MYSORE

PHYSICAL GEOGRAPHY

THE State of Mysore[1] occupies a position physically well defined, in the South of India; and has been termed a rocky triangle, a not inapt description. It is a table-land, situated in the angle where the Eastern and Western Ghat ranges converge into the group of the Nilgiri Hills. West, south and east, therefore, it is enclosed by chains of mountains, on whose shoulders the plateau which constitutes the country rests. On the west the boundary approaches at one part to within 10 miles of the sea, but in general preserves a distance of from 30 to 50 miles from the coast: on the east the nearest point is not less than 120 miles. The southern extremity is 250 miles from Cape Comorin. The northern frontier is an exceedingly irregular line, ranging from 100 miles south of the river Krishna on the west to 150 on the east.

The country extends between the parallels of 11° 38′ and 15° 2′ north latitude, and between the meridians of 74° 42′ and 78° 36′ east longitude, embracing an area of 29,305 square miles, as determined by the Surveyor-General of India from the recent survey on the one-inch scale. (It is therefore nearly equal to Scotland, whose area is 29,785 square miles.) The greatest length north and south is about 230 miles, east and west about 290.

[1] The name is that of the capital, properly *Maisúr*, for *Mahishúr*,—from *mahisha*, Sans. for buffalo, reduced in Kan. to *maisa*, and *úru*, Kan. for town or country,—which commemorates the destruction of Mahishásura, a minotaur or buffalo-headed monster, by Chámundi or Mahishásura-mardani, the form under which the consort of Siva is worshipped as the tutelary goddess of the Mysore royal family.

Except in a passage in the Mahawanso, where it is called Mahisha-mandala, the designation of the country throughout Hindu literature is Karnáta or Karnátaka (for derivation see chapter on Language), which properly applied to the country above the Ghats. But the Muhammadans included in the name their conquests below the Ghats as well, and the English, going a step further, erroneously restricted it to the low country. Hence Carnatic and Canara now designate, in European works of geography, regions which never bore those names; while Mysore, the proper Karnátaka or Carnatic, is not so called.

It is surrounded by the Madras Presidency on all sides, except on part of the west, where the Bombay Presidency northwards and Coorg southwards form the boundaries. The Madras Districts bordering on it are Bellary and Anantapur on the north; Kadapa, North Arcot and Salem on the east; Coimbatore, Nilgiris and Malabar on the south; South Canara on the west. The Bombay Districts of Dharwar on the north and North Canara on the west complete the circle. Coorg intervenes between the adjacent parts of South Canara and Malabar on the south-west.

The general elevation rises from about 2,000 feet above the sea level along the northern and southern frontiers to about 3,000 feet along the central water-parting, which separates the basin of the Krishna from that of the Kávéri and divides the country into two nearly equal parts. But the surface is far from preserving the even character suggested by the designation of table-land. For the face of the country is everywhere undulating, much broken up by lines of rocky hills or lofty mountains, and scored in all parts by *nálas* or deep ravines. There is probably not a square mile in the whole superficies absolutely flat or level, the slope of the ground ranging from 10 to 20 feet per mile in the more level portions, and as high as 60 and 80 feet elsewhere.

The country is longitudinally intersected by single or aggregated chains of hills, running chiefly north and south, or in a direction nearly parallel to the two coasts. They lie at uncertain and unequal distances from each other, and accordingly form sometimes wide and sometimes narrow valleys. Isolated peaks of massy rock, termed by Europeans *droogs*,[1] rearing their heads to 4,000 or 5,000 feet above the level of the sea, stand forth like sentinels on every hand; mostly crowned with the remains of fortifications, whose position, with the advantage of an unfailing supply of water at the summit, rendered them wellnigh impregnable strongholds. Besides these, clusters or piles of naked rocks, composed of immense rounded boulders, are frequent; large fragments being often delicately poised, like logging stones, upon some projecting point; appearing as if a touch would overturn them, and yet sometimes supporting a shrine or *mandapa*.

Natural divisions.—Mysore naturally divides itself into two separate regions, each of which has well-marked and distinctive features.

Of these the Malnád,[2] or hill country, lies to the west, and is confined to the tracts bordering or resting on the Western Ghats. It is a land of magnificent hill and forest, presenting alternations of the most diversified

[1] Properly *dur-ga*, a Sanskrit word meaning *difficult of access*, and denoting hill-fort.

[2] Kan. *Male*, hill; *nádu*, district, region.

and charming scenery. A fertile soil and perennial streams clothe the valleys with verdant cultivation. The sheltered hillsides are beautiful with waving woods, which give shade to numerous plantations of coffee. Higher up are swelling downs and grassy slopes, dotted over with park-like groups of trees. Above all, the gigantic mountains rear their towering crests in every fantastic form of peak. Human dwellings are few and far between. A cottage here and there, picturesquely situated on the rising ground bordering the rice-fields, and hidden amid plantations of areca palm and plantain, marks the homestead of a farmer and his family. Towns there are none, and villages of even a dozen houses rare. The incessant rain of the monsoon months confines the people to their own farms. Hence each householder surrounds himself with all he needs, and succeeds in making himself to a great extent independent of the external world. The conditions of this isolated life are insupportable to immigrants from the plains.

But by far the greater portion of the Province, or all to the east and north of a line from (say) Shikarpur to Periyapatna, continued along the southern border to the Biligirirangan hills, belongs to the division of Maidán, Bail shíme, or open country. Although much of the intermediate region partakes of the characteristics of both, the transition from the Malnád to the Maidán is in some places very marked. Dense forests, which shut in the view on every hand, give place to wide-spreading plains: the solitary farm to clustering villages and populous towns. Man meets with man, the roads are covered with traffic, and the mind feels relief in the sympathy of numbers.

The means of water-supply and the prevailing cultivation give the character to the various parts of the open country. The level plains of alluvial black soil, as in the north, growing cotton or millet; the districts irrigated by channels drawn from rivers, as in the south and west, displaying the bright hues of sugar-cane and rice-fields; the lands under tanks, filled with gardens of cocoa and areca palms; the higher-lying undulating tracts of red soil, as in the east, yielding ragi and the common associated crops; the stony and wide-spreading pasture grounds, as in the central parts, covered with coarse grass and relieved by shady groves of trees. The aspect changes with the seasons, and what in the dry and cold months, when the fields are lying fallow, appears a dreary and monotonous prospect, speedily assumes under the first operations of the plough the grateful hues of tillage; which, under the influence of seasonable rains, give place in succession to the bright verdure of the tender blade, the universal green of the growing crops, and the browner tints of the ripening grain. The scene meanwhile is full of life, with husbandmen, their families and cattle engaged in the

labours of the field. These are prolonged in stacking and threshing until the cold season again sets in and the country once more assumes a parched and dusty aspect.

River systems.—The drainage of the country, with a slight exception, finds its way to the Bay of Bengal, and is divisible into three great river systems; that of the Krishna on the north, the Káveri on the south, the two Pennárs, and the Pálár on the east. The only streams flowing to the Arabian Sea are those of certain taluqs in the north-west, which, uniting in the Sharavati, hurl themselves down the Ghats in the magnificent falls of Gersoppa; and some minor streams of Nagar and Manjarabad, which flow into the Gargita and the Netravati.[1]

A line drawn east from Ballálráyan-durga to Nandidurga (Nundydroog) and thence south to Anekal, with one from Devaráydurga north to Pavugada, will indicate approximately the watershed separating the three main river-basins. From the north of this ridge flow the Tunga and the Bhadra, rising in the Western Ghats and uniting in the Tungabhadra, which, with its tributary the Hagari or Vedavati, joins the Krishna beyond the limits of Mysore in Srisaila near Karnul. From the south of the line, the Hemavati (with its affluent the Yagachi), the Lokapávani, Shimsha, and Arkavati flow into the Káveri, which, rising in Coorg and taking a south-easterly course through the country, receives also on the right bank the Lakshmantirtha, the Gundal, the Kabbani and the Honnu Hole before quitting the territory. From the east of the line, in the immediate neighbourhood of Nandidurga, spring three main streams, forming a system which Lassen has designated "die Tripotamie des Dekhans," namely, the Uttara Pinákini or Northern Pennár (with its tributaries the Chitravati and Pápaghni), which discharges into the sea at Nellore; the Dakshina Pinákini or Southern Pennár,[2] which ends its course at Cuddalore; and between them the Pálár, whose mouth is at Sadras. A continuation of the east and west line through Nandidurga to Sunnakal will mark the water-parting between the first and the other two; which, again, are divided by a line passing from Jangamkote to Bowringpet and the Betaráyan hills.

More accurately described, the axial line or "great divide" which forms as it were the backbone of the country, starts from the north of Ballálráyandurga and runs east-by-north to near Aldur. Thence it makes a bend, first, northwards up to the western extremity of the Baba

[1] The course of each river is described in detail in Vol. II.

[2] Its name below the Ghats appears to be *Poni-ár* or *Ponn-ár*, golden river, *ár* being the Tamil for river. It would be very convenient were geographers to agree upon restricting the name Penna to the northern stream and that of Ponna to the southern. The former is also called Pennér (written Pennair), *éru* being the Telugu for river.

Budan range and then south-east, passing between Belur and Halebid, down to Sige Gudda in the north of the Hassan taluk. From this point it strikes across the map in an east-north-east direction, rounding the southern extremities of the Harnhalli and Hagalvadi hills, up to near Kortagiri, where it encounters the great meridional chain of mountains. Following the range south, past Devaráydurga to near Dodbele, it resumes an east-north-easterly course to Nandidurga and continues the same to the frontier near Sunnakal. Geographically it lies between the parallels of 13° 10′ and 13° 25′.

A line projected north from the west of Kortagiri up through Pavugada to the frontier, and one south from Nandidurga by Bangalore to Anekal, mark pretty nearly the limits of the respective river-basins in the transverse direction. This water-parting falls between the meridians of 77° 10′ and 77° 30′.

The basin of the Sharavati, which runs to Honávar on the Canara coast, occupies the west of the Shimoga District. It may be defined by a line drawn from Kodachádri south-east to Kavaledurga, thence north-east by Humcha to Masarur, and west-north-west by Anantapur and Ikkeri to Talguppa. The streams between Kodachádri, Kavaledurga and the Agumbi ghat westwards, run down to Kondapur; and those of western Manjarabad, to Mangalore.

The following statement contains an estimate of the total length, within the Province, of the main rivers with their principal tributaries; and the total area of the catchment basin under each river-system within the same limits :—

River System	Total Length of Rivers	Total Area of Basins
	Miles.	Square Miles.
Krishna	611	11,031
Kávéri	646	9,486
N. Pennár	167	2,280
S. Pennár	32	1,541
Pálár	47	1,036
Sharavati and west coast rivers	103	1,881

Owing to either rocky or shallow beds, none of the Mysore rivers is navigable,[1] but timber floats are carried down the Tunga, the Bhadra,

[1] From the following statement in Buchanan it appears that Haidar attempted to establish navigation on the Tunga. "From Mangalore Haidar brought to Shimoga many carpenters, and built a number of lighters of about eight tons burthen. They are strong and flat-bottomed; but, as the greater part of them have been allowed to remain on the bank where they were built, I doubt not that they were found very useless. The attempt is, however, no impeachment on the sagacity of Haidar, who

and the Kabbani at certain seasons. Most of the streams are fordable during the dry months, or can be crossed by rude bridges formed of logs or stones thrown across from boulder to boulder. During floods, and when freshes come down, traffic over the streams is often suspended until the water subsides. But throughout the rainy season they are generally crossed at the appointed ferries by rafts, basket boats, canoes, or ferry boats. Men also sometimes get over supporting themselves on earthen pots.

The *teppa* or raft is formed of bamboos lashed together, and merely affords an unsteady footing, the water washing freely through. The *harigólu* or coracle is a circular basket of stout wicker-work, composed of interlaced bamboo laths and covered with buffalo hides. It is 8 or 10 feet in diameter, with sides 3 or 4 feet high.[1] A smaller one, which holds only two people, is used for crossing some jungle streams. The *dóni* or canoe is a dug-out, or hollowed log pointed at the two ends. The *sángda*, or regular ferry boat,[2] is formed of two canoes secured together, with a platform or deck fastened upon them, and has sides turning on hinges which, let down, form a gangway for loading and unloading. All these craft are propelled by a long bamboo pole, and are dependent for their course upon the currents. But paddles are sometimes used with the canoe.

Though useless for purposes of navigation, the main streams, especially the Kávéri and its tributaries, support an extensive system of irrigation by means of channels drawn from immense dams, called anicuts,[3] which retain the upper waters at a high level and permit only the overflow to pass down stream. These works are of great antiquity,

having been educated in a place remote from every kind of navigation, could have no idea of what boats could perform, nor of what obstacles would prevent their utility. To attempt dragging anything up such a torrent as the Tunga would be vain; but, after having seen the boats, and known that some of them have been actually navigated down the river, I have no doubt of its being practicable to carry down floats; and on these perhaps many bulky articles of commerce might be transported."

[1] Herodotus notices, as one of the most remarkable things he had seen at Babylon, boats of a construction so exactly similar, that the description of one would precisely answer for the other, with the single difference of substituting willow for bamboo. These boats carried the produce of Armenia, and "the parts above Assyria," down the Euphrates to Babylon; and each boat along with its cargo carried a few asses for the purpose of conveying the returns by a shorter overland route. Boats of the description noticed by Herodotus, although apparently unknown in Greece at that period, were in after ages commonly used in Italy on the Po; and in Britain in the time of Cæsar. Boats of the same materials but of different shape are used at this time in South Wales, and the north-west of Ireland; in the former country they are named *corracle*, in the latter *corraigh*.—WILKS, i, 257.

[2] The mention of *σάγγαρα* occurs in the Periplus.

[3] From Kan. *ane katte*, both meaning dam, dyke, or embankment.

the large Talkad anicut, the lowest down on the Kávéri, having been constructed a thousand years ago; while the most recent, with few exceptions, are not less than three centuries old. "The dreams which revealed to favoured mortals the plans of these ingenious works (says Wilks) have each their appropriate legend, which is related with reverence and received with implicit belief." The channels or *kálvés* thence drawn, meander over the adjoining tracts of country on either bank, following all the sinuosities of the ground, the total length running being upwards of 1,200 miles.[1]

There are no natural lakes in Mysore, but the streams which gather from the hillsides and fertilize the valleys are, at every favourable point, embanked in such a manner as to form series or chains of reservoirs, called tanks,[2] the outflow from one at a higher level supplying the next lower, and so on all down the course of the stream at a few miles apart. These tanks, varying in size from small ponds to extensive lakes, are dispersed throughout the country to the number of 38,080; and to such an extent has this principle of storing water been followed that it would now require some ingenuity to discover a site suitable for a new one without interfering with the supply of those already in existence. The largest of these tanks is the Súlekere, 40 miles in circumference. Other large ones are the Ayyankere, Madaga-kere, Masur-Madaga-kere, Vyása samudra, Rámaságara, Moti Taláb, &c., of which accounts will be found elsewhere (Vol. II).

The spring-heads called *talpargis* form an important feature of the hydrography of the north-east. They extend throughout the border regions situated east of a line drawn from Kortagiri to Hiriyur and Molkalmuru. In the southern parts of this tract the springs may be tapped in the sandy soils at short distances apart, and the water rises close to the surface. Northward the supply is not so plentiful. In Pavugada a soft porous rock has to be cut through before reaching the water, and in the other taluqs of the Chitaldroog District hard strata of rock have sometimes to be perforated. When the water is obtained, it is either conducted by narrow channels to the fields, or a *kapile* well is constructed, from which the water is raised by bullocks.

Mountain systems.—From the gigantic head and shoulders, as it were, of the lofty Nilgiri group, which commands the southern frontier, are stretched forth like two arms, in a north-west and north-east direction respectively, the Western and Eastern Ghat ranges, holding within

[1] The anicuts and channels are fully described under the respective rivers in Vol. II.

[2] *Kere* is the general name in Kannada, but *koḷa*, *kuṇṭe*, and other terms are applied to certain descriptions.

their mighty embrace the mountain-locked plateau of Mysore. The hills of this table-land, though rarely in continuously connected chains, arrange themselves into systems crossing the country longitudinally, in directions more or less parallel with the Eastern and Western Ghats according to their proximity to one or the other; and attaining their greatest elevation between 13 and 13½ degrees of north latitude, along the north of the watershed line dividing the Krishna and Kávéri river systems.

