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II.—*On the Trigonometrical Survey and Physical Configuration of the Valley of Kashmir.* By WILLIAM H. PURDON, C.E., F.R.G.S., &c., Executive Engineer, Punjab.

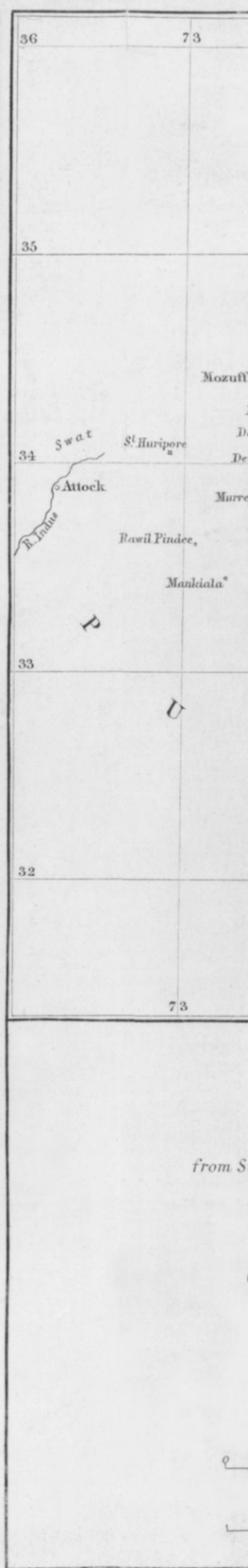
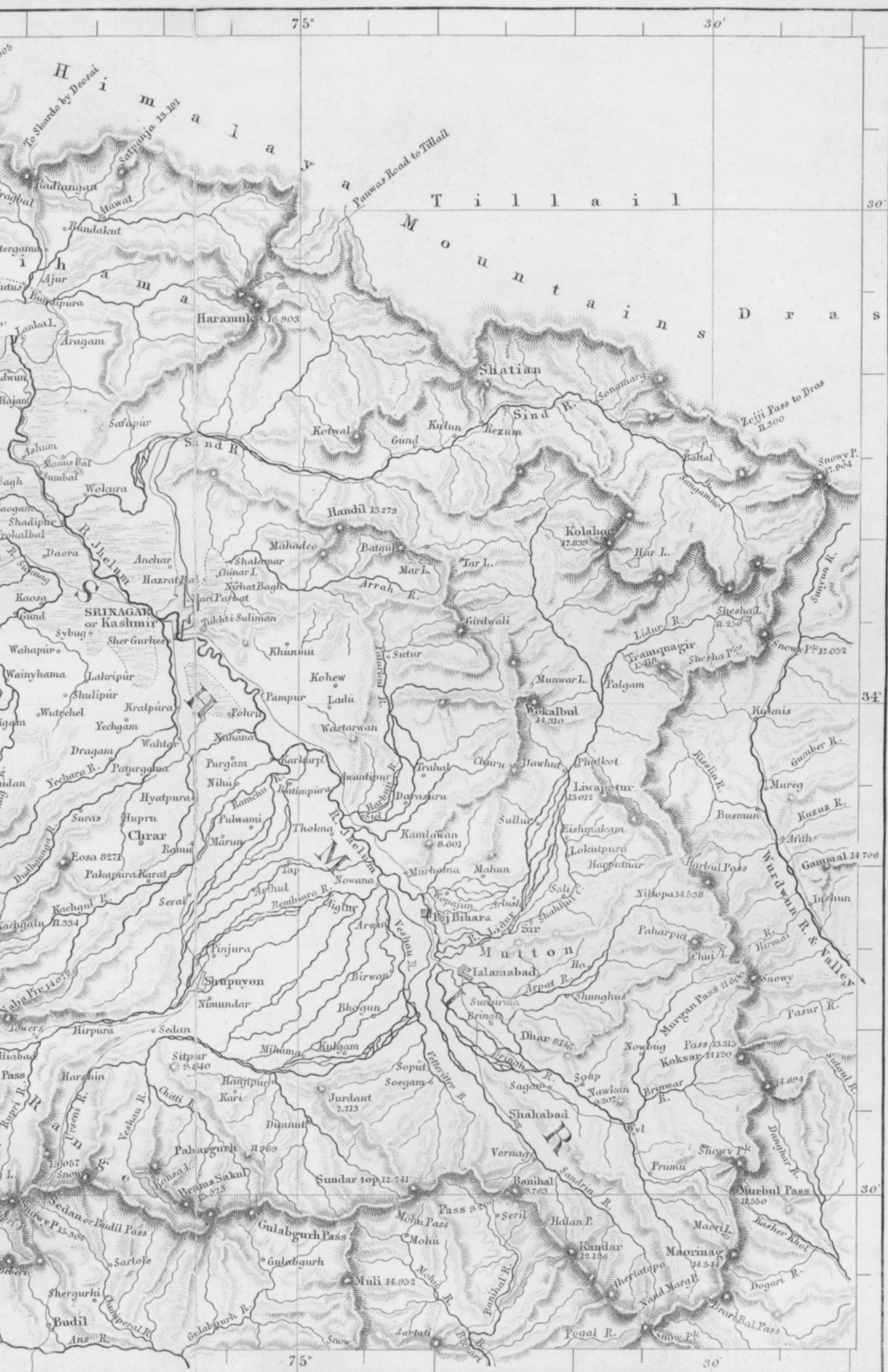
Read, December 12, 1859.

