

THE
AMERICAN
JOURNAL OF SCIENCE AND ARTS.
[SECOND SERIES.]

ART. XVI.—*Notice of an Account of Geological Observations in China, Japan and Mongolia*; by RAPHAEL PUMPELLY.

[Read before the National Academy of Sciences,¹ Aug. 26th, 1865.]

IN the present brief notice, I propose to call attention to some of the principal conclusions to which I have been led by geological observations made during journeys in China and Mongolia. In a longer memoir I hope to give in detail the grounds on which these conclusions are based. The range of travel was as follows :

In the summer of 1863, from *Shanghai* to *Hunan* and the boundary between *Hupei* and *Szechuen*.

In the autumn and winter of 1863 and 1864 and during the following spring, from *Peking* through the mountains of western *Chihli*; and from *Peking* to beyond the Great Wall of China and westward on the plateau, following its southern edge to about the 112th meridian, E. of Greenwich, returning by a route south of the Great Wall.

In the winter of 1864 and 1865, from *Peking* across the plateau of Central Asia, via *Kalgan* and *Urga*, and *Kiachta* in Siberia.

The almost total absence of previous observations of a geological character, through this wide field, the comparatively small amount of surface seen in the above journeys, and the great difficulties that a single observer has to contend with, owing to the jealousy of the inhabitants in the center of China, and the extreme cold of a winter journey over the table land, restricted my range of observation, and permit me to give in the paper I am

¹ The work to which this brief notice calls attention, and which the National Academy has kindly volunteered to publish in its memoirs, contains also an itinerary of geological observations in Japan, and will be accompanied by a considerable number of maps, sections and illustrations.

preparing only a general and necessarily very incomplete idea of the geology of that interesting country. The data at my service are: my own observations, the extremely limited number of those of other foreigners, and the information obtained from Chinese works on the geography of the empire, chiefly bearing on its mineral productions and scattered through an immense range of literature.

The chief results arrived at are as follows:

I. There is reason for believing that there exists throughout China, an immense development of Devonian limestone, which rises to the surface in all the important ridges, and attains in places a thickness of over 10,000 feet.

II. Wherever the formations beneath this limestone were seen, they were found to be, either granitic rocks, or metamorphic schists, non-conformably stratified as regards the limestone.

III. Overlying the limestone, there exists in almost every part of China, a great coal-bearing formation of sandstones, shales, conglomerates, etc., as a rule in nearly, if not quite, conformable stratification as regards its limestone floor. The fossil plants obtained from this formation in widely separated localities, in the province of *Chihli* and on the *Yangtse Kiang* in western *Hupei*, are being examined by Dr. J. S. Newberry, who considers them to be decidedly supra-carboniferous. The absence of Carboniferous forms and the presence of Cycads closely resembling Triassic species, make it probable that the coal-fields of China, which vie with our own in extent, are referable to the Triassic period.

IV. Although from the limited range of actual observation, it would be assuming too much to assert that there is a total absence of all formations younger than the Chinese Coal-measures, still I failed to find any traces of them, and I feel justified in doubting the existence of marine Jurassic, Cretaceous or Tertiary deposits to any important extent, within the limits of the Eighteen Provinces, or China Proper, unless they may be represented on the frontiers of Assam, Burmah or Cochin China, or on the islands of Formosa or Hainan.

V. Excluding the N. S. ranges of mountains that form the eastern edge of the Thibetan highland, only two systems of elevations occur in China, of sufficient importance to have left a marked impress on the surface. These are the N.E., S.W. and the E.W. systems. The N.E. system of trends, in all eastern Asia, east of the 110th meridian, determines the outline of that part of the continent, and they, as well as nearly all the more important features of this region, can be represented by lines drawn parallel to a line running N. 47° E., and coinciding with the middle course of the *Yangtse Kiang* and the lower course of the *Amur*, with the longer axes of the Gulfs of *Penjinsk* and of *Pechele*, and with that of the depression occupied by the delta plain of the *Hwang Ho*.

The E.W. system exists in western China in the *Min* mountains and in the *Nan ling* range.

While the N.E. system has determined the eastern outlines of the continent, and much of its inland configuration, to the E. W. system is due the *general* course from west to east of the three principal rivers, the *Hwang Ho*, the *Yangtse Kiang* and the *Si Ho* of the south.

The disturbance of the N.E. system began after the deposition of the great Devonian limestone formation. It appears to have been acting slightly, during the forming of the coal-bearing beds, but its chief operation was after these had been deposited.

There is a striking analogy between this system and the Appalachians, both having the same trend, and, within certain limits, contemporaneous origin, and both folding immense areas of coal-bearing strata, and determining the eastern outlines of their respective continents.