The best defined of these ranges is a belt, from 10 to 20 miles wide, running between the meridians of 77 and 77½, from the Biligirirangan hills as their western limit, through Kankanhalli northwards up to Madgiri, and on to the frontier by way of Pavugada and Nidugal. It separates the eastern from the northern and southern river-basins. On the west, a somewhat corresponding range, not more than 10 miles in width, runs north along the meridian of 75½ from Ballálráyan-durga up to beyond Shikarpur, having on its east the loop of the Baba Budans, projecting as it were like some Titanic bastion guarding the approaches to the Malnád or highland region formed by the congeries of hills and mountains which intervene between the range and the Ghats on the west.

Intermediate between the two internal ranges above described is placed a hilly belt or chain, with considerable intervals between its component parts, tending to the east on the south of the central watershed and to the west on the north of it, so as to form a very obtuse angle in traversing the centre of the country. Starting from the Wainad frontier at Gopalswami betta, between Gundlupet and Heggadadevankote, it passes by Seringapatam and Nagamangala to Chunchangiri, where, exchanging its easterly for a westerly course, it reappears to the west of Kibbanhalli in the Hagalvadi hills, and crossing in a continuous belt through the middle of the Chitaldroog District, quits the country to the north of Kankuppa.

In the northern section of the territory, where the distance between the Ghat ranges, and by consequence between the intermediate belts, continues to increase, the interval is occupied by minor ranges. Of these the most important is the Nandidroog range, commencing near the hill of that name and stretching northwards by Gudibanda to Penukonda and the Anantapur country. In the west, a similar medial chain, but of lower elevation, passes from the eastern base of the Baba Budans south of Sakrepatna, up by Ajimpur, the Ubrani hills and Basvapatna, between Honnali and Male Bennur, along the right bank of the Tungabhadra, to the frontier, where it meets that river.

Viewing the mountains as a whole, the Eastern and Western Ghat

ranges might be compared to the antlers of a stag, the branching tynes being represented by the intermediate parallel chains starting from the north of the central watershed and more or less connected by cross ridges along their southern extremities. The chief peaks of the western system are loftier than those of the eastern. Except on the verge of the Western Ghats, all the mountains throughout the country, it is believed, present their steepest escarpment more or less eastwards. In the west, Mulainagiri, and in the east, Nandidroog, are the highest elevations, and they are almost on the same parallel, or between 13° 23′ and 13° 24′, immediately north of the central watershed. The loftiest points just south of that line are Ballálráyan-durga in the west, and Sivaganga in the east, both situated between 13° 8′ and 13° 10′.

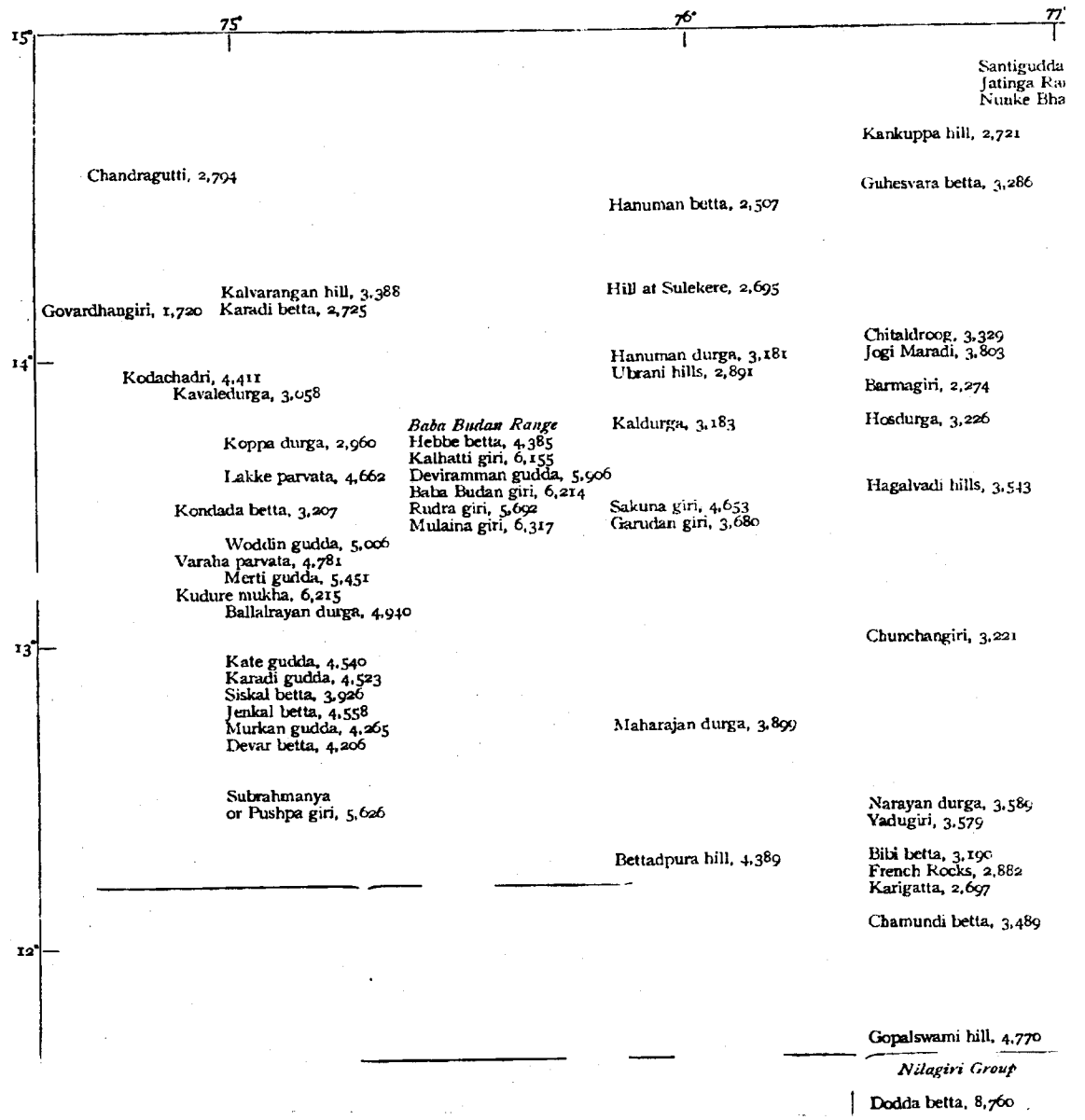
The table on the following page will serve to show the arrangement and altitude of the principal peaks in each system. The figures are mostly taken from the charts of the Great Trigonometrical Survey of India, supplemented from those of the Topographical Survey. Furnished at the summit with springs which yield an unfailing supply of water, most of these heights seem formed by nature for secure retreats. Hence there are few of the more prominent ones that have not been surrounded or capped with fortifications, often carried in long lines, with a vast expenditure of labour, along all the spurs and projections of the droog, forming strongholds with good reason deemed impregnable before the time when British artillery was directed against their walls. A particular account of the most interesting will be found under each District.

It may be useful to quote here the following most recently published opinion regarding the physical geography of this part of India:—"In the peninsular area the mountains are all remnants of large table-lands, out of which the valleys and low lands have been carved. The valleys, with a few local exceptions, are broad and open, the gradients of the rivers low, and the whole surface of the country presents the gently undulating aspect characteristic of an ancient land surface." "The Anamalai, Palni and Travancore hills, south of the Palghat gap, and the Shevaroy and many other hill groups scattered over the Carnatic, may be remnants of a table-land once united to the Mysore plateau, but separated from it and from each other by ancient marine denudation. Except the peculiar form of the hills, there is but little in favour of this view, but on the other hand there is nothing to indicate that the hill groups of the Carnatic and Travancore are areas of special elevation."[1]

[1] R. D. Oldham, "Manual of the Geology of India," 2nd edition (1893), pp. 2, 4.

WESTERN SYSTEM

Central Chain



Central Chain EASTERN SYSTEM

77° 78° 15°

Santigudda, 2,595
Jatinga Ramesvara hill, 3,469
Nunke Bhairava hill, 3,022

Ka[illegible]ppa hill, 2,721

Guhesvara betta, 3,286

Chitaldroog, 3,329
Jogi Maradi, 3,803

Nidugal, 3,772
Pavugada, 3,026

Itikal durga, 3,569

14°

Barmagiri, 2,274

Midagesi durga, 3,376

Dokkal konda, 3,807

Hosdurga, 3,226

Madgiri durga, 3,935
Channarayan durga, 3,744
Kortagiri, 2,906

Gudibanda, 3,361
Hariharesvar betta, 4,122

Mudimadagu, 4,528
Sunnakal, 4,229

Hagalvadi hills, 3,543

Devaray durga, 3,940

Kalavar durga, 4,749
Chanrayan betta, 4,762
Nandi durga, 4,851
Brahmagiri, 4,657
Dibgiri

Ambaji durga, 4,399
Rahman Ghar, 4,227

Nijagal, 3,569

Kurudu male, 3,312

Sivaganga, 4,559
Bairan durga, 3,499

Halsur betta, 3,341

Kolar hills, 4,026

Chunchangiri, 3,221

Hutri durga, 3,713
Savan durga, 4,024
Hulyur durga, 3,086

Tyakal hills, 3,704

Betrayan konda, 3,006
Yerra konda 3,359

13°

Bannérghatta, 3,271

Ramgiri, 3,066
Sivangiri, 2,931
Mudvadi durga, 3,131
Banat mari betta, 3,422
Kabbal durga, 3,507

Narayan durga, 3,589
Yadugiri, 3,579

Koppa betta, 2,821

Bibi betta, 3,190
French Rocks, 2,882
Karigatta, 2,697

Chamundi betta, 3,489

Biligirirangan Hills

12°

Biligirirangan betta, 4,195
Matpod hill, 4,969
Punajur hill, 5,091

Gopalswami hill, 4,770

Nilagiri Group

Dodda betta, 8,760

77° 78°

GEOLOGY[1]

The great ranges of the Western and Eastern Ghats, together with the intervening table-lands, may be regarded as part of one magnificent elevation of Plutonic rocks by a succession of efforts, during a period which may be termed Plutonic, breaking up the hypogene schists and in some instances uplifting aqueous beds of a more recent origin. The true general direction of this elevation is nearly N. 5° W, though the apparent directions of the lateral chains on its flanks are to the east and west of north respectively.

The surface of the table-lands between these chains has a general inclination easterly by south towards the Bay of Bengal, into which the principal rivers empty themselves. This gentle inclination, often assisted by cross lines of elevation, determines the great drainage lines of the country. The singular appearance of the detached hills and clusters of hills, which above the Ghats are seen abruptly starting up from the flat plains with little or no *tali*, have been sometimes compared to a table with teacups here and there reversed on its surface, a not inapt though homely illustration.

The bare extensive surfaces of the granitic, trappean and hypogene rocks in Southern India afford on a grand scale *exposés*, not to be surpassed in any other portion of the globe, of the protean aspects under which these rocks present themselves. The very absence of those fossiliferous beds which so thickly encrust the surface of a great portion of Europe and many other parts of the world, is in itself a subject of interesting research; and the geologist may in the peninsula of India advantageously study a huge and disjointed mass of the nether-formed

[1] Chiefly from articles by Captain Newbold, F.R.S., on the "Geology of Southern India."—(J. R. A. S. viii, ix, xii.)

[NOTE.—When compiling the first edition, I applied to the Geological Survey of India for information on the geology of Mysore, and was informed in reply that, as the country had not been surveyed, nothing was known of its geology. Being thus thrown on my own resources, I discovered the articles from which this chapter was taken. Their value has since been recognized by the Geological Survey, for Mr. W. T. Blanford, in the Introduction to the first edition of the "Manual of the Geology of India" (p. lxxii), writes as follows :—

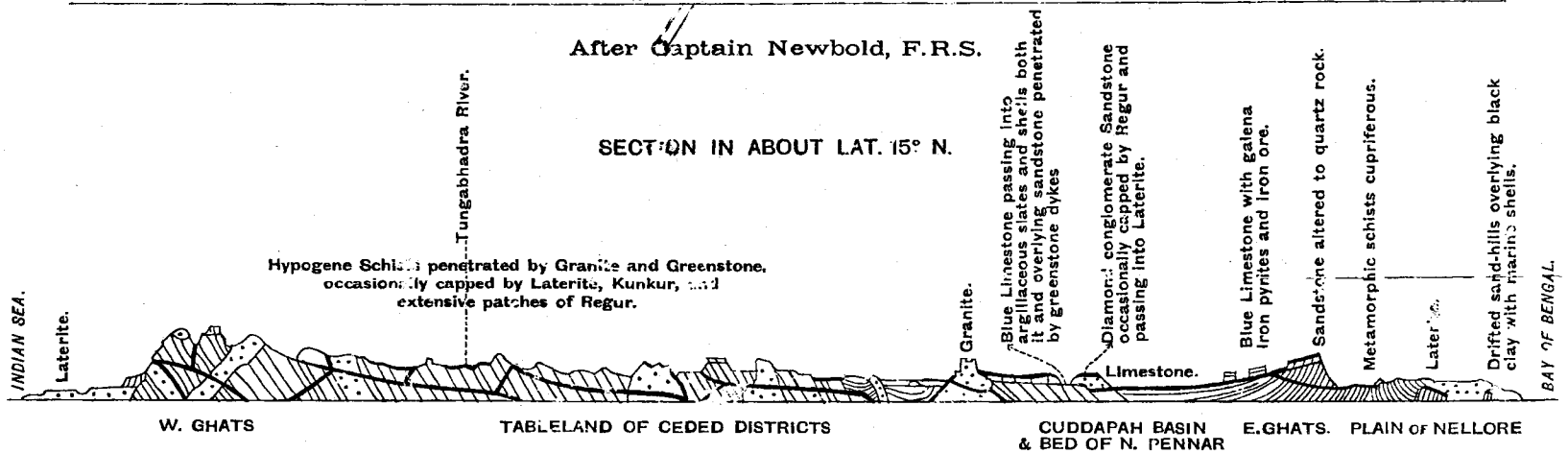
Newbold, 1844–1850.—This account refers to the southern part of the Peninsula alone; but it is the work of one of the best, if not actually the best, of the earlier Indian geologists; and it has the peculiar advantage over all other summaries published up to the present time, that the author possessed an extensive personal acquaintance with the country described. . . . . Most of the observations recorded in the summary are admirable; and altogether the paper is so valuable, that the neglect with which it has been generally treated is not easy to understand.]

To face page 13.

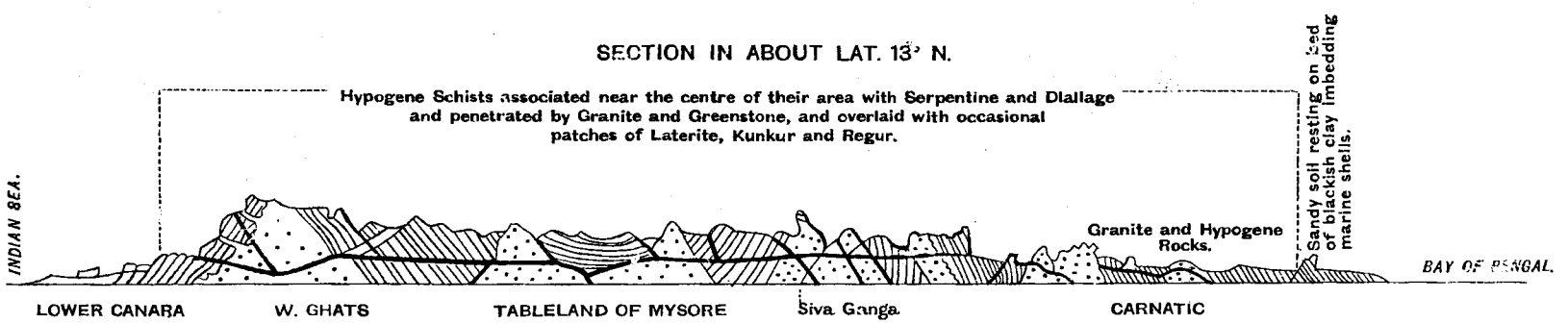
GEOLOGICAL SECTIONS IN THE LATITUDES OF BANGALORE AND OF THE NORTHERN FRONTIER.