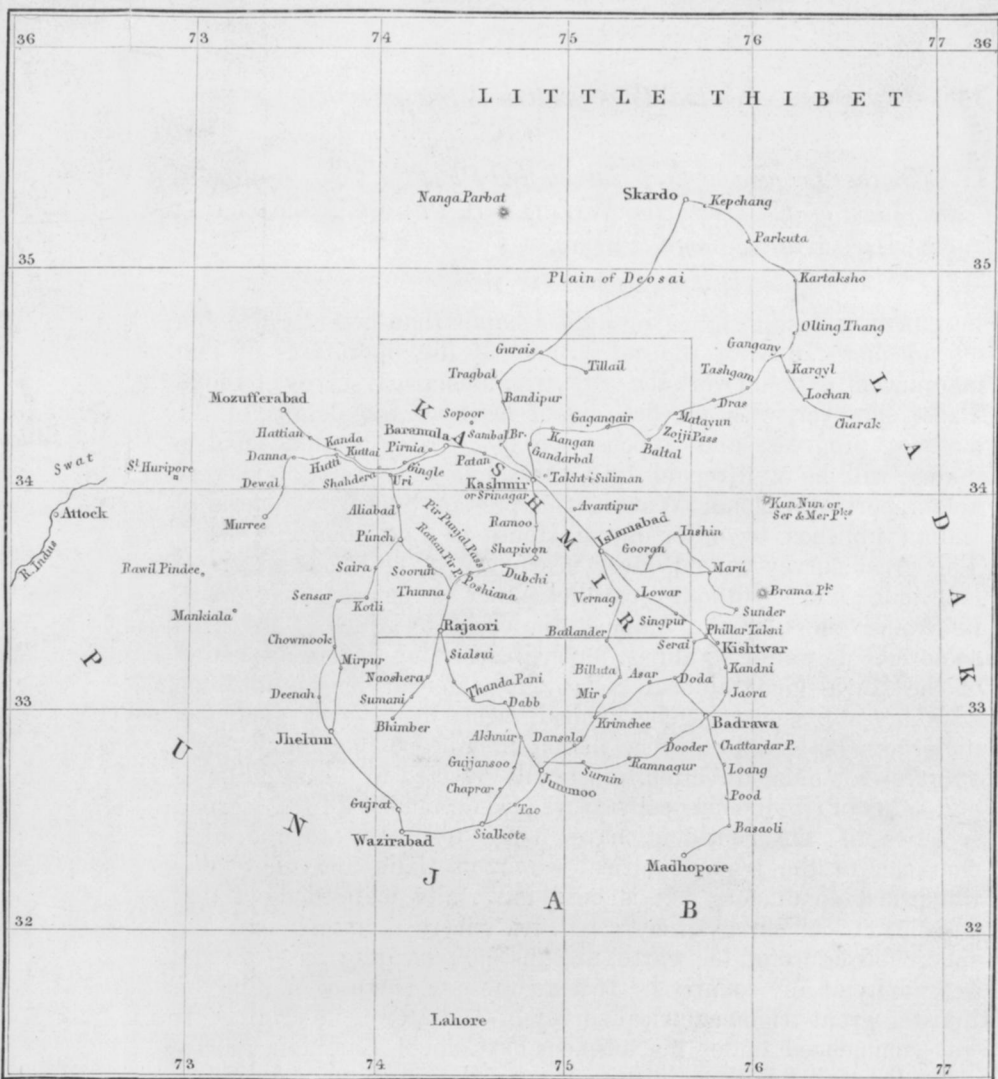
I REGRET it has not fallen into abler hands than mine to give you an adequate idea of the magnitude of the operations of that magnificent national work the great trigonometrical survey of India. Those, however, who are desirous of learning the details of the manner, progress, and expense of that great geodetic undertaking, will be well repaid by a perusal of the succinct and very able report of Colonel Waugh, the present Surveyor-General of India (published by order of the House of Commons in 1851).^{*} This great survey extends over nearly 26° of latitude and 28° of longitude; and is without a parallel, either as regards its accuracy, its extensiveness, or the unity of the effect by which it has been achieved. It would be almost impertinent in me, before a meeting of the Royal Geographical Society, to enter at length into the advantages to science—geographical science in particular—of such undertakings. Almost every nation in Europe has, by its own efforts in a similar direction, practically testified to the importance and value of trigonometrical surveys; while almost all the learned societies of the continent have borne testimony to the high character of the trigonometrical survey of India and of its distinguished conductors. It is now universally acknowledged that trigonometrical surveys, corrected for spherical excess, and the spheroidal figure of the earth, are the only accurate bases for the geography of any country.[†] It is to the late Duke of Wellington that the great trigonometrical survey of India owes its origin. It was commenced under his auspices by Colonel Lambton, shortly after the fall of Seringapatam: and it has been carried on (notwithstanding many interruptions, owing to the disturbed political state of the country) by the steady support of the Indian Government, whose perseverance was well worthy of the original great design. The immediate results of Colonel Lambton's

^{*} Colonel Everest, of the Bengal Engineers, and one of the Vice-Presidents of this Society, who succeeded to the charge of the Trigonometrical Survey on the death of Colonel Lambton in 1823, had been that officer's chief assistant since 1818. The whole system as respects field-works was changed by Colonel Everest, and in his Second Report of the Operations of the Survey, published at the close of his connection with it, may be seen a detailed account of the new system of signals, heliotropes, lamps, &c., as well as of the other changes introduced by him in that great work. In that Report, which brought the account up to the time of his retirement in 1843, Colonel Everest suggests the extension of the survey over the Himalaya, with a view that it might be ultimately carried on to Chinese Tartary and connected with the Russian Survey, so as to extend the meridional or arcal measurements from Cape Cormorin on the south, to Nova Zembla on the north.—*Ed.*

[†] *Vide* Colonel Blackie's Report.



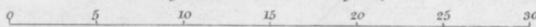




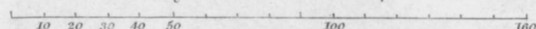
Map of the
VALLEY OF KASHMIR:

from Surveys made by Captⁿ T. G. Montgomerie, under the direction of
 The Surveyor General of India;
 to illustrate the Notes of
 Captⁿ Godwin Austen and William Purdon Esq^r;
 to which is added,
 a Sketch of surrounding Countries.

English Miles on the Survey Map.



English Miles on the Sketch Map.



operations were, the discovery of an error of more than 40 miles in the breadth of the Peninsula, as formerly laid down by astronomical observations; and further, that nearly all the chief towns were misplaced on the old maps. The advantage reaped by mathematical science was, a more accurate knowledge of the figure of the earth, as deduced by Colonel Lambton, by a measurement of an arc of the meridian. "A true knowledge of the figure of the earth is no mere object of curiosity, inasmuch as it effects a large proportion of the calculations upon which navigation is based, especially those in which the moon's parallax is an element."