I have taken the liberty of applying to this widely extended upheaval, the name of the SINIAN² system.

The E.W. system appears to be younger than the Sinian. It has raised the limestone and overlying rocks in the *Min* mountains and in the *Nan ling* range, and M. de Semenow found Carboniferous limestone forming synclinal folds in the longitudinal valleys of the *Tien shan*.

VI. Evidences of recent oscillations, extending over a great area, are visible in terraces on the coast of *Shantung*, along the whole course of the *Yangtse Kiang* from the sea to western *Szechuen*, and on the western skirt of the delta plain, as well as throughout the islands of Japan.

VII. The great plain of north-eastern China is a delta deposit, mainly of the *Hwang Ho*, stretching over nearly eight degrees of latitude and yearly increasing in extent. Within the limits of this delta the *Hwang Ho* varies its course every few centuries, emptying into the sea, alternately to the north and to the south of the mountainous peninsula of *Shantung*.

VIII. The great table land that lies between China and Siberia is made up, where my route crossed it, of basins of undisturbed strata of sandstone, probably younger Tertiary, containing, in places, beds of gypsum. These basins are separated by low ridges, often of granitic rocks, but more generally, of highly inclined and folded strata of schists, sandstones and limestones, etc., all highly metamorphosed. The general trend of these ridges is between E. and N.E.

In the south the plateau rises gently, terminating in a precipitous wall facing the S.S.E. Where I travelled along this southern edge, between the 112th and 115th meridians (E. of Green-

² From *Sinim*, the name under which the earliest mention of China is made; Isaiah, xlix, 12.

wich), it is formed by an immense development of lava flows, in places more than 1,500 feet thick. Wherever the rocks underlying this volcanic formation were observed, they were invariably found to be granitic, with metamorphic schists, chiefly gneiss, granulite and hornblendic varieties.

The abrupt termination of the plateau is owing to a great dislocation which marks, approximatively, the coast line of a former ocean to the north, in which the more recent deposits of the plateau originated, and along whose southern shore there existed an extensive region of volcanic activity.

This high escarpment seems to be the *Inshan*, and the fact that it is volcanic goes to prove the justness of Humboldt's belief, that the *Inshan* forms the continuation of the *Tienschan*.

While the plateau is terminated on the south by this escarpment, it is limited on the east by parallel ridges, and descends by successive terraces, to the Manchurian lowlands.

By the elevation of the plateau, north of this line of fracture, a great basin was formed between the escarpment and the range of mountains nearly marked, on the maps, by the Great Wall. This area became the seat of a series of lakes extending several hundred miles, from W.S.W. to E.N.E., and which have left a deposit of loam often visible in terraces several hundred feet thick. These lakes seem to have covered the whole land of the *Ortos*, within the great northern bend of the *Hwang Ho*, and the valley system of the *San Kung* and *Yang* rivers. The fresh-water character of the loam is proved by the presence of fresh-water shells.

The circumstances seem to warrant the supposition of a connected chain of lakes, stretching from the 106th to the 116th meridian, which received the waters of the *Hwang Ho*, before the formation of, or during a long continued obstruction of, the deep channel in which that river now flows between *Shansi* and *Shensi*. The main outlet seems to have been the present gorge, by which the *Yang Ho* traverses the mountains west of *Peking*, to join the *Pei Ho* of the delta plain.

The lower *Pei Ho* has, within historical times, more than once formed the mouth of the *Hwang Ho*.

Thus the *Hwang Ho* appears to present a most remarkable instance of one of the great rivers of the earth, not only shifting its lower course over an area of several degrees of latitude on its delta-plain, but also reaching the sea at the same point, at different times, after following two widely separated routes through a highly mountainous country.

IX. Among the more practical results obtained, I may mention the determination, from personal observation and from native sources, of a large number of extensive coal-basins, and of localities producing other useful minerals, all of which I have tabulated and represented, so far as is practicable, on a map.

These are so widely distributed throughout the empire, as to warrant the belief that China stands second to not even the most favored countries, as regards the quantity and quality of its coal and the long list of its other mineral resources.

Such great gifts of nature, combined as they are, with an unsurpassed variety of favorable circumstances, both climatal and structural, cannot long lie idle; they are the elements of the civilization of the present age, and in the natural course of events, the country possessing them cannot avoid being drawn into the stream of industrial and intellectual progress. They seem to predetermine a future history for that distant people; for, far from witnessing the often asserted signs of decay in the Chinese race, I am, and I think every careful observer must be, rather astonished at the evidences of a most remarkable vitality.