After Captain Newbold, F.R.S.

SECTION IN ABOUT LAT. 15° N.



SECTION IN ABOUT LAT. 13° N.



John Bartholomew & Co. Edinr.

rocks which constitute the framework of our planet, and which here present themselves almost divested of integument, weathering under the alternations of a vertical sun and the deluging rains of the tropics.

Metamorphic Rocks.—Hypogene schists, penetrated and broken up by prodigious outbursts of plutonic and trappean rocks, occupy by far the greater portion of the superficies of Southern India. They constitute the general bulk of the Western Ghats from between the latitude of 16° and 17° N. to Cape Comorin; and from the northern base of the Eastern Ghats to their deflection at latitude 13° 20′ N. They are partially capped and fringed in the Western Ghats by laterite, and in the Eastern Ghats by sandstone, limestone and laterite. They form the basis of the valley of Seringapatam and of the table-land of Mysore.

The inequalities and undulations of the surface, though originating in the dislocations and flexures of the metamorphic strata at the periods of their upheaval, have been evidently modified by aqueous erosion and by the faster weathering of the softer members of the series,—such as mica and talcose schists,—the softer clay slates and shales; which, crumbling and washed away, have left their harder brethren standing out in relief on the face of the country. Where we see gneiss, hornblende schist and quartzite rising in parallel ridges separated by valleys, we generally find the valleys occupied by the softer members of the series, often deeply covered with debris from the ridges.

Where gneiss rises above the general level of the surrounding plain, its elevations may be distinguished from those of granite, which the hills of thick-bedded varieties of gneiss sometimes assimilate, by their greater continuity and uniformity of altitude; their tendency to a smooth dome-shaded outline; and greater freedom from precipices and disrupted masses. Near lines of plutonic disturbance, however, these distinguishing marks are less perceptible.

Elevations of mica and talcose schists obtain, generally, a less altitude than those of hornblende or gneiss; and have a more round-backed and smoother contour on the whole. Yet the outline in detail is jagged, owing partly to these rocks weathering in larger, more angular or less concentric fragments, often leaving abrupt steps and small precipices. Hornblende and gneiss are seen rising, as in the Western Ghats and the Nilgiris, to the height of 8,000 feet above the sea's level. The former is recognized by its bold sharp ridges, often precipitous, but rarely presenting conical peaks.

Hills composed entirely of actinolite or chlorite schist are seldom

met with; those of quartzite have long crest-like outlines, often running smoothly for some distance, but almost invariably breaking up into large, angular masses, sometimes cuboidal: the sides of the crests are usually precipitous. Hills of clay slate are distinguished by a smooth, wavy outline, separated by gently sloping valleys. Outliers or detached hills of this rock are usually mammiform. But, as before remarked, all these normal crystalline rocks, when near lines or foci of plutonic disturbance, frequently undergo great changes in physiognomical aspect; and in lieu of the smoothly rounded hills of clay slate, and its gently sloping vales, smiling with fertility, we behold it cleaved into sterile, rugged ravines and rocky precipices.

Gneiss is usually found lowest in the series: next to it mica and hornblende schist, actinolite, chlorite, talcose and argillaceous schist, and crystalline limestone, in due succession: but to this rule there are numerous exceptions. All these rocks, except crystalline limestone, have been observed resting on granite without the usually intervening gneiss. The strata are often violently contorted or bent in waving flexures, particularly in the vicinity of plutonic rocks; and much irregularity occurs in the amount and direction of dip throughout the hypogene area. In the Western Ghats it is usually easterly, and at angles varying from 10° to 90°. At the summit of the Ghats near the falls of Gersoppa, the gneiss dipped at an angle of 35° to the N.E.

But the hornblende schists do not always dip from the plutonic rocks —in many instances the dip is towards them: a fact indicating that the strata have been disturbed at some previous period, or that they may have suffered inversion; which is known to be the case in beds of more recent origin. While the dip of the two great lines of elevation, viz., the East and West Ghats, is generally westerly and easterly, or at right angles with the direction of the strata, that of the minor cross ranges is usually southerly. Numerous irregularities and exceptions, however, to this general rule occur, particularly near the northerly and southerly great synclinal line of dip on the table-lands between the Eastern and Western Ghats, and near localities where it is traversed by the cross lines of elevation. The intrusion of trap dykes has also caused much diversity in the dip. These irregularities will always prove obstacles in tracing out with accuracy the synclinal dip line between the Eastern and Western Ghats.

Gneiss and *hornblende schist* are by far the most prevalent rocks of the series: to gneiss the other members may be termed subordinate. Near its contact with the granite it commonly assumes the character of what has been styled granitoidal gneiss, losing its stratified appearance, and not to be distinguished in hand specimens from granite. Spherical

and oval masses of granite, resembling boulders, are sometimes observed impacted in the gneiss. Veins of reddish compact felspar, felspar coloured green with actinolite, epidote or chlorite, with and without quartz; also of milky quartz with nests of iron ore, mica and hornblende are very common in gneiss: also dykes and veins of granite. All these veins are of older date than the intrusion of the greenstone dykes which invariably sever them. Particular varieties of gneiss prevail in different districts. These rocks not only abound in nests and veins of rich magnetic and oxidulated iron ore, but in thick interstratified beds and mountain masses of these minerals.

Mica schist is found sparingly distributed over the whole of the hypogene area in thin beds. It is found in the greatest abundance and purity in the western parts of Mysore. A vein of granite in it is rare, though abounding in those of quartz. *Talcose*, *chloritic*, and *actinolitic schists* are still more sparingly distributed: the first is seen in the west of Mysore. Fine varieties of actinolitic schist occur in the Western Ghats at the falls of Gersoppa; and it is pretty generally distributed in thin beds over Mysore. *Hornblende schist* ranks next to gneiss in extent and thickness of beds, and is seen washed by the sea at the bases of the Eastern and Western Ghats, forming some of the loftiest peaks of the latter and supporting large level tracts of table-land. This rock varies from the compact structure of basalt to the crystalline texture of granite, and to that of porphyry, and may be seen from laminæ of a few lines in thickness, passing into beds forming mountain masses. The principal constituent minerals are hornblende and felspar. Quartz, garnet and mica are frequently mixed. Large beds of *compact felspar*, generally of a pinkish hue, with a little quartz and a few scales of mica, quartzite and milk quartz, having a similar direction to that of gneiss, occur, forming low ranges of hills. *Clay slate* does not occupy a large surface of the hypogene area. It occurs at Chiknayakanhalli, Chitaldroog, and in parts of the Shimoga District.

Imbedded Minerals.—Chert is pretty generally distributed, also the common garnet; the latter occurs in the greatest abundance in the Eastern Ghats, but is also found in the Kempukal river at the Manjarabad Ghat; black garnet and tremolite occur in the granitoidal gneiss of Wurralkonda (Kolar District). Epidote and actinolite are found usually in quartz and felspar veins. Indianite occurs sparingly with corundum, fibrolite and garnet in gneiss and hornblende schist in the valley of the Kaveri. Corundum is found in Mysore in talc, mica, or hornblende schist associated with iron ore, asbestus, and sometimes indianite and fibrolite. It occurs imbedded in the rock in grains and crystals. Its principal localities are Gollarhalli near Chanraypatna,

Mandya near Seringapatam, Begur, Bannerghatta, Bagepalli and other places.[1] Fibrolite occurs but rarely with indianite and corundum. Kyanite occurs in gneiss with tremolite, pearl spar, bitter spar, almandine and staurolite. Steatitè occurs in the talcose schists in the west of Mysore; as also potstone, in beds of considerable size and veins, and more or less dispersed over the whole hypogene area; occasionally associated with nephrite. Magnesite, an almost pure carbonate of magnesia, occurs in the vicinity of Hunsur. Mica is found universally diffused. In some parts of the Western Ghats and on the table-lands to the east, this mineral and talc are found in plates large enough for windows and lanterns, for which purpose they are used by the natives, as also for ornamental devices and for painting on. Chlorite is rarely found uncombined with felspar, silex, or hornblende. Nacrite or scaly talc is here and there met with. Adularia is found in the gneiss at some places. Albite or cleavlandite occurs occasionally throughout the gneiss districts, as also tourmaline or schorl, both black and green. Sulphate and sub-sulphate of alumina are occasionally found in thin incrustations and efflorescences between the layers of the soft ferruginous slates into which the hornblende and mica schists pass.

Iron pyrites or sulphuret of iron is distributed in small proportions in the hypogene rocks; but the oxides, both magnetic and hæmatitic, exist in extraordinary abundance, forming masses and large interstratified beds in the mountain chains. In gneiss these ores frequently replace hornblende and mica; alternating with quartz in regular layers. Magnetic iron ore with polarity is found in the massive state on the Baba Budan hills. Micaceous and specular iron ores are less common. A dark magnetic iron sand is usually found in the beds of streams having their origin among hypogene rocks, associated with gold dust and sometimes with menaccanite. Iron ore slightly titaniferous is found over the whole hypogene area. The black oxide of manganese associated with iron ore is found sparingly in the hills. Antimony occurs in the Baba Budan hills, and at Chitaldroog.

[1] Attention having been drawn to corundum as a valuable article of export, and on account of its possible use for the manufacture of aluminium, Mr. Petrie Hay, of Hunsur, has recently collected a quantity from villages to the south and west of that town. Very excellent crystals of yellowish corundum, with a brown weathered surface, were collected from the fields. Some tapering hexagonal prisms up to five inches in length, and a cubical piece of about four inches side, with a block weighing 300 lbs., were sent by him to the Madras Museum. Dr. Warth, of the Geological Survey, considers them of great importance as indicating the probability of a large and continuous yield. The quality of the quarried pieces is very little inferior to that of the crystals. The specific gravity of the large crystals was 4·02 and of the rock corundum 3·80.

Ores of silver have been said to occur in Belli Betta near Attikuppa.[1] Ainslie states that Captain Arthur discovered this metal in small quantities in Mysore, both in its native state in thin plates adhering to some specimens of gold crystallized in minute cubes, and mineralized with sulphur, iron and earthy matter, forming a kind of brittle sulphuretted silver ore.

Gold has long been found in the alluvial soil bordering on the Betaráyan hills in Kolar District. The geognostic position of gold in this and other localities appears to be in the primary schists, viz., gneiss, mica slate, clay slate, and hornblende schist, particularly near the line of their contact with granite or basaltic dykes, where we generally find the tendency to siliceous and metallic development unusually great. The gold is almost invariably discovered either in thin veins or disseminated in grains in the veins and beds of quartz, associated with iron ore and sometimes platinum, and alloyed with small proportions of silver and copper, or in the tracts of alluvial soil, beds of clay and sands, with the washings of primary rocks. Mining operations were carried on here by the natives from a remote period and abandoned. But since 1875 gold mining has been revived on a large scale by European enterprise, and what was virtually a desert waste has thus been converted into a populous and thriving industrial centre. The details of these operations will be found farther on under Industrial Arts.

Plutonic Rocks.—*Granite* prevails throughout the great hypogene tracts, sometimes rising abruptly from the surface of immense level plains in precipitous peaked and dome-shaped masses; sometimes in low steppes; sometimes in great heaps of amorphous masses; at others with sharp outlines, obscured and softened down by a mantle of the hypogene schists which have accompanied its elevation. This latter occurs most frequently in continuous mountain chains, such as the Ghats; but to view this rock in all the boldness of its true physical contour, we must approach the detached ranges, clusters, and insulated masses that break the monotony of the table-lands. Here we find but little regularity in the direction of elevation. In many clusters the granite appears to have burst through the crystalline schists in lines irregularly radiating from a centre, or in rings resembling the denticulated periphery of a crater.

The most remarkable of the insulated clusters and masses of granite on the table-land of Mysore are those of Sivaganga, Sávandroog,

[1] But Mr. Bruce Foote, of the Geological Survey, reported in 1887 as follows:—"I searched the hill most carefully and could not find the slightest trace of any ore of silver."

Hutridroog, Nandidroog, Chandragutti, and Chitaldroog. The rock of Nandidroog is almost one solid monolithic mass of granite, rising 1,800 feet above the plain and upwards of 4,800 feet above the sea; that of Sivaganga is nearly as high. These masses have usually one or more of their sides precipitous, or at such an angle as to be inaccessible except at few points. Most of them, like that of Sávandroog, are so steep as to admit of little vegetation, and present surfaces of many thousand square feet of perfectly naked rock, in which the veins and mineralogical structure are beautifully laid bare to the eye of the geologist.

It is not to be understood that granite is to be met with only in this abrupt amorphous form. On the contrary, it is sometimes found in immense undulating layers like lava, rising little above the general level of the country, separated by fissures and joints, and running for a considerable distance in a given direction like a regular chain of hills. The horizontal fissures often impart a pseudo-stratified appearance, and when crossed by others nearly vertical, give the whole the semblance of some huge wall of cyclopean masonry. The cuboidal masses composing these walls weather by a process of concentric exfoliation into spheroids. This process occurs often on a grand scale, and the exfoliated portions compose segments of circles of many yards radii. This decay of lofty granitic masses produces some of the most picturesque features of an Indian landscape; its strange columnar piles, trees, and logging stones, which far excel those of Dartmoor in grandeur and in the fantastic forms they assume. Some of these piles are held together in the most extraordinary positions, and the blocks composing them are found connected by a felspathic siliceous and ferruginous paste, the result of the decay of the upper masses, washed down and deposited around the joints by the action of the rain. There they stand; some tottering on their base, leaning over and threatening every instant to topple down upon the unwary traveller; others erect, amid a ruin of debris at their feet,—silent monuments of the process of the surrounding decay. Sometimes the summits of the higher elevations are composed of immense monolith peaked masses of granite, which split vertically; the separated portions are often known to descend from their lofty position with the rapidity and thunder of an avalanche. As the rocks waste from the summit, at their base will be usually observed a tendency to a re-arrangement of the component particles of the rock going on in the debris there accumulated. At Chitaldroog may be seen, at the base of a granite cliff which tops one of the hills, a porphyritic-looking mass thus formed of a reddish clayey paste, imbedding reddish crystals of felspar.

Almost every variety of this rock is found, but the prevailing granite is composed of felspar, quartz, mica and hornblende. Quartz, felspar and hornblende, the syenite of some mineralogists, is also common, and runs into the ordinary granite. That beautiful variety called protogine, in which talc, or chlorite, or steatite replaces the mica, is not very common in India, but is met with in a few localities in the west of Mysore. In all these cases chlorite and talc are the replacing minerals, the former predominating. Pegmotite, granite composed of quartz and felspar, is frequently met with; but the variety called graphic granite is rare. Schist granite never occurs as a mountain mass, but is found in veins or patches imbedded in ordinary granite. The same may be said of actinolitic granite, or granite in which actinolite replaces mica. The latter usually is most frequent in hornblendic granite, and the actinolite passes by insensible gradations into hornblende. The felspar of actinolitic granite is usually flesh or salmon-coloured. Porphyritic granite, or granite having large crystals of felspar imbedded in ordinary or small-grained granite, is common. The rock of Sávandroog affords a good example of the prevailing variety. It is composed of a granite base of felspar, quartz, mica and hornblende, imbedding long pale rose-coloured crystals of felspar. Fine granite porphyries are less frequently met with: a beautiful specimen occurs in a large vein or dyke which traverses the gneiss in the bed of the Kávéri at Seringapatam, nearly opposite the sallyport close to which Tipu was killed. It is composed of a basis of compact reddish and salmon-coloured felspar and a little quartz, imbedding lighter-coloured crystals of the same, with needle-shaped crystals of green tourmaline.

The great prevalent mineralogical feature in the granite of Southern India is its highly ferriferous nature. The mica and hornblende is frequently replaced by magnetic iron ore in grains, veins, and beds; and sometimes by fine octohedral crystals of the same, with polarity.

Most of the minerals and ores described as occurring in gneiss are also found in granite.