"But there is *no* branch of physical science, specially effected by the three co-ordinates of latitude, longitude and elevation, in which great trigonometrical operations are not of primary importance."* "The triangulation of the great trigonometrical survey of India supplies a permanent and accurate basis for the present as well as for future internal surveys; for it must be borne in mind, that as the resources of the country become developed, under the fostering protection of British rule, the topographical aspect of many districts must, in a moderate number of years, be completely changed. Tracts, now covered with jungle, will be reclaimed, canals will be dug, marshes drained, and roads established. New towns and villages will arise, and fresh groves be planted, and rivers will change their course; for these reasons, revised surveys will be required; and these, like the present ones, will be based on the operations of the great trigonometrical survey of India, which are intended to form a lasting monument for future generations, and an imperishable record of the landmarks of the present time."

The foundation of the triangulation, of which the survey of Kashmir forms a portion, was commenced shortly after the Punjab was conquered, and it is to the prompt and powerful support given to these operations by the late Lord Hardinge, that the valuable results, of which the topographical map now exhibited forms but a small portion, was, in the first instance mainly due.

The topographical survey of Kashmir is based on the great trigonometrical survey of India: the whole country, by means of primary and secondary triangulations, was covered with trigonometrical points, at an average distance of little more than four miles from each other; the topographical detail was sketched in the field on plane table. "Altogether, the area already surveyed amounts to 22,000 square miles in three years, and 40,000 square miles of triangulation, including all Little Tibet, in four years; the chief merit of which achievement," adds Colonel Waugh, "is

* *Vide* Colonel Waugh's Report.

deservedly due to Captain Montgomerie." Considerable physical difficulties were imposed, by the nature of the country and survey, arising from the necessity of ascending, and encamping, on snowy mountains of great elevation; out of the 16 principal stations in Tibet, 14 exceed 15,000 feet in height, two were over 18,000 feet.* On the principal series of triangles, the observations were invariably made to luminous signals, viz. heliotropes and lamps; notwithstanding the physical difficulties and the severity of the climate on the snowy peaks, so especially trying to the natives of India, who served the signals. Occasionally, in consequence of clouds and storms, the party had to remain pitched on the snow for upwards of a week at a time. On the Pir Punjal peaks, the electricity was so troublesome, even when there were no storms, that it was found necessary to carry a portable lightning-conductor for the protection of the theodolite."

Colonel Waugh pays a willing tribute to the cheerfulness with which the native establishment endured the hardships to which they were necessarily exposed. "The signallers and headmen were mostly natives of Hindustan, to whom extreme cold is a condition of positive suffering; yet these men have been loyal, cheerful, and contented, as they have indeed been in all survey parties over India during the mutinies, though many are of the same class as Sipahis, among whom they had brothers and relations." But the physical character of the country formed by no means the chief difficulty of the survey, conducted in a foreign territory, and which at no time could be expected to be agreeable to the ruler, his officials, and people. To them the influx of a considerable body of surveyors, spread over the country, however orderly and well-conducted, must bear the aspect of an intrusion. It is to the tact, delicacy, and ability, with which Captain Montgomerie maintained amicable relations with the court, a most difficult one to deal with, and preserved discipline in a large mixed establishment, that the successful completion of the operations of the survey are chiefly due.

Colonel Waugh estimates the total area of British India at 800,758 square miles, and that of the native states at 508,442 square miles, making a total of 1,309,200 square miles. "This," he adds, "is the area of the survey under my charge." "A complete delineation of this vast superficial extent, amounting to nearly $1\frac{1}{3}$ million square miles, confined with an external boundary of 11,260 miles in length, including every variety of configuration and climate, is an undertaking of unprecedented magnitude; demanding considerable time to accomplish with any pretensions to mathematical accuracy." "The exertions," adds Colonel Waugh,

* See Captain Montgomerie's Report to Colonel Waugh.

“hitherto made, have been unremitting, and it is but justice to say that the progress has been, generally speaking, as creditable to the officers employed, as the results have been useful to the country.”*

It has been asked: When will the survey be completed? It should be remembered how vastly our dominions in India have extended since Colonel Lambton laid down his base line. The conquest of the Punjab and Sind alone added nearly 170,000 square miles of territory; nevertheless, in a few short years, the net-work of triangles will have been woven over the entire continent of India. Further, it may be added, that the Ordnance Survey of Great Britain was commenced before Colonel Lambton laid down his base line, and that India is more than twelve times as large as Great Britain. A copy of the Index to the Indian Atlas, which Mr. J. Walker, the Hydrographer to the Government of India, has kindly prepared for me, coloured, so as to show at a glance the actual amount which has been surveyed. Of the 121 squares, which, when complete, will embrace the entire Peninsula, 59 have already been engraved, on a scale of 4 miles to the inch, and are available to the public, at a cost of four shillings each, coloured: many others are in an advanced state.

I would now venture to offer some remarks on the physical configuration of that most interesting and beautiful portion of the earth, the Valley of Kashmir. My own observations were made during two explorations of the valley, in the years 1854 and 1856, which were undertaken chiefly with the view of obtaining some knowledge of its geological structure. On these occasions I took with me several barometrical and other instruments for determining heights, &c.

Kashmir appears to have been a regular kingdom for a period that transcends the limit of legitimate history.† Herodotus,‡ the father of history, informs us, that a portion of Upper India, including Kashmir (Kaspatyrus), formed the twentieth Satrapy of the vast Persian Empire, under the reign of Darius Hytaspes, who flourished 521 years before Christ. Amongst

* Colonel Waugh's Report.

† *Vide* Professor Wilson's Report.

‡ Thalia, cii. Elsewhere, Melpomene, xliv., Herodotus describes Kaspatyrus as on the banks of a river navigable thence to the Indus; from which some writers are led to suppose it must have been on the Kabul River. I doubt very much whether a fleet of ships could have sailed down the Upper Indus. Too much stress must not be laid upon this passage. We find our own countryman, Sir Thomas Roe, who ought to have been able to obtain correct information, describing the river Behut as falling into the Ganges; “though,” he adds, “some say it runs into the sea in the north part of the Bay of Bengal.” *Vide* Roe's Travels, in Churchill's Collection, ed. 1744.

