominance of argillaceous matrix, and a lithological assemblage derived from distant localities combined with the great thickness and lateral extent, strongly suggest that the deposit is a typical tillite.

It will be found that the horizon of this boulder bed in Bundelkhand is the same as that of the boulder bed of Son Valley, being

situated at the bottom of the Semris and at the top of the Bijawars. The shortest distance between the two areas is about 150 miles and the glaciation seems to be fairly extensive in scale.

This study indicates that India did not escape the late Pre-Cambrian glaciation which affected the neighbouring regions such as Australia, China and South Africa. Considering the principle of universality of great ice ages and also allowing for the fact that the precise datum is not obtained by comparing the evidences of glacial action in distant countries we have to reconsider the conventional position of Vin-dhyans. They may be younger than what they are believed to be.

I. Oldham, R. D., "Geology of Son Valley in Rewah State and Part of Jabbalpur and Mirzapur," *G.S.I. Mem.*, 1901, 31, Pt. 1, 41.

SCIENTIFIC SPIRIT IN ANCIENT INDIA*

THE development of a rational attitude of mind and a spirit of inquiry into the mysteries of the universe, which form the basis of all scientific study, is rightly claimed to be one of the greatest legacies of Greece to humanity. As in Greece, so in India, speculative philosophy was followed by a true scientific inquiry based on close observation of facts and phenomena. The method of science, which has been described fully in Indian literature, involves, among others, perception, observation, experiment, inference and hypothesis. By application of this method great advances were made in astronomy and medical science including anatomy and surgery. These led to the growth of other sciences such as mathematics and chemistry. The actual achievements of the Hindus in these branches of science were very great and compare favourably with those of any other ancient people.

Even in other branches such as botany, zoology, mineralogy, metallurgy and physics, where actual attainments were not as great, we find the scientific process at work, viz., observation and classification of phenomena, experiment and inference. As regards botany, reference may be made in particular to the classifi-

cation of plants, treatment of seeds for successful germination, study of diseases of trees and the method of improving flowers and plants—even to the extent of changing their essential properties. More striking is the detection in plants of the phenomena of life and death, sleep and waking consciousness, of pleasure and pain, sensitiveness to heat and cold, and movements towards what is favourable and away from what is unfavourable. In zoology we find various classifications of animals on the basis of their *vija* (ovum or seed), the number of senses possessed by them and according to their habitat, mode of life and dietary value. In mineralogy and metallurgy we have reference to the working of underground mines, manufacture of various metals and a scientific process of treating metals. The iron pillar of Delhi is a living testimony to the forging of iron on a scale unknown to recent times and the process, now forgotten, of evolving a type of iron which does not rust in 1,500 years. The true nature of gems and their classifications show some knowledge of geology.

The study of ancient Indian science is yet in its infancy, and if India suffers in this respect in comparison with Greece and other countries, it is perhaps due more to our ignorance than to her actual backwardness, either in scientific spirit or in actual achievements in various branches of science.

* From the 14th Sir J. C. Bose Memorial Lecture, delivered by Dr. R. C. Mazumdar at the Bose Institute, on 30th November 1952.