The ordinary granite is traversed by veins of granites both finer and larger grained: the former pass into eurite, a rock in which all the component minerals of granite are mingled together in one almost homogeneous paste. The minerals composing the larger grained veins are often in a state of segregation and crystallization. The mica, instead of being scattered in minute scales throughout the substance of the rock, is sometimes collected in large plates nearly a foot in length (used by natives for painting on); the quartz in large amorphous nodules, or hexahedral pyramidal prisms of equal length; and the felspar by itself

in reddish layers and beds. The veins and beds of felspar are usually reddish, and penetrated by fissures, which give a prismatic structure: these fissures are often lined with compact felspar, coloured by actinolite, or chlorite, or with drusy crystals of the former mineral, which is also found in nests. Milky quartz is segregated into large beds forming chains of hills, usually containing nests and seams of iron ore, rock crystal, and crystals of amethystine quartz. Both oval and lenticular nests of hornblende and mica occur in granite.

Granite is seen in veins penetrating the hypogene schists. Good examples occur near Seringapatam. In many situations granite appears to have broken through the earth's crust in a solid form; as is evident from the sometimes unaltered and shattered condition of the strata immediately in contact.

Eurite is found throughout the granite and hypogene tracts, but more frequently among the latter rocks, with which it often has all the appearance of being interstratified; in the granite it occurs in dykes. The eurite of Seringapatam may be regarded as a type of the petrosilex eurites. It sometimes passes into eurite porphyry, imbedding distinct crystals of laminar felspar. *Diallage*, euphotide or gabbro, occurs at Banavar, about eight miles westerly from Bangalore, associated with gneiss and mica schist. It there presents itself in low elevations, consisting of angular rough masses of the diallage rock, half-buried in a detritus the result of its own disintegration. The masses have not the slightest appearance of stratification; but are divided by fissures, like granite, into cuboidal blocks. The rock is composed chiefly of diallage and felspar; the colours of the former varying from light and dark grey to greyish green and bright green. The felspar is white and greyish white; sometimes in distinct crystals, but generally confusedly aggregated. The general colour of the rock is light grey and greenish grey. The diallage at Banavar has more the appearance of a dyke or vein in the hypogene strata than of an interstratified bed; but no natural section of the junction line of the two rocks presents itself.

Serpentine.—Near Turuvekere a dark crystalline rock occurs, composed of a dark grey or black talcose paste, imbedding numerous small black crystals of a mineral containing a large proportion of iron, being strongly attracted by the magnet. It bears a beautiful polish; the surface exhibiting, on close inspection, in the dark shining paste, still darker spots occasioned by the magnetic crystals. It was quarried by the sovereigns of Mysore for architectural purposes, and forms the material of the beautiful pillars which support the mausoleum of Haidar at Seringapatam. This rock has been mistaken for basaltic greenstone,

but it may be a bed of massive ferriferous potstone—here common in the talc schist—elevated, indurated, and altered by one of the basaltic dykes that traverse the rocks in the vicinity. Geologically viewed it has all the characters of a serpentine; and mineralogically it resembles the ferriferous serpentine or ophiolite of Brongniart, which consists of a magnesian paste imbedding disseminated grains of oxidulated iron.

Volcanic Rocks.—*Basaltic greenstone* is universally distributed. It prevails in hypogene areas, diminishes in those occupied by the diamond-sandstone and limestone, and totally disappears in districts covered by laterite and deposits of a more recent epoch. It is most developed in the stretch of table-land between Bangalore and Bellary. It never occurs in continuous overlying sheets like the newer trap, but penetrates in dykes the rocks just described, up to the age of the laterite. These dykes often terminate on reaching the surface of the rock, or before reaching it; while others project from the surface in long black ridges, which, originally like a wall, have since tumbled into both globular and angular fragments by disintegration. Most of the blocks usually remain piled up on the crests of the elevations, while others have lodged on their sides or rolled down to their bases. Many of these blocks have a peculiar metallic or phonolithic sound when struck; the well-known "ringing stones" west of Bellary afford a good example. These black bare ridges of loose stones, standing out in relief against the light-coloured granite or gneiss rocks, add another striking feature to the landscape of the plutonic and hypogene tracts. They often cross the country in a thick network, particularly between Nandidroog and Bagepalli.

In many cases the protrusion of the basaltic greenstone above the general surface of the imbedding rock appears to have been occasioned by the weathering of the latter from its sides. The greenstone thus left unsupported and exposed to atmospheric action soon breaks up by the process of fissuring and concentric exfoliation. In a few instances it appears to have been forced in a semi-solid state beyond the lips of the rent in the rock without overlapping the rock, but none of these projecting dykes have remained in that solid continuous wall-like state in which we see the prominent dykes of Somma or the Val del Bove. Their height above the general level of the country rarely exceeds eighty feet. The direction of the main dykes appears generally to coincide with that of the elevation of the mountains; but if we trace any dyke, the general direction of which in a course of many miles may be north and south, we shall find it to zig-zag and curve in various directions at different parts of its course. Fragments of granite and gneiss, both angular and

of a lenticular form, are sometimes entangled and imbedded in the basalt; and have been mistaken for veins or nests of these rocks. It is evident that, in many instances, the granite and hypogene rocks were solidified prior to the great eruptions of basalt that burst up from below into their seams and fissures, and that the molten fluid imbedded all loose fragments of rock, &c., lying in them. It is probable that many of the fissures themselves were caused, or enlarged, as seen in modern volcanoes, by the expansion of the molten basalt and its gases from below, while struggling for a vent.

The lithologic structure of this rock is as protean as that of granite. In the centre of large dykes we usually find it crystalline and porphyritic; and nearer the edges, less crystalline and more compact; in fact, every gradation of amphibolitic and augitic rocks, from basalt to melaphyre, in the distance of a very few paces. Near the sides, in the compact varieties, may be seen needle-shaped crystals of augite, glancing in confused arrangement here and there in the close texture of the basalt; while a little nearer to the centre the augite almost disappears, and is replaced by fine large crystals of hornblende, and sometimes a few scattered scales of mica. Near the line of contact with gneiss, the basalt often loses its dark colour, and becomes of a faint green, like some varieties of eurite or serpentine, imbedding iron pyrites. This faint green eurite is also seen as a thin vitreous and vesicular enduit on its surface, like the scoriaceous lava found on the surface of the dykes of Etna. The cavities sometimes contain a yellowish-brown powder, which becomes magnetic before the blow-pipe; or small crystals of epidote: in one specimen was found prehnite. The surface of the compact basalt in the dykes is often scored by small fissures, which, as in the Vesuvian dykes, divide the rock into horizontal prisms and run at right angles to the cooling surfaces. All the darker varieties of basaltic greenstone melt into a black or dark-green coloured glass or enamel; and affect the magnetic needle. They are composed of felspar, hornblende and augite, in varying proportions, and occasionally hypersthene.

The minerals most common to these are, iron pyrites, garnets, epidote, and actinolite. These minerals distinguish them from the newer trap, which abounds in zeolites, calcedonies and olivine.

The greenstone occasionally assumes the prismatic columnar forms of the newer basalts, or rather approaches to this structure; thin layers of carbonate of lime often intervene between the joints, and between the concentric layers of the globular greenstone. In many instances the basalt has a fissile structure, which, when intersected by joints, form prisms well adapted for building purposes. In some cases, under the

hammer it breaks into rhomboidal fragments, the joint planes of which are marked superficially with dark brown or blue dendritic appearances on a pale yellow or brown ground.

Rocks altered by Dykes.—Granite and gneiss in contact with a dyke usually become compact, or tough, or friable; the felspar crystals lose their brightness and a portion of the water of crystallization, become opaque and of porcelain hue; the mica is hardened and loses its easily fissile lamellar character. In gneiss it may be seen replaced by minute crystals of tourmaline, epidote and garnet, as near Chanraypatna. Limestone is converted into chert, or becomes siliceous; sandstone into quartz; and clay slate into basanite and jasper.

In districts most intersected by dykes a general tendency to crystalline and metallic development will be remarked, as well as an increase in the deposition of saline and calcareous matter, apparent in extensive layers of kunker, and efflorescences of the carbonate, muriate, and sulphate of soda. The fissures through which the springs charged with these minerals rise, were originally caused, perhaps, by the same disruptive forces that opened vents through the earth's crust to the molten basalt: and it is not improbable that these minerals and sulphates have their origin in causes connected with these ancient subterranean volcanic phenomena. Frequently no alteration is to be traced in the rocks in contact with dykes; a circumstance readily accounted for when we reflect that the temperature of the injected rock is liable to great variation. In certain localities, indeed, the basalt appears to have been reciprocally acted upon by the rock it has traversed.

Aqueous Rocks.—*Sandstone and Limestone.*—Resting immediately on the hypogene and plutonic rocks are found beds of limestone, sandstone, conglomerate, argillaceous, arenaceous, and siliceous schists. Next to the hypogene schists, and the associated plutonic rocks, these limestone and sandstone beds occupy perhaps the greater portion of the area north of a line drawn through Sira to the west. They are most frequently observed exposed in the vicinity of the great drainage lines of the country and occur in irregularly-shaped patches, separated usually by broad and apparently denuded zones of the subjacent hypogene and plutonic rocks.

The tracts occupied by the limestone and sandstone beds present a diversified aspect, sometimes flat and monotonous, and at others, near lines of plutonic disturbance, bare, rugged and picturesque. The limestone in some situations has evidently been denuded of the usually superjacent sandstone, dislocated, and elevated several hundreds of feet above the general level of the surrounding country in regular

ranges, and often in highly-inclined strata. Caps of sandstone, though in such cases often wanting, are sometimes seen still covering the limestone peaks. The outline of these limestone ranges usually presents long, flattish-topped ridges, whose sides and summits are not unfrequently covered with detached angular blocks of the rocks, with a grey, weathered, and scabrous exterior, resembling that of the mountain limestones of Europe.

The sandstone, where undisturbed by plutonic intrusion, occurs in low, flat, wall-like ranges, rising at an almost similar level, rarely exceeding 500 feet from the surface of the surrounding country, supporting table-lands of some extent and evidently once continuous. It is often intersected by deep fissures, extending from the summit of the rocks down to the base. When disturbed by plutonic force, the sandstone exhibits a striking contrast in its outline to the tame horizontal aspect it assumes at a distance from the axes of disturbance. It rises in bold relief against the sky in lofty rugged cross or hogbacked and crested hills, with precipitous mural ridges, which, rarely running at the same level for any distance, are interrupted by portions of the same ridge, thrown up at various angles with the horizon in steep and often inaccessible cliffs. When it crests the hypogene rocks, the lower part of the elevation is often composed of the latter to the height of about 200 to 400 feet, the slope of which has usually an inclination of from 15° to 20°, while that of the cap of sandstone presents a steep or precipitous declivity varying from 45° to 90°, giving a decided character to the aspect and configuration of the mountains and ranges thus formed.

The hills of arenaceous schists are to be recognized from the more massive sandstones by their undulating, round-backed summits, and their buttressed and dimpled flanks; while those of the softer slates and shales affect the mammiform outline.

Both limestone and sandstone beds, there is little doubt, were formerly of greater extent than now, and owe much of their present discontinuity and scattered positions to the agency of plutonic disturbance and subsequent denudation. The tracts of country intervening between their areas are usually occupied by granitic and hypogene rocks.

Laterite occupies a large portion of the superficies of Southern India. It is found capping the loftiest summits of the Eastern and Western Ghats and of some of the isolated peaks on the intervening table-lands. Beds of small extent occur near Bangalore and Banavasi. That at Bangalore extends northerly towards the vicinity of Nandidroog. Hills of laterite are usually distinguished by their long, low,

flat-topped character, assimilating those of the trap and horizontal sandstone formations. The lands they support are, however, not so much furrowed as those of the sandstone by water channels, a circumstance ascribable to the drainage passing rapidly off through the pores of the rock. When capping detached rocks, the laterite usually imparts to the whole mass a dome-shaped or mammiform outline, or that of a truncated cone.

On the surface of table-lands it is spread out in sheets, varying from a few inches to about 250 feet in thickness, terminating on one or two sides in mural escarpments. Immense detached blocks, generally of a cuboidal shape, are often seen occurring on the flanks of the Western Ghats, and on the southern slopes of the Sondur hills, often separated and dislodged. The valleys intervening between ranges of laterite hills are generally winding, like those formed by the course of a stream, and flat-bottomed, particularly in districts where it overlies the newer trap.

The laterite varies much in structure and composition; but generally speaking it presents a reddish-brown or brick-coloured tubular and cellular clay, more or less indurated; passing on the one hand into a hard compact jaspideous rock, and on the other into loosely aggregated grits or sandstones, and into red sectile clays, red and yellow ochre, and white porcelain earth, plum-blue, red, purplish and variegated lithomarges. Sometimes it presents the character of a conglomerate, containing fragments of quartz, the plutonic, hypogene and sandstone rocks and nodules of iron ore derived from them, all imbedded in a ferruginous clay. The cavities are both vesicular, tubular and sinuous; sometimes empty, but in the lower portions of the rock usually filled, or partly filled, with the earths and clays above mentioned, or a siliceous and argillaceous dust, often stained by oxide of iron. A species of black bole, carbonized wood and carbonate of lime sometimes occur, but rarely, in these cavities. Minute drusy crystals of quartz not uncommonly line the interior. The walls separating the cavities are composed of an argillo-siliceous paste, often strongly impregnated with iron and frequently imbedding gritty particles of quartz. The oxide of iron prevails sometimes to such an extent as to approximate a true ore of iron, and the nodules are often separated and smelted by the natives in preference to using the magnetic iron ore, which is more difficult to reduce, from its greater purity. When the whole mass is charged with iron and very vesicular (not unfrequently the case) it might easily be mistaken for iron slag. The colour of the *parietes* separating the tubes and cells, which in the less ferruginous varieties is a light brick-red or purple, changes into a liver-

brown, having externally a vitrified or glazed aspect; while the surface of the interior cavities puts on iridescent hues. The walls of these cells are sometimes distinctly laminated.

The air-exposed surfaces of laterite are usually hard and have a glazed aspect, and the cavities are more empty than those in the lower portion. A few inches or more below the surface the rock becomes softer, and eventually as it descends so sectile as to be easily cut by the native spades, but hardens after exposure to the atmosphere. Hence it is used largely as a building stone in the districts where it prevails, and to repair roads. From its little liability to splinter and weather (time appears to harden it), it is a good material in fortifications. The accumulation of the clays and lithomargic earths in the lower portions of the rock, which absorb some of the moisture percolating from above, renders the mass soft and sectile. These earths doubtless existed once in the upper cavities of the rock, from which they have been gradually removed to the lower strata by the downward action of the water of the monsoon rains. They accumulate at various depths from the surface and form impervious beds, on the depressions of which the water collects, forming the reservoirs of the springs we often see oozing from the bases and sides of lateritic hills and cliffs. Some of the tubes and cavities are *culs de sac*, and do not part with their contents; but the generality have communication with those below them, either directly or indirectly.

Associated Minerals.—Nodular, reniform and pisiform clay iron ore occur pretty generally distributed. Large beds and nests of lithomargic earths, and white porcelain earths, are not uncommon.

Older Alluvium.—The designation of alluvium is here used in its extended sense to indicate certain beds of gravel and sand that are occasionally found covered by the regur deposit, and which occur in such situations as not to be accountable for by the agency of existing transporting powers; simply prefixing the term "older" to distinguish it from the alluvium now forming from the disintegration of rocks washed down by the rains and springs, and transported by rivers and local inundations.

In the valleys of the Bhima, Krishna, Tungabhadra, and other large rivers are occasionally seen beds of alluvial gravel elevated beyond the highest existing inundation lines. Some of these deposits may be ascribable to shifts from time to time in the course of the river's bed; a few to the action of rain in bringing down alluvium from the mountain sides; but the majority appear to have been accumulated under conditions not now in existence; probably, during the slow upheaval of the Western Ghats and plateau of the Dekhan, when the water

occupied a much greater extent than at present. In many places the rivers have cut their way through these deposits; in others, channels exist of rivers, where now no water flows, or but a diminutive streamlet. Thus the Moyar valley, which runs along the table-land of Mysore by the base of the Nilgiris, differs entirely from a common mountain glen. Though a mile or more in breadth at some points, yet it is rather a ravine or fosse cut in the plain and not hemmed in by mountains. It opens out into the lower plain of the Carnatic at the Gajalhatti pass: the sides are precipitous, and its bed very much like the deserted channel of a river. The only stream now flowing in it is the Moyar, which, even in the monsoon, does not fill one hundredth part of its breadth and height: yet this singular excavation, extending some thirty miles in length, is unquestionably a waterworn channel. It is no fissure; for its bed is quite solid and connected and composed of strata of the hypogene rocks.