Hamilton, who visited India in 1688-1723, describes the Indus as navigable for vessels as high as Kashmir. *Vide* “Account of the East Indies,” Edinburgh, 1227.

ancient authors who allude to Kashmir, we find the venerable names of Ptolemy, Strabo, and Pliny. Ptolemy indeed very accurately describes the position of the valley itself, which appears at that day to have given its name to the whole country as far south as the Vindya mountains,* which formed, as we learn, the southern boundary of the Aryavarta or Holy Land of the Hindus. Our Honorary Member, Carl von Ritter, considered Kashmir, with Tibet, as the intellectual cradle of the Hindus, although not the primeval source of their civilization, and the Hindus of the present day themselves consider Kashmir as holy ground.†

The most ancient Hindu history extant, the Raju Frangrini, is a history of the kings of Kashmir. It was compiled in the twelfth century, from the works of seventeen authors, as well as from the archives of the temples, and gives lists of the dynasties and powers that ruled in the valley, as well as describes the building of the temples in the valley, the ruins of which, form some of the most interesting monuments in India, of an ancient and high civilization.‡ We learn from this history of the long past, that at a period, when half Europe was in a state of semi-barbarism, the Hindu had attained an excellence in many of the arts, architecture, sculpture, &c., in some of which they are to this day unrivalled. Down to the time of the Venetian traveller, Marco Polo,§ who wrote in the thirteenth century, Kashmir appears to have existed as an independent kingdom, and the population to have been chiefly Hindu, although followers of Buddha existed there; a sect which does not appear to have been quite exterminated even in the sixteenth century, as the Mohammedan historian, Abul-fazel, tells us that near two thousand of them existed in Kashmir in his day.¶ It appears that in early times,

* *Vide* also Lassen *De Pentapotamiæ Indica*.

† Masûdi, the Arabian historian who wrote A.D. 947, observes, "The kingdom of Cashmere forms part of India; it is surrounded by very high mountains; it contains a prodigious number of trees and villages; it can be entered only by a single pass which is closed by a gate." This evidently alludes to the Baramula Pass, across the entrance of which a wall, with forts, connecting a bridge over the river, formerly existed.—W. P.

‡ Compiled by Kalhano the Pundit. *Vide* a translation in French, by M. A. Troger, Paris, 1840.

§ *Vide* Marsden's translation, published by Bohn.

¶ The most ancient religion of Kashmir was the orphite or snake worship; it was suppressed by the Buddhists; the first thirty-five kings of Kashmir were Buddhists; Buddhism was in the zenith of its fame in the time of Asoka, B.C. 263, 226; he it was who erected the laths, or inscribed pillars.

Brahminism was introduced about the first century of our era; the two religions appear to have flourished contemporaneously; when Fa Hian, the Chinese Buddhist, visited Kashmir in A.D. 399, Buddhism was in the ascendant there. Ramagupta, King of Kashmir, in the tenth century, destroyed the Buddhist images and burnt the monasteries.

Kashmir, the ancient seat of the Hindu religion and literature, furnished Southern India with carved images of the deities for the temples, and it was the wealth, derived from its manufactures and its idolatrous sanctity, which tempted the avarice and caused the zeal of the Mohammedans, by whom it was invaded at an early period. The last Hindu sovereign of Kashmir, the heroic Raj-pootnee princess Koteran, having lost her kingdom by an internal insurrection, perished by her own hand in A.D. 1341; the valley then passed into the hands of independent Mohammedan kings, who held possession down to A.D. 1586, when it was reduced by the Emperor Akbar, and became an integral portion of the empire of Delhi; and its pleasures perhaps contributed not a little to hasten the downfall of the Mogul dynasty. In A.D. 1753 it passed from under the sway of the Mogul throne into the power of the Affghans, from whom it was wrested by the Sikhs under Runjeet Singh in 1819; "then, after the lapse of nearly five centuries, it again fell under the sway of a Hindu sovereign."

When the Sikhs took possession of the valley in 1819, the population is said to have numbered 800,000. Shortly after, an earthquake destroyed 1200 persons, a pestilence followed, which is said to have carried off 100,000 more, and a great famine added to the miseries of the people, thousands of whom died, and many fled the country to Hindustan and the Punjab, so that in 1833, the total number is said to have been reduced to 200,000: of this, about 30,000 are Hindus of the Brahmin cast and Sikhs; the remainder are Mohammedans, chiefly of the Sooni sect.*

Years of oppression and systematic tyranny have completely changed the character and broken the spirits of this once brave and warlike race, for although still the finest specimens of the Indian race, and remarkable for their symmetry and strength, they are wholly wanting in all the finer qualities for which they were formerly distinguished, and have at length acquired the vices of slaves. The exceeding wretchedness of the villages, and poverty of the inhabitants, have for years past formed a theme for the description and commiseration of every traveller.

The best work on Kashmir is Mr. Vigne's, F.R.G.S.; it is perhaps not so philosophical as the Baron von Hügel's, but it is far more practical, and a better guide-book, while it is eminently trustworthy; the map which accompanies it has, for a long time past, been the mine whence others have been manufactured; and when the time,

* The language of Kashmir is considered by the learned to be of undoubted Sanscrit origin, but considerably corrupted by the number of Persian words introduced by the Mohammedan conquerors. *Vide* Major Leech, on the Kashmir Language.

and difficulties under which it was compiled, are considered, it must be regarded as an astonishing production.*

Captain Montgomerie's survey shows that the valley is surrounded by a well-defined and connected Cordillera, which varies in height to nearly 18,000 feet above the sea; this is covered with snow for at least eight months in the year. Humboldt describes it correctly as a true caldron-shaped valley in the midst of the Himalaya.

The valley of Kashmir is somewhat of an oval form; its greatest length being, from north-west to south-east, 89 miles; the breadth varies from 10 to 35 miles. The lowest part of the valley is the Wullur lake, which is 5189 feet above the sea; the average height of the valley may be taken at about 5500 feet above the sea. The distance of the high ridge, from what may be termed the valley, varies from 10 to 20 miles; one of the most striking points is that of the Haramuk mountain, which, rising immediately over the Wullur lake, reflects its lofty summit in its surface. The summit of this mountain is 16,903 feet above the sea, and it is one of the highest points seen from the valley, while it is but 14 miles distant in a direct line from the Wullur lake. The high range, which separates the valley from the plains, is called the Pir Punjal range, the highest point of which is 15,528 feet above the sea.