Regur or Black Cotton Clay.—This singular deposit, which in sheets of considerable thickness covers at least one-third of Southern India, is less common in Mysore. The plains occupied by the cotton soil are in general marked by their horizontal sea-like surface and almost treeless aspect. It covers the kunker and gravel beds just described, and is generally seen as a surface soil; but if we examine the edges of great sheets they will generally be found to dip for some distance under the recent alluvium, which conceals and replaces them as a surface soil. It not only covers extensive plains, but the tubular summits of hills overlooking those of the sandstone and limestone, newer trap and laterite formations, far above the present drainage level of the country: it covers all rocks from the granite to the laterite and kunker, and often fills up depressions and chinks in their surface.

The purest regur is usually of a deep bluish-black colour, or greenish or dark greyish black. The quantity of iron it contains is not sufficient to account for the black colour of this soil, which may be partly attributed to the extractive or vegetable matter it contains. The regur is remarkably retentive of moisture; a property to which is ascribable much of its fertility. During the dry season, when the crops are off the ground, the surface of regur, instead of presenting a sea of waving verdure, exhibits the black drear aspect that the valley of the Nile puts on under similar circumstances, and which powerfully reminds one of the regur tracts of India. Contracting by the powerful heat of the sun, it is divided, like the surface of dried starch, by countless and deep fissures, into figures usually affecting the pentagon, hexagon and rhomboid. While the surface for a few inches in depth is dried to an impalpable powder raised in clouds by the wind and darkening the

air, the lower portions of the deposit, at the depth of eight or ten feet, still retain their character of a hard black clay, approaching a rock, usually moist and cold; when the surface dust has a temperature of 130°. In wet weather the surface is converted into a deep tenacious mud.

The purest beds of regur contain few rolled pebbles of any kind; the nodules of kunker we see imbedded have probably been formed by concretion from the infiltration of water charged with lime; and it is only near the surface that the regur becomes intermingled with the recent alluvium of the surrounding country, or in its lower portions, where it becomes intermingled with the débris of whatever rock it happens to rest on,—trap and calcedonies in trappean districts; granite, sandstone, pisiform iron ore and limestone, in the plutonic and diamond sandstone areas. It sometimes exhibits marks of stratification.

That the regur of India is an aqueous deposit from waters that covered its surface to a vast extent, there is little doubt: but it would be difficult to point out at the present day the sources whence it derived the vegetable matter to which in great measure it owes its carbonaceous colour, and the rocks from the ruins of which its remaining components were washed.

Kunker.—The calcareous deposit termed *kunker*[1] is irregularly distributed in overlying patches. No tract is entirely free from it, with the exception, it is said, of the summits of the Nilgiris. It occurs, however, at the height of 4,000 feet above the sea among the ranges on the elevated table-lands. It is most abundant in districts penetrated and shattered by basaltic dykes, and where metallic development is greatest. It is perhaps least seen in localities where laterite caps hypogene or plutonic rocks. It occurs filling, or partially filling, fissures and chinks in the subjacent rocks, in nodular masses and friable concretions in the clays and gravels above the rocks, and in irregular overlying beds, varying from a few inches to forty feet in thickness. It has been found at the depth of 102 feet below the surface of the surrounding country, prevails alike in granite, the hypogene schists, the diamond sandstone and limestone, and in the laterite: hence the springs which deposit it must bring up their supply of calcareous matter from sources deeper beneath the earth's crust than the limestone.

The older kunker is usually of a light brownish, dirty cream, reddish or cineritious grey tint; sometimes compact and massive in structure,

[1] A Hindustani word کنکر but of Sanskrit extraction, signifying a nodule of limestone or pebble of any other rock.

but more usually either of a nodular, tufaceous, pisiform, botryoidal, or cauliflower-like form. Its interior is sometimes cancellar, or slightly vesicular; but compact or concentric in the pisiform and nodular varieties. Its interior structure is rarely radiated. When compact it resembles the older travertines of Rome and Auvergne. It aggregates in horizontal overlying masses, usually intermingled with the soil without much appearance of stratification. It is broken up and used as a rough building stone in the bunds of tanks, walls of inclosures, &c., by the natives, and is universally employed to burn into lime.

In the banks of rivers it is often seen concreting in stalactiform masses round the stems and roots of grasses, which, decaying, leave casts of carbonate of lime. This lime, held in solution and suspension by existing streams, mingling with the fine particles of sand and ferruginous matter in suspension, sets under water like pozzolana; and uniting the shells, gravel, sand, and pebbles in the bed and on the banks, forms a hard and compact conglomerate.

Its origin may be referred to the action of springs, often thermal, charged with carbonic acid, bringing up lime in solution and depositing it as the temperature of the water gradually lowered in rising up to the earth's surface or in parting with their carbonic acid.

Modern Alluvia.—Where regur does not prevail, the ordinary soils are distinguished by a reddish tinge, owing to the great prevalence of oxide of iron in the rocks of which they are, in great measure, the detritus. Patches of white soil occur, and are usually the consequence of the weathering of beds of quartz, or composed of kunker, which abounds so generally, and enters into the composition of almost every variety of soil. These white soils are characterized by sterility. In tracts of country shaded by eternal forests, for instance the Ghats, and sub-ghat belts, a dark vegetable mould prevails,—the result of the successive decay and reproduction of vegetation for a series of ages, under the stimulating alternations of excessive heat and moisture. In such regions, where unsheltered by forest and in exposed situations, the soil is either lateritic or stony according to the nature of the subjacent rock.

At the bases of mountain ridges we usually find an accumulation of large angular blocks, composed of the same rocks as the hills down whose declivities they have rolled in weathering. At a greater distance from the base in the plain, these are succeeded by pebbles, whose reduced size, mineral composition, and worn angles proclaim them to have travelled from the same source, diminishing in bulk the further we recede from the mountains, until they pass, by the gradations of grit

and sand, into deposits of a rich clay or loam. Such are the gradations generally to be traced in the modern rock alluvia, and which strikingly distinguish them from the vegetable soil of the forest tracts and the regur, which are often seen in the state of the greatest richness and fineness of composition at the very bases of the hills and resting immediately on the solid rock.

The alluvia brought down by the streams from the Western Ghats flowing easterly to the Bay of Bengal, are usually composed of silt, sand and gravel—detritus of the rocks over which they have passed: they almost always contain a considerable portion of lime derived from the springs which supply them, and from the limestone and kunker beds over which most of them flow. The alluvia of the rivers of the western coast are of a more carbonaceous and less calcareous character, owing to the greater absence of lime in the formation, and the dense forests and luxuriant vegetation which almost choke their passage.

During the hot season, when the surface of the alluvial sand in the beds of the rivers and rivulets is perfectly dry, a stream of clear water is frequently found at various depths below them, stealing along or lodging in the depressions of some impervious layer of clay or rock, to which it has sunk through the superincumbent sand. So well is this fact understood by natives, that in arid, sandy tracts, where not a drop of water is to be seen, they will often be enabled to water whole troops of horse and cattle by sinking wells a few feet deep through the sands of apparently dried-up rivulets.

The benefit resulting from the admixture of lime into soils consisting almost solely of vegetable, siliceous, or argillaceous matter, is too well known to be dwelt on here; and it is a remarkable and bountiful provision of nature in a country like Southern India, where limestone is so rarely seen in the rocks from which a great part of its soil is derived, that innumerable calcareous springs should be constantly rising through the bowels of the earth to impregnate its surface with this fertilizing ingredient.

The alluvia of Southern India are remarkable for their saline nature. The salts by which they are impregnated are chiefly the carbonate and muriate of soda, which prevail so much (particularly in mining districts) as to cause almost perfect sterility. The carbonate appears on the surface covering extensive patches, in frost-like efflorescences, or in moist dark-coloured stains, arising from its deliquescence in damp weather or by the morning dews. Where such saline soils are most prevalent there will be usually a substratum of kunker, or nodules of this substance, mixed with the soil; and there can be little doubt that their origin may

be referred to the numerous springs rising through the fissures or laminæ of the subjacent rocks, some charged, as already noticed, with carbonate of lime, and others with muriate of soda and sulphate of lime. The carbonate of soda, like the natron of Egypt, is the result of a mutual decomposition of the muriate of soda and carbonate of lime. It may be as well to remark that muriate of lime is invariably found in the saline soils of India, which are known to the natives by the term *chaulu*. The soda soil is used by the *dhobis*, or washermen, to wash clothes with, and hence is called washermen's earth; it is also employed by the natives in the manufacture of glass.

Both the carbonate and muriate of soda are found mingled in varying proportions, in white efflorescences, in the beds and on the banks of springs and rivulets.

Nitrous Soils.—Soils impregnated with nitre are found on and around the sites of old towns, villages, &c. Here a vast quantity of animal matter must gradually have been blended with the calcareous and vegetable soil: from their decomposition the elements of new combinations, by the agency of new affinities, are generated:—nitrogen from the animal, and oxygen, &c., from the vegetable matter. The nitric acid thus produced combines with the vegetable alkali, forming the nitrate of potass, while its excess, if any, combines with the lime, forming a deliquescent salt,—the nitrate of lime. The affinity lime has to nitrogen and oxygen materially assists the formation of the acid by their combination. The natives of India, in their rude manufactories of saltpetre, act upon these principles without being aware of their rationale. Having collected the earth from old ruins, or from places where animals have been long in the habit of standing, they throw it into a heap mingled with wood ashes, old mortar, chunam, and other village refuse; and allow it to remain exposed to the sun's rays and to the night dews for one or two years, when it is lixiviated. The salt obtained is not very pure, containing either the muriate and sulphate of soda or potash, or nitrate and muriate of lime.

Nitrous soils are easily recognized by the dark moist-looking patches which spread themselves irregularly on the surface of the ground, and by capillary attraction ascend walls of considerable height. They are more observable in the morning before the sun has had power to dissipate the dews.

Auriferous Alluvia.—The alluvium brought down by the rivers flowing easterly towards the Bay of Bengal is usually silt, sand, or calcareous matter,—detritus, as before observed, of the rocks over which they pass; while that of the rivers flowing westerly is of a more carbonaceous character. Most of these alluvia are auriferous, particularly those

of the Malabar and Canara coasts, but grains of gold are also found in considerable abundance in the alluvial soils of Mysore.

Betmangala lies on the eastern flank of the principal gold tract, which, according to Lieutenant Warren, who examined this district in 1802, extends in a north-by-east direction from the vicinity of Budikote to near Ramasamudra. The gold is distributed in the form of small fragments and dust throughout the alluvium covering this tract.

At Markuppam, a village about 12 miles south-west from Betmangala, were some old gold mines, worked by Tipu without success. The two excavations at this place demonstrated the great thickness, in some parts, of these auriferous alluvia. They were 30 to 45 feet deep respectively. There can be little doubt that the auriferous black and white stones in these mines were fragments from the gneiss, granite and hornblende schist which base this auriferous tract, and constitute the singular ridge which runs through it in a north and south direction, and which may be regarded as having furnished most of the materials of the reddish alluvium on its east and west flanks, and therefore as the true matrix of the gold. The orange-coloured stones were caused by the oxidation of the iron in the mica.

This auriferous range on the table-land of Mysore may be traced to the Eastern Ghats, southerly, by the hill fort of Tavuneri, to the south of Kaveripatnam matha in the Amboor valley. Two passes, however, break its continuity near Tavuneri. To the north it appears to terminate at Dásarhosahalli; though the line of elevation, taking a gentle easterly curve, may be traced by the outliers of the Bétaráyan hills, Amani konda or Avani, Mulbagal, Kurudu male, Rájigundi to Ramasamudra in the Cuddapah collectorate, a little west of Punganur.

Dunes.—Sand dunes are not confined to the coasts, but are seen on the banks of the larger rivers in the interior, as at Talkád on the Kávéri. During the dry season, the beds of these rivers, deriving but a scanty supply of water from perennial springs, usually present large arid wastes of sand. These are acted upon by the prevailing westerly winds, which blow strongest during the months of June, July, and August, and raise the sand into drifts, which usually advance upon the cultivation in an easterly direction. The advance of these moving hills is usually very regular where no obstruction presents itself, such as high bushes, trees, hedges, &c., which are often planted by the natives purposely to arrest the progress of these invaders on their cultivated lands. The sand is often held together and retarded by the embraces of the long fibrous plants that grow up and are interwoven with its layers. (*See* account of Talkád, Vol. II.)

TRAVERSE NOTES.

From the Bisale Ghat to Betmangala, by Captain Newbold, F.R.S.

At the western foot of the pass, and along the base of the Subrahmanya hill, hornblende rock containing garnets and dark-coloured mica occurs, with veins of a very large-grained granite composed of white quartz, red and white felspar, and silvery mica in very large plates: gneiss is seen on the steep face of the ghat, and hornblende rock, often coated with the red clay and its own detritus. This formation continues to the summit of the ghat. At Uchchangi the formation is generally gneiss. One of the hills of this rock is crested by hornblende rock in large prismatic masses. Patches of laterite occur covering these rocks in various localities, and a few bosses of granite.

Near Kenchamman Hoskote I crossed the Hemavati, one of the principal tributaries to the Kávéri, in a canoe. It is about fifty paces broad, with steep banks of clay, silt, and sand with mica. Near the village, mammillary masses of gneiss project from the red alluvial soil. This rock has here lost much of its quartz, and is of that variety of thick-bedded gneiss which in a hand specimen might pass for granite; the felspar is often of a reddish tint. Laterite is found in this vicinity a little below the surface in a soft sectile state. At Hassan gneiss and hornblende schist are still the prevalent rocks. Talc slate with layers of a fine greenish potstone interstratified also occurs. The mica in the gneiss near Gráma is sometimes replaced by talc and passes into protogine.

After exploring the corundum pits of Gollarhalli, I passed through Chanráypatna and Bellur to Hutridurga. Granite, protogine, gneiss, talcose and hornblende schists, penetrated occasionally by trap dykes, constitute the formation, overlaid here and there by patches of laterite or kunker on which rests the surface soil. The latter is usually reddish and sandy. Sometimes these deposits are wanting, when the substratum consists of the gravelly detritus of the subjacent rocks. At Belladaira a large bed of ferruginous quartz occurs. The mass of granite on which stands the fortress of Hutridurga is somewhat saddle-shaped, and runs nearly north and south; it terminates abruptly at either extremity. The northern extremity, crowned by the citadel, is a sheer scarp of rock nearly 200 feet high; its base is rugged with large precipitated masses. The granite is similar to but less porphyritic than that of Sávandurga.

From Hutridurga I proceeded to Magadi, and thence ascended the stupendous mass of Sávandurga. The country for a considerable distance is wild and woody, abounding with low hills and rocks, among which a porphyritic granite prevails. A magnetic iron sand is found in the beds of almost all the rivulets. I ascended the rock from the north-east side. The major axis of the mass runs nearly east and west, and is crossed at right

angles by a profound fissure, which cleaves the rock from summit to base into two distinct portions, both fortified, so as to be independent of the lower fort It is entirely composed of a granite, which from small-grained may be seen passing into the large-grained and porphyritic varieties. Some of the crystals of reddish felspar on the Karidurga were nearly two inches long, imbedded in small-grained reddish granite.

The principal rock at Távarekere is gneiss, with fragments of iron-shot quartz, green actinolitic quartz, felspar, fragments of hornblende schist, gneiss, granite and basaltic greenstone scattered over the face of the country, and occasionally patches of kunker. Near Bánávar I found diallage rock, projecting in large, angular, scabrous blocks from the top and sides of a low elevation. The great mass of the rock was chiefly white felspar and quartz. The crystals of diallage were well defined, and passed from dull olive-grey shades to the lively decided green of smaragdite. There was more quartz in this diallage rock than is seen usually in the euphotides of Europe; and the external aspect of the blocks was almost trachytic in its roughness. Not far hence, the gneiss with which the diallage is associated, apparently as a large vein, loses its mica, which is replaced by minute silver scales of graphite.

Gneiss is the prevalent rock about Bangalore, penetrated by dykes of basaltic greenstone, and occasionally by granite, as is seen near the petta and adjacent fields. The granite in these localities splits into the usual cuboidal blocks or exfoliates into globular masses. It often contains hornblende in addition to mica. The gneiss strata, though waving and contorted, have a general north and south direction, and often contain beds of whitish quartz preserving a similar direction. The strata are nearly vertical. Approaching Bangalore from the north-west, a bed of laterite is crossed, forming a hill (Oyáli dinne) on which stands a small pagoda. This bed extends northerly in the direction of Nandidroog, where laterite also occurs. In other situations, covering the gneiss and granite, a reddish loam is usually found, varying from a few inches to twenty feet in depth, containing beds of red clay, used in making tiles, bricks, &c.; the result evidently of the weathering of the granite, gneiss, and hornblende rocks. A similar formation continues to Kolar. The gneiss is occasionally interstratified with beds of hornblende schist. Granite, gneiss, and hornblende are the prevailing rocks at Betmangala. About eight or nine miles east of this the Mysore frontier is crossed into South Arcot. Kunker occurs on the banks of the rivulet near the village, both on the surface and in a bed below the alluvial soil. Efflorescences of muriate of soda are also seen in the vicinity.

From Seringapatam to Coorg, by the same.

From Seringapatam my route lay westward over a stony, kunkerous, uneven, and rather sterile tract to the banks of the Lakshmantirtha. The formation at Hunsur is a micaceous gneiss with veins of quartz, and beds of the same mineral evidently interstratified with the layers of gneiss. These beds, on weathering, leave the surface-soil covered with their angular and

rust-stained fragments. Glimmering hornblende rock, veined with milky quartz, and a pale flesh-coloured felspar alternate with the gneiss. The outgoings of two or three dykes of basaltic greenstone are passed on the roadside. The surface of the country from Seringapatam gradually rises as it approaches the Ghats.

The country between Hunsur and the Ghats is a succession of rocky risings and falls of the surface, covered for the most part with reddish alluvial soil, over the face of which are scattered numberless angular fragments of the surrounding rocks ; especially white and iron-stained quartz, and occasionally kunker. Some of these alluvia have not travelled far, since we often find the colour of the surface-soil a true index to the nature of the rock beneath ; viz., dark red or coffee-coloured soil over hornblende rock and trap ; light red to sandy soil over gneiss and granite ; light greenish-grey over talc schist ; and white, or what is nearly white, over felspar and quartz rocks. The quartz beds, being usually harder than their neighbours, are written in white bas-relief characters over the face of the country. They never weather—like the felspars, hornblendes and micaceous rocks—into clay, but usually break up into fragments by imperceptible fissures, into which water, impregnated with iron from the surrounding weathered rocks, soon insinuates itself and stains the rock. At length the particles composing the fragments themselves lose their cohesion and break up into an angular gritty sand.

At Periyapatna basaltic greenstone is seen in the bed of a nullah crossing the gneiss and hornblende rock, and veined with kunker. Large blocks of fine red granite are seen in the ruined fort walls, brought evidently from no great distance. The Ghat line west of Periyapatna presents a succession of round-backed hills and smooth knobs, which continue to Virarajendrapet in Coorg. Their surface is covered with dark vegetable mould, and shaded by a fine forest, the roots of which strike into the red loam or clay on which the vegetable mould rests. It produces excellent sandalwood.

At the Gersoppa Falls, by the same.

The precipice over which the water falls affords a fine section of gneiss and its associated hypogene schists, which dip easterly and northerly away from the Falls at an angle of about 35°. The gneiss is composed of quartz and felspar, with both mica and hornblende, and alternates with micaceous, talcose, actinolitic, chloritic and hornblende schists, imbedding (especially the latter) iron pyrites. These rocks are penetrated by veins of quartz and felspar, and also of a fine-grained granite, composed of small grains of white felspar, quartz and mica. The mass of hypogene rocks has evidently been worn back several hundred feet by the erosion and abrasion of the cataract ; the softer talcose and micaceous schists have suffered most. Rock basins are frequent in the bed of the river, which is worn in the rock and rugged with water-worn rocky masses.

From Jalarpet to Shikarpur (in 1881),[1] *by R. Bruce Foote, F.G.S.*

The results of combined traverses show that the Mysore table-land is traversed by great bands of granitoid and schistose gneiss, the southerly extensions of some of the great bands recognized in the South Mahratta country. When the whole of this region shall have been geologically examined it is more than probable that all the bands known to the north of the Tungabhadra will be traced far to the south. The traverse now to be described shows that three great bands of schistose rock occur on the Mysore plateau, and that two of these are actual continuations of two of the great schistose bands in Dharwar District. For convenience of description these bands will in the sequel be referred to as the "Dharwar-Shimoga" and "Dambal-Chiknayakanhalli" bands. Both these bands have been traced across the Tungabhadra, the latter in a chain of hills running down southward to Chitaldroog and Chiknayakanhalli, while the former forms another chain of hills passing Harihar and Shimoga and stretching further south towards Hassan. These bands are of considerable width, the Dambal-Chiknayakanhalli band, which is considerably the narrower of the two, measuring 18 miles across where crossed by the line of section. In addition to their geological interest, these two bands are of importance, as within their limits occur several of the auriferous tracts which have of late attracted so much attention. The Dharwar-Shimoga band is slightly auriferous at its northern extremity, and streams rising on it near Bail Hongal and Belavadi in the Sampgaon taluq of Belgaum District used formerly to be washed for gold. The auriferous tract of Honnali lies within the same schistose band a little to the north of Shimoga. The Dambal-Chiknayakanhalli band contains the auriferous tract of the Kapputgode hills near Dambal, to the north of the Tungabhadra; while south of that river, on the Mysore plateau, near the town of Chiknayakanhalli, are quartz reefs reported to be auriferous, and which have attracted the notice of several speculators, who have taken up land for mining purposes.

This schistose band is seen to stretch away far to the south-south-east in a line of low hills, and is said to extend to Seringapatam, passing that place and the town of Mysore to the eastward, and then trending round to the south-west and continuing into south-eastern Wynád, where it forms the gold-field around Devala. This tallies with Mr. King's observations in the Wynád, a strong band of schistose gneiss having been shown by him to occur at and around Devala, in which chloritic schists occupy an important position. My informant as to this extension of the Dambal-Chiknayakanhalli band was Mr. Lavelle, the pioneer gold-prospector of the present time, who has traced the band from the Wynád north to beyond Chitaldroog. I have no doubt but that Mr. Lavelle's observations will be fully confirmed when the whole of Mysore shall have been surveyed geologically. If the parallelism of strike continues between the southward extension of the Dharwar-Shimoga band and that of the Dambal-Chiknayakanhalli band,

[1] Records of the Geological Survey of India, Vol. XV., Part 4.

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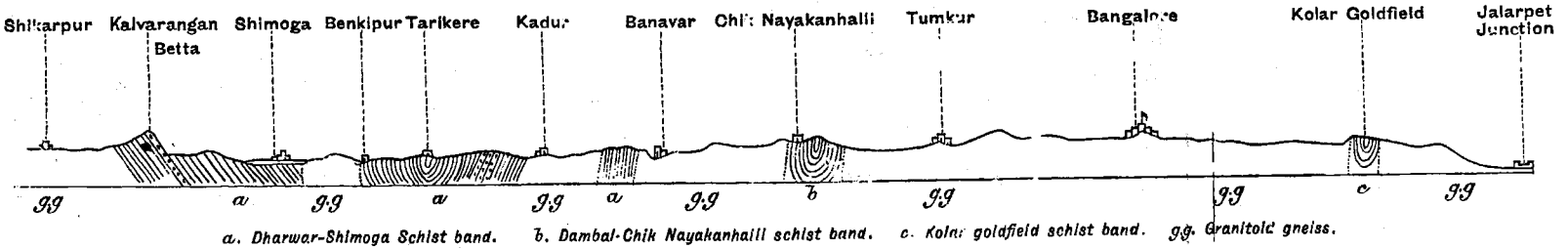


a. Dharwar-Shimoga Schist band. b. Dambal-Chik Nayakanhalli schist band. c. Kolar goldfield schist band. gg. Granitoid gneiss.

SKETCH SECTION FROM JALARPET TO KALVARANGAN BETTA NEAR SHIKARPUR

After R. Bruce Foote, F.G.S.

John Bartholomew & Co Edinr

it is highly probable that the former will be found to constitute the auriferous tract said to exist in the north Wynád. The stratigraphical relations of the several great bands, both granitoid and schistose, have yet to be worked out, for in the northern part of the great gneissic area they were found too obscure to be satisfactorily explained, and it remains to be seen whether they represent two or more great systems. Their position and relation are shown in the accompanying map and section.

If the line of section be followed from south-east to north-west it will be seen to traverse a region of very typical granite-gneiss, extending from Jalarpet Junction (Madras Railway), for a distance of some 30 miles. This granite-gneiss tract forms the eastern edge of the great Mysore plateau, which is here a wild, rugged, picturesque jungle region.

To the west the section crosses at its narrowest part the band of schistose rocks in which lies, a little to the north of the railway, the now well-known Kolar gold-field, at present a scene of energetic mining work on the lands taken up by a number of large Mining Companies. This schistose band, which will be most appropriately called the Kolar schistose band, forms an important synclinal trough resting on the adjacent granite-gneiss rocks. It is the only one of the great schistose bands whose relations to the associated bands of granitoid rocks have (as yet) been distinctly traced. A fuller account of this band with especial reference to its auriferous character will be given further on. (*See* p. 43.)

On crossing this Kolar gold-field band, the section trends northerly as far as the Bowringpet railway station, when it bends sharp round to the west and continues in that direction as far as Bangalore. The very broad band of granitoid gneiss, which extends between the Kolar gold-field schistose band to the second great schistose band (the Dambal-Chiknayakanhalli band), forms in its eastern part an open undulating plain from which rise a few important rocky hills, as the Tyakal, Balery and Vakkaleri hills north of the railway. A number of small low table-topped hills are also to be seen at small distances from the railway, as the Betarayan Betta, 3½ miles north-east of Bowringpet railway station, the Patandur hill, 2 miles south-west by south of the Whitefield railway station, and the low hillock crowned by a mantapam about a mile north of the Maharajah's new palace at Bangalore. These three hillocks are capped with beds of true sedimentary laterite underlaid by lithomargic clays. Of precisely the same aspect, both in form and colour, are the Sivasamudra, Jinnagra and Chikka Tagali hills, which lie a few miles north of the railway near the Whitefield and Malur stations. Identical in form and appearance also is a much more extensive development of table-topped plateaus, which are well seen from Betarayan hill, lying several miles to the north and covering a considerable area. The laterite at the north-eastern end of the Patandur hill is distinctly conglomeratic and contains a tolerable number of well-rolled quartz pebbles. The red colour of the sides of these hills and plateaus, added to their sharp-cut tabular shape, makes them conspicuous from considerable distances. No organic remains were found in connection with these laterite beds, and the number of sections examined was not sufficient to enable me to form any positive opinion as to

their origin, and still less so as to their geological age,—but there can be no doubt that they are the scattered outlying remains of a formerly far more extensive formation.

To the north-west of Bangalore the undulation of the country increases considerably, and the streams run in much deeper channels, affording more numerous sections both of the surface soil and sub-rock. The surface of the country is generally covered with a thick layer of red soil, which often contains a large percentage of pisolitic iron (hæmatite) in segregational form.

Thirty-two miles north-west of Bangalore the section cuts across the line of hills[1] running north and south from the Kávéri river, a little east of the great Falls, up to Nidugal on the frontier of the Anantapur District. This line of hills culminates close to the section in the fine peak of Sivaganga, which attains the height of 4,559 feet above sea-level. Like many other groups of granitoid-gneiss hills in the south, these hills are very rocky and bare, and look as if they had never been covered with a real forest growth.

The section maintains its north-westerly course up to Tumkur, beyond which town it turns suddenly westward and, after a course of 16 miles, in which remarkably few outcrops of rock are seen, meets the second great band of schistose rocks in the line of hills rising between Hagalvadi and Chiknayakanhalli. This second great band of schists is the southerly continuation of the Dambal-Chiknayakanhalli schist band as defined above. The width of this extremely well-marked schistose band, which the section crosses at right angles, is 18 miles. The character of the scenery is markedly different; smooth, grass-grown hills, generally well rounded, with very few conspicuous exposures of rock, take the place of the bold rocky bare hill masses seen east of Tumkur. The rocks consist of hornblendic, chloritic and hæmatitic schists cropping out at very high angles or in vertical beds. Several large quartz reefs occur traversing these schists, and one large one crosses the road some distance west of Doddiganhalli. Time did not allow of my doing any prospecting here, but several prospectors have stated that their researches were rewarded by the discovery of gold in appreciable quantity both in the quartz and by washing the local soils. The extension southward of this schist band may be traced by the eye for many miles, owing to the very characteristic features of the low line of heights which extends south in the direction of Seringapatam. That they extend still further south and then trend south-westward into the south-eastern part of the Wynád may be assumed as a fact on the strength of the information kindly furnished by Mr. Lavelle. The contact of the schists and granitoid gneiss is unfortunately concealed by superficial deposits at the places where the section cuts across their respective boundaries; but the impression left in my mind by the general appearance of the localities was that the schists were overlying the granitoid beds, and the same relation appeared to me to exist in the Dambal gold-field, as far as its western boundary is concerned.

[1] The expression line of hills is used in preference to the term chain, as there is little continuity of high ground, the hills being mostly quite detached and separated in some parts by considerable spaces.

The eastern boundary of the schist band was not traced near Dambal and Gadag, but further north it is completely hidden by the tremendous spread of cotton soil there prevailing. Passing on a little to the south of west from the schistose band the section runs across a granitoid-gneiss region, and after passing Tiptur crosses the watershed between the Kávéri and Krishna hydrological basins, the section trending more and more north-westerly along a rapid descent. It leaves the high, picturesque, granitoid hill masses of Hirekal Gudda and Gardangiri to the right, and beyond Banavar skirts the eastern boundary of the third or Dharwar-Shimoga schist band for several miles, but does not actually leave the granitoid rocks till it has passed Kadur by some six miles. The rocks of this granitoid band, which may for convenience be called the Mulgund-Kadur band, offer no speciality calling for remark. Like the hilly region running east of Tumkur, the hills may preferably be described as forming a line rather than a chain, for they occur in numerous detached masses.