The monarch of the mountains which surround the valley is the magnificent mass of Dayamur, or Nanga Parbat, literally Naked Mountain; so called, from its being bare of snow, owing to the remarkable steepness of its sides. This mountain reaches the enormous height of 26,629 feet above the sea. It is but 65 miles distant in a direct line from the Wullur Lake, and upwards of 21,000 feet above it. It is the culminant point of a great mass of mountains, which, for 15 miles from it as a center, are over 20,000 feet in height; it is 900 miles distant in a direct line from the Great Mount Everest, and lies on the range of the true Himalaya, which even in this latitude, $35^{\circ} 14' \text{ N.}$, asserts its great superiority over all other mountain ranges in the world.†

A recent letter from Northern India informs me that Captain Montgomerie has discovered in the Kárákorum, or Trans-Tibetan Chain, a peak measuring 28,400 feet above the sea; and Colonel Waugh, in his letter to Government, alludes to a peak measuring 28,270 feet above the sea; so that it is probable that here a rival will be found even to Mount Everest itself. We know as yet little of this region. Dr. Thomson ascended the Kárákorum

* Hügel's map was made by Arrowsmith from the Baron's own MS. map, in conjunction with data from Moorcroft's and Trebeck's journals.—ED.

† This mountain ranks fourth amongst the highest measured summits on the globe.

Pass in 1846. He found it to be 18,660 feet above the sea ; a great height for a pass, even in the Himalaya. We have a record of this pass having been crossed by the Chinese pilgrim, Fa-Hian, fifteen hundred years ago.*

There are perhaps a dozen passes by which the valley may be entered ; the following are the heights of some of the principal :—

	Feet.
Koksar Pass	13,315
Murbul Pass	11,550
Murgan Pass	11,600
Pir Punjal Pass	11,400
Banihal Pass	9,200
Ratan Pir Pass	8,200

The valley is drained by the Jhelum river, called Vehut in the valley, the Bedusta of ancient times, which the Greeks changed into Hydaspes. It has its source in the Sesha Nag lake, at the head of the Lidur river. I found this lake to be 11,250 feet above the sea ; it is situated in a small amphitheatre of mountains, points of which reach 17,000 feet above the sea. This lake is the most distant source of the Jhelum river, and the Lidur the largest of its tributaries. This stream passes through a most picturesquely-wooded rocky glen, for a distance of about 35 miles to Islamâbâd, in the valley through which the Thelam winds, for a length of fully 90 miles, in snake-like curves, and with a gentle current, spreading out in places into several lakes, the largest of which, the Wullur Lake, is a fine expanse of water, 10 miles in length by 5 in breadth.

In ancient times, the river was carefully inclosed by banks, to prevent inundations ; these, however, have long been neglected, and now many square miles of the flat lands are reduced to swamps, by the constant overflow of the river, when swollen by the melted snows.

The Jhelum enters the Himalaya, near Buramula, penetrating the range, in a direction nearly at right angles to the strike of the hills, for a distance of about 20 miles, in a direct line to Uri, whence its course lies along the strike of the outer range, following a line of fault to Mozufferabad, about 40 miles, in a direct line to the north of Uri.

The defile by which the river Jhelum leaves the valley of Kashmir, is perhaps one of the grandest in the world. The great chain of the Himalaya is cleft in two by a great chasm, upwards of 7000 feet in depth ; the bottom is very narrow, and is wholly occupied by the river ; near Uri it is but 70 feet across, with almost perpendicular sides ; through this natural sluice passes the

* Fa-Hian, A.D. 399.

whole volume of the Jehlum River, with the most astonishing velocity.*

The whole way from Barumula to Uri the scenery is one of striking grandeur. In the first 10 miles, the river, although confined to a narrow channel, meets with few obstacles to oppose it, and, with a calm consciousness of its own strength, rolls onward with an almost noiseless tide. For the next 15 miles the bed of the river is a succession of rapids, and a mass of foam, which forms a fine contrast to the dark mass of forest of oaks, planes, and cedar trees, which clothe its banks down to the very edge of the water. It is only along this section of its course that the river deserves the name of the "Cedar-fringed Hydaspes," for this tree is rarely found in the valley of Kashmir, nor does it grow at lower elevations. The river is here about 4500 feet above the sea.

It is probable that the cedar forests, through which the river here flows, furnished the fleet of Nearchus upwards of twenty centuries ago. The Punjab obtains its chief supply of this almost imperishable timber from these forests.

I may here state, that recent surveys have established the fact, that where the classic stream Hydaspes debouches into the plains of the Punjab, Alexander fought his last great battle in India, defeating his powerful and gallant foe Porus, the king of the Upper Punjab.

The river there, flowing through a rocky bed, has so little changed its features, that the description of the locality, given by the Greek historian Arrian, corresponds almost minutely with what we now see it. The British Cantonment of Jhelum marks the site of Bucephalia, the city which Alexander founded in memory of his celebrated charger. Many interesting relics have been found in the vicinity.

The district which there borders the river is still called Sikunderabad. Sikunder was the name by which Alexander was known in India. This is a singular instance of the preservation of an historical fact through so many generations. Alexander fought this battle 326 years before Christ.

It would be impossible to convey any idea of the exceeding grandeur of the scenery of the valley of Kashmir itself: unquestionably the finest view is obtained from the summit of the

* The traveller seldom enjoys a very extensive prospect of this truly grand defile, owing to the abrupt bendings of the river and the precipitous nature of the sides. In places the slopes are remarkably steep: a little beyond the village of Gingal, a point of the high range reaches a height of 11,583 feet above the sea, or 7600 feet above the river; in a horizontal distance of 3 miles, another peak, called Kaj Naj, is 8100 feet above the river, and but 5 miles distant; another is 10,400 above the river, and but 8 miles distant from it: these will suffice to give some idea of the features of this remarkable defile.

Takht-i-Suliman hill,* which, rising abruptly fully a thousand feet above the plain, and situated almost in the center of the valley, commands every object of interest around it. The panorama which this position affords, is one unrivalled for variety, extent, or magnificence. The valley itself one of the largest in the world, and the mountains which surround it amongst the highest, grassy plains, snow-clad summits, river, lake, and forest, every element in fact of fine landscape, and all on a grand scale, are here seen blended together in most perfect harmony.