As just mentioned, the section gets on to the third schistose band six miles to the north-west of Kadur, and here the schists are mostly chloritic of pale colour with intercalated more highly siliceous bands, ranging from chloritic gneiss to quartzite. To the south of the road the quartzites increase much in development and rise into a high ridge with a great cliffy scarp on the eastern face of Coancancul peak. Further west, to the south of the high road, rises a considerable hill of very rugged nature, which, when seen from a distance, presents great resemblance to a typical granitoid-gneiss hill. On closer approach the rock is seen to have a very coarsely mottled structure, which turns out to be due to the presence of enormous numbers of well-rounded pebbles of a granite or compact granite gneiss. The size of the included stones ranges in the part I examined from small pebbles to small boulders, all enclosed in a greenish-grey foliated chloritic matrix. The thickness of the conglomerate here exposed must be very great, as proved by the size of the hill which goes by the name of the Kal Droog. To the north, the beds are soon lost sight of under the local alluvium of the Kushi river, and they are not seen to reappear conspicuously in the hilly country on the north side of the valley. To the west of the great conglomerate beds follow more schistose beds, and, as seen on the hill slopes south of the road, a great series of quartzites. Near Tarikere, and to the north-west of it, very few exposures of rock are met with as far as Benkipur, but the few that do show through the thick woods which here cover everything, prove the country to be formed of schistose members of the Gneissic Series. About four miles north-west of Tarikere the road crosses a very small outcrop of typical hæmatite schist, striking in a northerly direction. A good deal of rock shows in the bed of the Bhadra river at and above Benkipur, but the forms seen are not very characteristic, and at the time of my passing everything was obscured by a thick layer of slimy mud left by a high fresh in the river. This part of the section would be very unsatisfactory were it not that the schistose character of the beds forming the line of hills extending northward parallel with the valley of the Bhadra shows quite clearly the extension of the rocks seen south-east and east of Tarikere. Between Ben-

kipur and Shimoga very little rock of any sort is seen, but about half-way across the Doab, between the Tunga and Bhadra rivers, a band of fine-grained grey granite gneiss is crossed, while to the east and south of Shimoga town are several conspicuous large masses of a chloritic variety of granite gneiss. The exact relation of these granitoid outcrops to the great schist series further east I had not the opportunity of determining, and am not quite certain whether they represent the eastern border of another great granitoid band, or whether they are part only of an unimportant local band of granitoid rock. I am inclined to think the latter will be found the real condition of things when the country comes to be fully surveyed. The short space of time at my command prevented my making a détour to settle this point. Here, too, the extent and thickness of the jungle growth greatly hide the general surface of the country along the road, while the rainy or misty character of the weather tended much to obscure the appearance of hills at but very moderate distances. Though the exigencies of dâk travelling compelled me to make the détour to Shimoga instead of following the line of schistose beds northward from Benkipur, I am perfectly satisfied as to the fact of these schists continuing northward, and joining those which cross the united rivers forming the Tungabhadra, a few miles below the junction of the Tunga and Bhadra. The country here is much freer from jungle, and many ridges of rock, consisting of quartzites and chlorite schists with rocks of intermediate character, can be traced for miles. This part of the section extends from the bank of the river for rather more than 20 miles,—from the travellers' bungalow at Holalur north-westward to the Tavankal-betta Trigonometrical Station, six miles east-by-south of Shikarpur. Along the 12 miles of road between Shimoga and Holalur but little is seen of the older rocks, the road lying close to the left bank of the Tunga and Tungabhadra, and passing almost entirely over the river alluvium which at and to the north-east of the Holalur bungalow forms a coarse bed of rounded shingles, rising a considerable height above the present high flood level of the united rivers.

The most striking features, both orographically and geologically, of this part of the Mysore country are the quartzite outcrops, which are numerous, but of which only the principal ones require notice. Of these the best marked, longest and highest culminates in the Kalva-Ranganbetta, a fine hill rising some 1,200 feet above the plain, and 3,388 feet above sea-level, 16 miles to the north of Shimoga. The out-crop of the great quartzite beds forming this ridge has a distinct dip of some 60°–65° (on the average) to the north-east. The quartzites are underlaid by a schistose (chloritic) series, the south-western extension of which was not ascertained. Overlying the quartzites, which are generally flaggy in character (but which here and there become so highly charged with scales of pale green chlorite as almost to lose their quartzitic character, and pass into chloritic gneiss), are local beds of true conglomerate,—the first I have met with or heard of in the gneissic rock of the peninsula. The conglomerate has evidently undergone considerable metamorphosis, but its real character and truly clastic origin cannot be doubted when carefully examined. Many of the included pebbles appear to

have been fractured by the great pressure undergone, but their truly rounded character is quite distinct and unmistakable. The beds seen by me and traced for several hundred yards, are exposed a little way up the slope of Kalva-Ranganbetta peak, and a little to the north-west of a small, but rather conspicuous, pagoda, which stands in a little recess. The included pebbles in the conglomerate consist chiefly of quartz, a few of gneiss, and some of what appeared an older quartzite. A second intended visit and closer examination of this very interesting bed was prevented, much to my sorrow, by bad weather. The second in importance of the quartzite ridges has its eastern extremity in the bed and left bank of the first west-to-east reach of the Tungabhadra below the Kudali Sangam, or junction. West of the new high road from Shimoga to Honnali the quartzite beds rise into the Phillur Gudda (hill), and beyond that rise again into a considerable hill some 400 to 500 feet high, and may be followed easily for several miles to the north-west. The quartzitic character is then in great measure or entirely lost by the rock becoming highly chloritic, and the beds can no longer be safely distinguished from the surrounding mass of chloritic schist. In the north-westerly part of this Phillur Gudda ridge several pebbly beds were observed intercalated between the more or less chloritic quartzite. They differed from the Kalva-Ranganbetta beds in being less coarse and having a more chloritic matrix, but had undergone about an equal amount of metamorphosis. A considerable number of quartzite ridges are intercalated between Phillur Gudda ridge, and the southern end of the Kalva-Ranganbetta ridge, which terminates in the Nelli Gudda Trigonometrical Station hill, seven miles west-north-west of the Kudali Sangam. To these ridges may be ascribed the existence of the group of hills they occur in, as but for their greater durability and resisting power to weather action, they would certainly have been worn down to the low level of the purely chloritic part of the schistose band, both to the north-west and south-east. Unless there has been an inversion of the strata on a rather large scale, or faults exist which were not obvious during the rapid survey, the Kalva-Ranganbetta quartzites underlie all the beds to the northward of it. Another series of overlying quartzites is shown to the north-north-west of Kalva-Ranganbetta; but the relation between it and the upper beds just described could not be determined without a much more close examination of the district, more especially as the space between the two sets of outcrops is very largely and closely covered by spreads of regur. The chloritic schists offer no specially interesting features, and they are not, as a rule, well seen, except on the slopes of the hills, the general face of the country being much obscured by red or black soil, which, both of them, occur in great thickness.

Honnali Gold-field.—One remaining point of great interest is the large number of important quartz veins, or reefs, which traverse the belt of chloritic rocks overlying the Kalva-Ranganbetta quartzites. They are the source of the gold occurring in the thick red soil which covers the whole face of the low-lying country, and which has been washed for gold, certainly for several generations past, by several families of Jalgars residing at Palavanhalli. The gold is so generally distributed through the red soil that

it is clear that many of the reefs must be auriferous, and the quantity found is sufficient to justify strong hopes that a profitable mining industry may be developed by working the richer reefs. Several of the series of reefs close to Devi Kop, a little village 3½ miles east-south-east of the Kalva-Ranganbetta, had been carefully and deeply prospected at the time of my visit by Mr. Henry Prideaux, M.E., and in one case certainly with very marked success. The quartz in this case was found very rich in gold, which was visible in grains and scales scattered pretty freely through the mass. The quartz in many parts had a quasi-brecciated structure with films and plates of blue-green chlorite occurring along cracks in the mass. Near the surface the chlorite, with which were associated small inclusions of pyrites, had often weathered into a rusty-brown mass. The reef which at the time of my visit was regarded as the most promising, and to which the name of Turnbull's reef had been given, is one of a series of three that can be traced with some breaks for a distance of six miles nearly parallel with the great quartzite ridge of the Kalva-Ranganbetta, the true strike of the reef being from N. 40° W. to S. 40° E. Another important set of three reefs having the same strike occurs about half a mile north of the first series, but they are not visible for such a long distance, their north-western course being covered by the thick spread of cotton soil. To the south-east they, or at least one of them, can be traced across the Nyamti nullah, which divides the gold-field in two. Out-crops of vein-quartz in a line with a south-easterly extension of this set of reefs are to be seen north and east of Palavanhalli. Numerous other quartz reefs having the same strike occur in the south-eastern half of the gold-field, *e.g.*, a set of four, rather more than a mile north-east of Palavanhalli, and several others to the north of Dasarhalli and south of Kuntra. A few reefs were also noticed whose strike was different from those above referred to. They represent two other systems of fissures, the one running N. 5° E. to S. 5° W.; the other, W. 5° N. to E. 5° S. Several of both these series are of very promising appearance, the "back of the lode" bearing considerable resemblance to that of Turnbull's reef. The greater number of the reefs in the Honnali gold-field are well-marked examples of these fissure veins.

During my stay at Devi Kop, I watched the results of many washings both of crushed quartz and of the red soil taken from many localities and various levels. The great majority were highly satisfactory. The Jalgars, or local gold-washers, seem to be a fairly prosperous set of men, so their earnings must be fairly remunerative. They confine their attention, as far as I could ascertain, pretty generally to the high-lying red soil banks, between Devi Kop and the Nyamti nullah. The head Jalgar, a very intelligent old man and dexterous gold-washer, informed me that the best day's work he had ever done was the finding of a small pocket in the gneiss which contained about Rs. 80 of gold in small grains and scales. I gathered from him that he had not found anything beyond the size of a "pepite." The position of these auriferous banks near Devi Kop would admit of hydraulic mining over a considerable area by a system of dams and channels to bring water from the Nyamti nullah, but the question of the

profitableness of such an undertaking could only be decided by an expert after careful examination and more numerous trials by washing.

Kolar Gold-field.—The schistose band, which bears within its limits the Kolar gold-field, forms an elongated synclinal fold which in parts rises somewhat over the general level of the surrounding granitoid country. The dip of the rocks forming the basement of the schistose band, and therefore the boundaries of the synclinal fold, is easily traced on both sides ; not so, however, is the dip of the uppermost members of the group, for all the beds exposed in the centre of the band have been much altered by great pressure, which has superinduced an irregular slaty cleavage to a great extent. This, combined with extensive minute jointing, has so greatly altered the original texture of the rocks that they have assumed to a very great extent a highly trappoid appearance. The lines of bedding are completely obliterated, and it was impossible to decide from the sections I saw whether the central axis of the synclinal represents one great acute fold, or a series of minor ones in small vandykes. The great petrological similarity of the strata forming the upper (central) part of the synclinal makes the decipherment of this difficulty all the greater. The sections I saw in the several shafts being sunk at the time of my visit threw no light on the subject ; it is possible, however, that a closer study of these sections would go far to enable this point to be decided.

The succession of formations seen from west to east, after leaving General Beresford's bungalow at Ajipalli on the road from Bowringpet railway station to the gold-field, is micaceous gneiss (resting on the granitoid gneiss), chloritic gneiss, micaceous schist, hæmatitic quartzite, and chloritic schist, on which rests a great thickness of hornblendic schists, which, as just mentioned, are highly altered, and have their planes of bedding almost entirely effaced by the pressure and crumpling they have undergone. The eastern side of the fold shows near the village of Urigam well-bedded schists—dipping west from 50° to 60° and resting finally on the granitoid rocks. The western side of the gold-field is very clearly demarcated by a well-marked ridge of hæmatitic quartzite which culminates in the Walagamada Trigonometrical Station hill, from the top of which the majority of the mines can be seen. The bedding is often vertical and highly contorted in places. The texture varies from highly jaspideous quartzite to a schisty sandstone. The hard jaspideous variety generally shows distinct laminæ of brown hæmatite, alternating with purely siliceous laminæ, generally of white or whitish-drab colour. It is only here and there, and over very trifling areas, that the ferruginous element ever assumes the character of red hæmatite. The beauty of the "vandykes" and complicated crumpling and brecciations of this rock in the Walagamada Konda is very remarkable. The thickness of the hæmatitic band is very considerable, and it forms the most striking feature of the western side of the gold-field. On the eastern side of the gold-field the hæmatite quartzite is much less well developed and exposed, excepting in the south-eastern part of the gold-field where it occurs in thick beds forming the main mass of the Yerra Konda Trignometrical Station hill. Here the dip is about 60°

westerly, and affords one of the clearest proofs of the synclinal character of the schist band. To the southward the hæmatitic beds appear to coalesce, the synclinal being pinched together, but I had no opportunity of following up the eastern boundary of the schistose band. The western boundary is a very conspicuous feature, a bold rocky ridge running up into the lofty Malapan Betta peak, the highest summit in this part of the country. South of Malapan Betta the hæmatitic beds appear to lose their importance and no longer form the most striking feature of the schistose band, and micaceous and chloritic beds abound. Owing to the great extent of jungle and the rugged character of the country, their general relations were not to be made out completely in the short time at my disposal. The beds run south into the Salem District, and probably occupy the valley lying east and north-east of Krishnagiri and, not improbably, extend on towards and past Darampuri. A subsidiary ridge of lower elevation, which branches off from the western side of Malapan Betta westward and then trends south-west and finally south-south-west, also consists of schistose beds of similar character, amongst which a hæmatitic quartzite is the most conspicuous. The relation of these latter beds to the Kolar gold-field synclinal fold is quite problematical, but it is very probable that several important faults have caused great dislocation of the strata first along the boundaries of the main synclinal fold. The stratigraphy of the several spurs radiating from Malapan Konda is very complicated and interesting and well worthy of careful consideration.

The auriferous quartz reefs which have attracted so much attention lie in the broader part of the synclinal fold north of the railway. None of any importance were seen by me in the tract south of Malapan Betta. The intermediate tract I had no opportunity of examining closely, but I did not hear of the existence there of any of interest or importance. The reefs make very little show on the surface as a rule; in many cases, indeed, the whole back of the reef, or lodes, has been removed during the mining operations of the old native miners, whose workings were on a rather large scale considering the means they had at command. Much also of the surface is masked by scrub jungle, or by a thick coating of soil, often a local black humus. The reefs are so very inconspicuous that I have not attempted to show them on the map. Their run is north and south with a few degrees variation either east or west. The hade of the reefs is westerly in most cases, as far as they have been tested by the shafts sunk. The angle they make with the horizon is a very high one, on the average not less than from 85° to 87°. Much has been said about the reefs in the Kolar not being true fissure veins, but I was unable to find any good reason for promulgating this view, and several mining engineers of high standing and great experience, as Messrs. Bell Davies, Raynor St. Stephen, and other practical miners well acquainted with the locality, have no hesitation about calling them "fissure veins" or "lodes." The quartz composing the reefs is a bluish or greyish-black diaphanous or semi-diaphanous rock, and remarkably free from sulphides (pyrites, galena, &c.) of any kind. The gold found is very pure and of good colour. Several washings of crushed vein stuff were made in

my presence at the Urigam and Kolar mines with really satisfactory results, the quantity of gold obtained being very appreciable. The samples operated on were not picked ones.

The principal new mines now in progress form a line stretching from south to north on the eastern side of an imaginary axis drawn along the centre of the synclinal fold, and this line coincides with that followed by the "old men," many of whose abandoned workings are being extended to greater depth than they had the power of attaining to without steam-pumping machinery.

Numerous large dykes of dioritic trap are met with traversing the gneissic rocks of this region. One set of them runs north and south with a variation of about 5° east or west. The other runs nearly east and west. The presence of these dykes will offer formidable obstacles to the mining works in some places, and it will probably be found that the intrusion of these great igneous masses has added considerably to the metamorphism of the schistose beds along the lines they traverse. As already mentioned, the schists are most highly altered along the central axis of the synclinal fold, and the largest of the north and south dykes shows a very little to the east of the synclinal axis.

The Kolar schistose band is the only one as to the exact stratigraphical relation of which to the granitoid gneiss any positively conclusive evidence had been obtained; but there is reason to believe that at least three of the schistose bands to the westward of it, *viz.*, those of Sundur, near Bellary, of Dambal-Chiknayakanhalli, and of Dharwar-Shimoga, are similarly superimposed on the granitoid rocks. Whether the superposition is a conformable or an unconformable one, is a point that has yet to be determined by further investigation; at the Kolar gold-field, however, the relation between the schistose synclinal and the underlying granite gneiss appears to be one of distinct conformity. The Hospet end of the Sundur schist band certainly presents every appearance of being the acute extremity of a synclinal basin. The south-eastern extension of this band is as yet unknown, but there is good reason to expect a considerable extension of it to the south-eastward of Bellary.

The remarkable length of the Dambal-Chiknayakanhalli and Dharwar-Shimoga bands precludes the idea that they can be each a simple synclinal fold, rather may they be expected to prove a succession of synclinal and anticlinal in échelon, with their contact boundaries not unfrequently coinciding with faults. The geographical position of these great bands confirms and amplifies the evidences to the fact which I specially pointed out in my Memoir[1] on the East Coast from latitude 15° N. northward to Masulipatam, that the Peninsula of India had been greatly affected by tremendous lateral forces acting mainly from east to west and thrusting up the gneissic rocks into huge folds. These great foldings have undergone extensive denudation, and the softer schistose beds especially have been entirely removed from large tracts of country which they must have formerly covered, if any of the bands now remaining really represent (as they in all probability do) portions of once continuous formations.