But the great charm of the valley is its variety. The traveller can, in the course of a few short hours, enjoy almost every variety of scenery and climate; while the man of science, the botanist, the geologist, or the antiquary, will find abundant matter for contemplation; add to this, that the climate of the valley is perhaps unrivalled; in the hottest months the thermometer rarely rises above 75° or falls below 50°, while in the winter it is not often seen much below the freezing point. The valley itself is adorned by trees, chiefly the mulberry, the chesnut, and Oriental plane, groves of which, with poplars, were planted in every village by the Mogul Emperors. Nearly every variety of fruit known in Europe flourishes in the valley, with the exception of the orange, the lemon, the fig, and the olive.

“It is to the enlightened and beneficent Akbar, the first Mogul Emperor of Kashmir, that it owes many of its chief attractions. It was he who caused it to be surveyed and reduced to order, beautified it with palaces and gardens, leaving little else to his son and successor, the magnificent Jehangir, than to enjoy the delights of this eastern paradise, in company with his empress, the peerless Noor Mahal, whose romantic spirit appears to have led her lord and emperor to roam into the most secluded and picturesque recesses of the valley, many of which pleasant retreats are to this day pointed out as the spots where the royal pair were wont to disport themselves in those days of regal abandon.”

Jehangir built many palaces and summer-houses; more especially he completed the construction of the celebrated Shalimar Gardens, immortalized by poets and travellers. The Nasam (or Salubrious) and Nirhat Bagh was the fancy of Noor Jehan Begum, to whose taste many other beautiful retreats owe their origin. The ruins of the palaces at Manasbul, Echibul, Virnay, &c., attest her taste in selecting picturesque sites.† The summit of the Takht-i-Suliman hill is crowned by a most ancient temple, built 220 years before Christ, and still in an almost perfect state. This is the oldest

* Immediately over the Capital, Sniragar, built A.D. 432.

† *Vide* a Sketch of the Mohammedan History of Cashmere, by Lieut. D. Newall, of the Royal Artillery, Journal As. Soc., 1854.

temple in the valley, and certainly occupies the finest position in it; here, as indeed everywhere in the valley, I have been struck with the fine appreciation of natural beauty the original inhabitants of the country evidently exercised. The site selected for a temple invariably commands the most picturesque view to be obtained in the vicinity. "A profound love of nature," observes Humboldt, "has been at all times a fundamental character of the Hindu mind."*

The valley is studded with the ruins of temples, which bear unmistakable evidence of the influence of Grecian art; they were built by its ancient Hindu sovereigns, but reduced to ruins by the bigoted zeal of the idol-breaking Sikandar, the Mohammedan prince who flourished in the early part of the fifteenth century. "The Kashmirian fanes are distinguished by the graceful elegance of their outlines, by the massive boldness of their parts, and by the happy propriety of their decorations. They cannot indeed vie with the severe simplicity of the Parthenon, nor with the luxuriant gracefulness of the monument of Lysicrates, but they possess great beauty; different indeed, yet quite their own."† They were built in the most substantial manner, of large blocks of marble, highly polished, and finely chiselled.

Of the many routes by which the valley may be reached from the plains, that which follows the course of the river Jhelum is the only one which is not closed by snow for some portion of the year. The route by the Pir Punjal is the most direct, and, when the pass is practicable, is the most frequented. This pass is one of the highest, being 11,400 feet above the sea; the ascent, however, from the valley is gentle, the rise being under 5000 feet in a horizontal distance of $17\frac{1}{2}$ miles. The descent, however, on the other side is very steep; Colonel Cunninghame, a very extensive traveller, considers it one of the worst in the Himalaya. My observations make the fall 4900 feet in a horizontal distance of 6 miles, or a slope of about 1 in $6\frac{1}{2}$; the slope of the next, or Rattan Pir range, is still steeper, being 1700 feet in a horizontal distance of 2 miles, or less than 1 in 5; that is, from Baramgula to the summit of the pass, which is 8200 feet above the sea.

From this pass a fine view is obtained of the belt of lower hills, about 30 miles in breadth, which intervenes to the Punjab plains, which are there not more than 1000 feet above the sea.

Hugel is incorrect in speaking of the eternal snow of the Pir Punjal range. Towards the end of summer the snow entirely disappears from off the range, although some of the higher points exceed 15,500 feet in height. In Colonel Cunninghame's valuable

* Kosmos, Sabine's translation, note 62, vol. ii.

† See Cunninghame's "Essay on the Arian Order of Architecture, as exhibited in the Temples of Kashmir," *Journal As. Soc. of Calcutta*, 1848.

work* on Ladák, we find a very instructive section, which shows, that as the mass of land rises, the snow-line recedes higher and higher, notwithstanding the increase of the latitude. In Labah, the country which lies to the east of Kashmir, the line at which all the snow which falls annually melts is elevated 20,000 feet.†

The character of the whole country, which separates Kashmir from the plains of the Punjab, is essentially mountainous, there being scarcely any extent of level ground to be found. Cultivation is exclusively confined to the more open portions of the slopes along the streams, terracing being almost always necessary to keep up the soil and admit of irrigation.

These hills are almost everywhere covered with dense forests and a thick undergrowth of jungle, rendering them imperishable; about 11,500 feet is the limit of forest; above this, a low bushy juniper is the only variety of tree foliage met with.

A variety of pine (*Picea Webbia*), with birch (*Taxus baccata*), reach the extreme limit of forest. The cedar tree (*C. Deodara*), with a very elegant variety of fir, of great height, and with pendant branches (*Abies Smithiana*), form dense forests from 6000 to 10,000 feet. Below this belt the forest assumes a more familiar face, the various variety of pines, including *P. excelsa*, *P. longifolia*, being mixed up with an occasional oak. *Quercus semicarpifolia*, sycamore, horse-chestnut (*Pavia indica*), and yew (*Taxus baccata*).

I have nowhere seen more beautiful or varied forest scenery than that which clothes these lower hills.

In the low hot valleys, approaching the Punjab plains, a very beautiful variety of wild olive (*O. Zartoon*) occurs, with a species of *Dodonæa*, together with the various kinds of acacia, indigenous to the Punjab: *A. arabica*, *A. modesta*, *A. albispina*.

It would perhaps be out of place here to enter into a detailed description of the geology of the region, some of the physical features of which I have endeavoured to describe; I shall, therefore, but briefly sketch some of its chief geological characters.

I would first remark, that no rock of a true crystalline nature occurs throughout the district I have described.

It has been asserted, that the core of the Outer Himalaya

* Ladák and Surrounding Countries. Allen and Co.

† The following note on the great elevation of the snow-line in Tibet occurs in Dr. Hooker's Himalayan Journals, vol. ii. p. 128.

“From the imperfect transmission of the heating rays of the sun through films of water, which transmit perfectly the luminous rays, it follows that the direct effects of the rays, in clear sunshine, are very different at equal elevations, of the moist Outer and dry Inner Himalaya. Secondly, naked rock and soil absorb much more heat than surfaces covered with vegetation, and this heat again radiated is infinitely more rapidly absorbed by snow (or other white surfaces) than the direct heat of the sun's rays is. Hence at equal elevations the ground heats sooner, and the snow is more exposed to the heat thus radiated, in arid Tibet, than in the wooded and grassed mountains of Sikkim.”

consists of rocks of a basaltic or sienitic nature ; neither of these rocks occur, as far as my investigations extend, and I have examined the localities where they are said to appear. I am disposed to refer the basaltic appearance the rocks locally assume, to igneous action, and to consider them as stratified metamorphic rocks. True gniess, which forms the prevailing rock of a great portion of the Himalaya, I did not observe.

The mountain mass, which forms that portion of the higher Himalaya which separates Kashmir from the plains of the Punjab, is composed of a vast series of pseudo-metamorphic and crystalline rocks, consisting of schists, quartzites, grits, conglomerates, and slates ; these rocks succeed and alternate with each other, and are in places penetrated by quartz veins, and dykes of amigdaloidal greenstone, the whole apparently stratified with a high dip, north to north-east.

When I examined these mountains, I was not aware of the result of the investigations of the brothers Schlagentweit, who have had opportunities, enjoyed by few, of examining a great extent of the Himalaya. These gentlemen state, that they are convinced that there is no real stratification, but only cleavage ; produced, as is now generally assumed, by a great tension in the interior of the highly altured rocks.

The great mass of the Rattan Pir, or Outer Himalaya, is composed of rusty-coloured schistose strata, unfossiliferous. The appearance of these rocks strongly recalls to mind the greywacke rocks of Caernarvonshire, which are, I believe, regarded as the lowest of the Silurian system. The dip of the rocks in this range is 30° to 50° in a north-east direction.

The next range, the Pir Punjal, or Mid-Himalaya, is separated from the last by the valley of the Paunch river. Ascending this range from Barangula, we meet with a vast series of micaceous schists, grey and satiny schists, and highly felspathic rocks, thin-bedded with rusty-coloured partings ; interstratified with these occur beds of pseudo-volcanic purplish-coloured grits and conglomerates, remarkably compact ; large rectangular masses of this rock strew the path on the ascent to the pass ; these masses exhibit perfectly clean pastures, the matrix being as hard as the enclosed rocks. These rocks are observed running up to the summit of the range, and continue until the descent on the Kashmir hill commences, where they are covered by coarse earthy roofing slates, unfossiliferous ; these again are covered by a rock of a very trappian aspect, having a dark green base, with kernels of quartz. I am inclined, however, to regard it as an altered chloritic slate ; it is regularly imbedded with the older strata. The dip of the strata is 30° to 40° , decreasing to about 15° as the valley of Kashmir is approached ; the direction north to north-east.

Reposing conformably on these older strata occur a series of fine-grained sandstones, clays, and conglomerates, containing boulders of prismatic rocks; these are undistinguishable from the Miocene strata which flank the Himalaya on the side of the Punjab; with which rocks I consider them to be contemporaneous. This formation tails out for several miles into the valley of Kashmir on its western side only.

Rocks of Miocene age form the entire mass of the lower hills, which intervene between the Outer Himalaya and the Punjab plains: they are doubtless the northerly extension of the Sivalic hills of Cantly and Falkner. I have obtained a large and various collection of mammalian remains, chelonians, and some bivalve shells, from this formation, which has a great development in the Upper Punjab, and in the country beyond the Indus.

I am by no means clear that the remarkable valley or gorge which separates the Outer from the Mid Himalaya, and along the bottom of which the Paunch river flows, does not mark a line of fault, and that, in the upper portion of the Pir Punjal range, we have repeated the rocks met with in the Rattan Pir range; admitting this, however, to be the case, still the thickness of the crystalline rocks is enormous, probably 30,000 feet or upwards. This portion of the Himalaya is so covered with dense forests, that it is exceedingly difficult to observe correctly the relations of the strata, which can be seen only in the beds of the gorges and water-courses in the vicinity of the regular track. When I crossed these mountains, the whole surface of the upper portion was marked by snow.

The rocks which I have described, as forming the Pir Punjal range, extend, in an unbroken band, right round the valley of Kashmir, from the Baramula Pass to the valley of the Sinde river, on the opposite side; and, doubtless, have a still further extension on the northern boundary of the valley, which, however, I have not had an opportunity of visiting.

Some variety of the rocks met with on the side of the Pir Punjal occurs in all the passes which I have examined. On the way to Wurduran I observed felspathic schists, distinctly ripple-marked: the elevation was about 14,000 feet.

I have already described the defile by which the river Jhelum leaves the valley of Kashmir; a magnificent natural section of the Himalaya is there exposed. The mass of mica-schists and felspathic rocks, which are so greatly developed in the Pir Punjal, are here wanting: instead we find compact chlorite slate with quartz veins. About Uri, these are altered by igneous action, so as to resemble some varieties of basalt, or whinstone; this rock occurs regularly interstratified with other rocks. Clay-slate occurs here in all its varieties.

Great disturbance and shattering of the strata is observed, especially about Uri, where the rocks are in a nearly perpendicular position; nor is there any igneous rock visible to account for this disturbance. The dip, for some distance beyond Uri, is very high, but gradually diminishes, as Naushera, at the entrance of the valley of Kashmir, is approached. Clay-slate, or some variety of it, forms also low hills in the valley of Kashmir itself. The Lakht-i-Suliman Hill is an example. The rock is there seen penetrated by veins of amygdaloidal greenstone. The direction of the dip of the rocks is nearly similar on both sides of the valley; it is in general, however, much higher on the east side, and forms frequently abrupt precipices, while the slopes on the western side are in general gentle. The long talus of Miocene rocks, which flanks the older strata on the western side of the valley, breaks greatly the abrupt appearance of the sides of the valley, as compared with its western side, where these rocks are not found.

Regarding the valley of Kashmir itself, the most casual, the most unscientific observer, cannot fail to be struck with the fact, that at one period of its history the valley was covered with water; the marks of former sea-beaches are so distinctly discernible at various elevations, especially along the steep cliffs which border the Wullur Lake; and accordingly we find a very pretty story, invented by the Brahmin priests, of the miraculous way the valley was drained, by the intervention of the gods. The period when the valley was submerged, although geologically recent, was long antecedent to all history; when, in fact, the greater portion of the Himalaya itself was still beneath an ocean.

A vast deposit of alluvium once covered the whole valley, to a height of probably 1000 feet above the level of the Wullur lake. This must have been deposited when the valley was submerged. In channeling out its bed, through this deposit, the river Thelam and its tributaries have, in the course of ages, removed a large portion. About the Wullur lake, which is the lowest part of the valley, the amount removed is greatest. Near Bij-Bihara,* at the higher end of Kashmir, the valley of the river is but 2 miles across, the alluvium deposit presenting abrupt faces to the river 20 to 50 feet in height; it is composed, in its upper portion, of very fine clays of various colours, and, in its lower portion, of beds of conglomerates; it is intersected by the numerous streams and water-courses, which descend from the high ranges on all sides, dividing it into many isolated patches, locally called Kariwas; these are richly cultivated, producing the saffron, for which the valley is celebrated.

I procured from this formation several species of fresh-water shells, some of which are of a similar variety to those abundantly

* Or, Vidyà Vihara—Temple of Wisdom.

found in the alluvium of the Upper Punjab—*Bulimus Karawarensis*, *Hutt*, *B. speldus*, *B. pullus*, *planorbis*, *indicus*.

The defile of the Jhelum river, between Kashmir and Mozufarabad, a distance of about 90 miles, is covered to a depth of several hundred feet by a deposit of coarse and fine drift, occasionally interstratified with beds of fine sand.

The river has cut its way down through this deposit to the level of the underlying slate rock, the surface of which has regulated the fall of the river, for nowhere does it appear to have removed the solid rock to any great depth. With such regularity has the river cut its way down through the deposit, that its channel has all the appearance of having been formed artificially.

In this drift deposit occur boulders and angular blocks of granite and other rocks, not found in the vicinity *in situ*; and near Banihár the flat surface of the terrace is strewn with large angular masses of porphyritic granite, many blocks being 30 tons weight and upwards. The nearest point to this locality, where granite occurs *in situ*, is on the opposite side of the valley of Kashmir, a distance of fully 50 miles, for where these erratic blocks are seen: they have, in all probability, been transported by icebergs across the valley, when it was, together with probably a large portion of the Himalaya, submerged beneath an ocean. We have here, perhaps, as fine an example of the transportation of erratics across a broad and deep valley, as the well-known one where the granite of Mont-Blanc has been carried across the lake of Geneva, and deposited upon the flanks of the Jura.* The channeling by the river of its bed must have taken place when the country was being upheaved, and, as we find terraces at different elevations, this action must have been intermittent. These facts all tend to prove the correctness of the view, which has been advanced by an able and experienced observer, Dr. Hooker, viz., "that the entire mass of the Himalaya has arisen from the ocean, and that every portion of it has been subjected to sea action."

It was by the route of the Pir Punjal that the Mogul Emperors passed to spend their summers in Kashmir. In the pages of Bernier, the French physician who accompanied the Emperor Arungzeb, in 1664, we have a lively and graphic description of the royal progress, and of the magnificent cortège which accompanied, consisting of 35,000 horse and 10,000 foot, 70 pieces of heavy cannon, and 50 to 60 pieces of stirrup artillery, as it was called. It is said that a good road across the mountains existed in those days; the route is still called the Emperor's Highway. I scarcely saw a vestige of a road, nor would it appear that any

* See Sir Roderick I. Murchison's Paper on this subject, *Journal Geographical Society*, 1849.

works of a permanent nature were ever attempted beyond serais ; the ruins of several very fine ones are to be seen on the route. "The present dilapidation of these buildings is sometimes adduced as a proof of our indifference to the comforts of the people ; it is not considered that where they do exist in good repair they are but little used, and that the present system of government no longer renders it necessary that travellers should seek protection in fortified enclosures. If they are to be considered proofs of the solicitude of former monarchs for their subjects' welfare, they are also standing memorials of the weakness and insufficiency of their administration ; add to which that many of the extant serais were the offspring not of imperial but of private liberality."

The British Government has frequently been taunted with the little they have done for the comforts of the people, as compared with their Mohammedan predecessors ; and although it is not attempted to deny the great beauty of many of *their* structures, it may be doubted whether the work of the Great Ganges Canal, which fertilizes a whole province, is not likely to prove of more substantial benefit to the people, than all the boasted works of their Mogul masters, during their 600 years' dominion ; while the scientific survey of India is as magnificent a monument of civilization as any country in the world can boast of.

III.—*Notes on the Valley of Kashmir.* By Capt. H. H. AUSTEN, F.R.G.S., 1st Battalion, 24th Regiment, Topographical Assistant, Government Trigonometrical Survey, Panjab.

Read, December 12th, 1859.

THE few following observations must be considered merely supplementary to the very interesting and able report by Colonel Waugh, giving a detailed account of the manner in which the Kashmir Trigonometrical Survey is conducted, the area which it comprises, and the high altitudes over which those connected with it have to carry the Trigonometrical net-work. Having been employed on the survey of several districts of that valley, perhaps a few remarks, however meagre, may prove interesting to those present who have never visited that part of the W. Himalaya range. Many general observers, looking at a map like the one now exhibited, however much taken with the drawing and execution of it, the last phase of its existence, as it may be called, may perhaps think little of the immense work—that of weeks, months, and years which it has taken ; the altitudes climbed, the long, wearing descents (for, of the two, the last is the most tiring and difficult