[1] Memoirs, "Geological Survey of India," Vol. XVI.

The schistose bands having only been mapped at different points, their general width, as shown on the annexed sketch map, is only hypothetical, and it is very possible that at intermediate points they may either spread out or narrow considerably. Their relation to the schistose gneissics of the Carnatic Proper has yet to be made clear, and it is not at all unlikely that a third subdivision will have to be recognized in the crystalline rocks of South India—a subdivision which will include the rocks of a character intermediate between the typically schistose rocks and the typically granitoid rocks of Mysore and the South Mahratta country, namely, the massive gneissics of the Carnatic, in which the ferruginous beds are magnetic, not hæmatitic.

From Report on Auriferous Tracts in Mysore (in 1887), *by the same.*

These tracts lie widely scattered, but may be conveniently grouped (for the purpose of description) in three groups corresponding to the three principal divisions of the great Auriferous rock series[1] which traverses Mysore in great bands in a generally north-north-westerly direction, and forms such important features in the geological structure of the table-land. These three groups may be appropriately termed the *Central*, the *West-Central*, and the *Western* groups ; the *Eastern* group being formed by the Kolar gold-field (*see* above, p. 43). The central group belongs to the Dambal-Chiknayakanhalli band of my former paper : and the western group to the Dharwar-Shimoga band of the same. The west-central group includes a number of small outlying strips of schistose rocks, some, if not all, of which are of the same geological age as the great schist bands lying to the east and west.

(*Nanjangúd to Jagalúr.*)

Central Group.—The rocks seen at *Holgere*, 7 miles south-west of Nanjangúd, are very gneissic in their general aspect, but they are very badly seen on the top of the ridge where the old workings are situated, and it is possible the hornblendic beds there occurring may belong to a very narrow strip of the auriferous schists (Dharwars), an outlier of them in fact, and probably faulted in along the strike of the underlying gneissic rocks. The

[1] Rocks of the same geological age as the auriferous rocks of Mysore occur largely in other parts of South India, both north, east, and south-west of Mysore, and to classify such a widely-developed system, it was necessary to have a collective name for them. The name of *Dharwar* rocks was therefore given by me to these rocks, on the usual principles of geological nomenclature, namely, for their having been first recognized as a separate system after the study of their representatives in the Collectorate of Dharwar (Bombay Presidency), where they occur very largely and typically, and underlie the important town of Dharwar. The use of this name in this report has, however, been deprecated on the plea that it might lead to confusion in the minds of readers unfamiliar with South Indian geography. I have therefore avoided using it wherever this was possible, but geologists who may peruse my report will understand that the alternative terms which I have used, "Auriferous" or "Schistose rock series," really mean formations of the Dharwar age.

quartz reefs here seen are small and coincide in direction with the north-to-south strike of the country rock, or deviate a little (3°–5°) to the east-of-north. The quartz exposed in the principal old working is highly ferruginous, being full of scales and films of impure hæmatite (specular iron), but contains no pyrites or other sulphides. North of the old working the reef is cut off by a broad band of a highly decomposed granite rock containing much pink felspar. The country between Holgere and Mysore is composed of micaceous gneiss with a few bands of hornblendic schist and potstone, with no quartz reefs of any importance, and the small show of gold obtained by Mr. Lavelle from washings in the Kadkole nullahs must have come from veins too small in size to be worth mining. I could not trace any connection between the Holgere auriferous rocks and the great Chiknayakanhalli band, the former must therefore be considered as a mere small outlier, if they are really of Dharwar age. The line of high ground commencing on the north bank of the Kávéri river near *Shettihalli* consists mainly of quartzites and hornblendic schists belonging to the Dharwar series and forming a narrow band (from 2 to 3 miles in width), which extends northward, widening very gradually as it is followed up. A number of small quartz veins occurs running in the direction of the strike of the beds, here nearly due north and south. The quartz is very white and "hungry-looking," and very few minerals are to be found in it. Those noted were blackish-greenish mica and a white decomposing felspar, the former not infrequently in distinct six-sided prisms. These included minerals show but very rarely and at wide intervals, but here and there become numerous and convert the vein into a true granite, a rock in which gold very rarely occurs in any quantity. Fragments of good-looking blue quartz were noticed scattered about the surface to the south-west of Siddapur village, but on tracing them up to their true source they were found to be derived from typical granite veins. As far as surface indications go, this tract appears a very unpromising one, and quite undeserving of consideration when so many really promising tracts remain as yet unprospected. The course of the extension of the Chiknayakanhalli schist band south of the Kávéri is yet undetermined, but as seen from the top of the Karigatta Trigonometrical Station, it appears to go southward, passing east of the granitoid mass of Chámundi hill; unfortunately want of time prevented my determining this point, which is one of considerable interest geologically. *Honnabetta* is a hill lying a mile and a half south by west of Nágamangala, and forming the central part of an outlier of the auriferous series on the western side of the Chiknayakanhalli band. The mass of the hill consists of hornblendic schist overlaid by chloritic schists. A washing made in the small nullah draining the north-east face of the hill just within the eastern boundary of the auriferous rocks gave a good show of gold of medium size and excellent colour. I noted one large bluish quartz reef on the high north spur of the hill which struck me as worthy of being tested in depth. At present merely the back of the lode is exposed, and but to a very small depth, so it is impossible to test the real quality of the stone. This reef runs through the chloritic schists. *Girigudda* forms the northern extremity of the outlier, and shows chloritic

and hornblendic schists, extensions of the Honnabeṭṭa beds. The ridge of the Girigudda is traversed by a pale green dioritic (?) trap. The north end of the outlier dies away rapidly northward of Girigudda, and disappears northward of the nullah. A careful washing in the small stream draining the east side of Girigudda, at a spot about a quarter of a mile eastward of the hill, gave a fair show of medium fine gold. The presence of trap rock among the schists is a favourable indication for the presence of gold. The whole outlier, which extends 7 miles from Girigudda southward to Maradipur, with a width of a little more than a mile across Honnabeṭṭa hill, is deserving of very close examination, and the reefs of being prospected to some depth. About 2 miles north of Girigudda and within the gneissic area lies *Hulmandibeṭṭa*, a low hill on the ridge of which occur several fine reefs which are being tested in depth by the Mysore Concessions Gold Company. The question—Are the quartz reefs occurring in the gneissic rock profitably auriferous as well as those occurring in the Dharwar series? (to which all the important gold-yielding reefs at present known unquestionably belong)—will doubtless ere long receive a definite answer from the results of these deep prospectings, and I sincerely trust it will be a very favourable one, as, if so, many other reefs of great size and beauty running through the gneissic series may probably also prove to be gold-yielding. Much of the quartz turned out at Hulmandibeṭṭa is good-looking, bluish in colour, contains some pyrites, and encourages the hope that it will prove auriferous at depths not reached by superficial weather action. *Haltibeṭṭa*, a large hill some three miles north of Nágamangala, has been reported auriferous, but the statement is highly improbable, the whole mass of the hill except the southernmost extremity consisting of granitic gneiss. A band of schistose rock extends from the southern spurs southward for a couple of miles till hidden by the alluvium of the Nágamangala stream. Large reefs of quartz were noted on either side of Haltibeṭṭa; they are very unpromising, the quartz being very white and free from included minerals. In miners' parlance, they are very hungry-looking. At *Kalinganhalli* the old native workings occupy a considerable area on which old dumps stood thickly, showing that a large amount of washing had been done. A very good show of gold was obtained by washing the dumps, but no reefs, large enough to be worth mining, could be found. Further south, however, fine reefs are to be seen pretty numerously, running north and south in the strike of the chloritic schists.[1] A narrow strip of very typical auriferous schists crosses the road a mile and a half west of the bridge over the Shimsha on the Hassan-Bangalore road, and may be seen stretching away north and south to a considerable distance, a strongly-marked bed of jaspery hæmatite quartzite forming a distinct ridge. This strip of schists is faulted against the gneiss along its eastern boundary about half a mile to the east. The northern extension of the schists crosses the Shimsha and is lost sight of in the broken ground east of the river, but the southern extension can be traced to the high ground north of Ankanhalli.

[1] The strike of the schistose beds here tends considerably eastward, and they appear to extend towards Kunigal, instead of running nearly due south down to Nágamangala, as I had formerly assumed on imperfect information.

South of Ankanhalli the highly characteristic hæmatite band reappears and forms a marked feature, continuing for several miles till almost abreast of the Narasimhaswami pagoda hill. The western boundary of this band of Dharwars is in all probability also a faulted one, several hundred feet in thickness of chloritic and hornblendic schists lying between the hæmatite bed and the gneiss near Nalkundi, while to the north, where the hæmatite bed crosses the Bangalore road (1½ miles west of the Yediyur bridge), it shows close up to the gneiss. The schistose rocks appear to spread out over a considerable area eastward of the Narasimhaswami hills, and may very likely reach as far as the line of granite-gneiss hills east of the Shimsha. A line of considerable hills, showing all the characteristics of the auriferous series, is seen to stretch southward for many miles some little distance west of Kunigal. These rocks, if really belonging to the auriferous series, represent the beds deflected eastward or south-eastward near Kadaba, and as such are worth examination. The old workings on *Honnebâgi* hill, near Chiknayakanhalli, lie a few yards down the eastern slope and just within the boundary of the auriferous schist area, the crest of the ridge being formed by gneiss on which rests the basement bed of the schist series, which is here a quartzite. The old workings, which consist only of small shallow pits surrounded by dumps, extend southward for nearly a mile along the watershed, and at the south end of the area they occupy have followed some east and west reefs across the boundary into the gneissic area. The reefs are white and "hungry-looking," and the old miners seem to have found no great encouragement, for they have made no extensive excavations. The principal reef on Honnebagi hill runs N. 15°–20° W., but trends southward; at the south end of the ridge it is about 5 feet thick. Overlying the basement quartzite on Honnebagi hill comes a series of schists, horneblendic, chloritic and micaceous, which occupy the space up to the foot of the hills, where they are overlaid by argillites and a great thickness of hæmatitic schists, locally very rich in iron, and giving rise to the formation of sub-aerial breccias which assume a lateritic appearance from the action of percolating rain-water. Quartz reefs of rather more promising appearance than those on Honnebagi hill occur here and there in the schists, and are probably the source of the gold obtained from the streams draining this tract. A set of washings made by me near the north-east end of Honnebagi hill in the main nullah and its branches gave very fair shows of medium fine gold of excellent colour. Tests by crushing and washing quartz from two of the trial pits recently sunk on Honnebagi hill gave no show, but this is not conclusive, the quartz being from too small a depth and the quantity of quartz to be treated by hand-crushing being necessarily insufficient for a reliable test. The reefs at *Kadekalgudda*, 2½ miles N.N.E. of Chiknayakanhalli, like those at Honnebagi, all lie within the schistose area though very near the boundary, and like them run in the strike of the country rock, which is here very nearly north-west-by-north. The quartz is white in colour, but a good deal iron-shot along the lines of fracture. I could find no enclosed minerals except a little chlorite and obtained no show from crushings, but a careful washing made in the stream draining the north-west end of Kade-

kalgudda gave a fair show of rather fine gold. On the slope of the hill above the great reef just mentioned are chlorite schists and an associated flow of dioritic trap, both favourable to the presence of gold, and other reefs of better quality may very likely be hidden under the talus which covers the slope very generally. A washing of material collected in the nullah draining the north-east side of Kadekalgudda gave no results. A washing of the alluvial deposit on the banks of the nullah draining the eastern side of the main ridge east of Chiknayakanhalli, close to the Dodrampur temple, gave but a poor show of gold; this, however, is not surprising, as the east flank of the range shows but very few quartz reefs of any size; the country is almost entirely formed of grey crystalline limestones with very numerous siliceous partings in the form of quartzite, which here and there attain to the magnitude of distinct beds. The limestones are much contorted, so their true thickness will be hard to ascertain by measurement, but they are certainly several hundred feet in thickness, and cover a large area stretching away to the south-east. A small show of similar limestones shows on the western side of the range just opposite the mouth of the gorge east of Ballenhalli which cuts so deeply into the hills. The range here unquestionably forms a synclinal fold, the axis of which corresponds with the crest of the range. To the north the limestones are replaced by schists and argillites as above mentioned. while to the south the tract at foot of the range is so thickly covered with deep red soil derived from decomposition of the hæmatitic schists on the summit of the ridge that the low-lying schists are completely obscured, for the red soil, which contains local conglomerate and breccia beds, is not cut through by the streams now flowing westward from the hills. A washing which I had made in the nullah south of Sondenhalli gave a small show of gold.

A great gap intervenes between the Chiknayakanhalli gold-field and the next metalliferous locality in the central group—Belligudda copper mine, close to Chitaldroog. The intervening area is geologically a *terra incognita*, in which a geological survey would assuredly find mineral tracts of importance. *Belligudda* is a fine hill lying some 5 miles south-east of Chitaldroog, on the western flank of which are four large open pits and several small shafts and short galleries sunk in clay schist in order to extract copper ore, which occurred there in the form of malachite or green carbonate. From the nature of the workings the ore appears to have occurred in pockets, not in a regular lode, and the pockets to have been worked out bodily, nothing remaining but thin films of a very poor earthy form of the carbonate deposited in the joints and cracks of the schists. A few fragments of quartz with small particles of rich malachite were picked out of the attle tipped down the very steep side of the hill, but no trace of any other ore or metal could be discovered after very careful search. *Kotemaradi* and *Gudda Rangavvanhalli* are two auriferous localities at the south-east and north-east extremities, respectively, of a tract of schistose rocks lying between 3 and 4 miles north of Chitaldroog. The country rock is varied, consisting of dark chloritic schists overlaid by beds of quartzite, and these again by various schists. Quartz reefs are rare, or else covered up by the extensive

talus, but the washings made were very successful and yielded gold in relatively large quantity and excellent quality. Taking all things into consideration, this tract is one of the most promising I have seen. The quantity of gold obtained was so good that the country north-west and north of the little Kotemaradi, and again to the north-east of Guddarangavvanhalli deserves to be most closely tested by costeaning and deep prospecting. The nature of the country rock, chlorite-schist with associated diorites, is all that can be desired, and there are no ostensible difficulties of a nature likely to hinder the opening up of mines, should rich reefs be discovered on further prospecting. About 14 miles north of Guddarangavvanhalli lies the small hill known as *Honnamaradi*, to the west and south-west of which are several fine reefs and numerous small veins of quartz cropping up through the soil which hides the country rock. The hill consists of a drab or yellowish gritty schist, passing into argillite in parts. Immediately east of the hill is an outcrop of gneiss, the eastern extension of which is masked by a great spread of cotton soil. The dip of the schists is easterly, but at a very high angle, and the two rock series are separated by a fault boundary. A careful washing in the little gully which drains the south and west sides of the hill gave a very fine show of coarse gold, which can only have come from a very little distance and is doubtless derived from one or more of the reefs above referred to. The gully which flows round the eastern side of the hill cuts some 12 to 15 feet into the decomposing gneiss, and has exposed several small reefs of very blue quartz. This spot had evidently been a favourite place of resort of the Jalagars in olden times, for two very large dumps are to be seen on the western bank of the gully. A washing of material collected in the bottom and banks of the gully gave a very fair show of fine gold; this may, however, have come from reefs lying within the schist area, as the gully rises within it on the north side of the hill. With regard to this gold-yielding locality, I quite agree with Mr. Lavelle that it is one of very great promise. Honnamaradi is the most northerly auriferous locality at present known in the Chiknayakanhalli band, which continues its north-north-westerly course for a few miles beyond Jagalur, and then crosses the frontier into the Bellary District. The Chiknayakanhalli schist band sends off a north-westerly branch some 6 or 7 miles south-west of Chitaldroog. This branch also continues its course into the Bellary country, and passes close east of the well-known Uchchangi-droog, a very conspicuous granite-gneiss hill crowned by a large fort. Several groups of hills rise out of this band, one of them occurring to the north of the high road leading from Chitaldroog to Davangere. At the north end of this latter group lies the village of Halekal, after which this end of the hills is called the Halekalgudda, and between it and the village lies the auriferous locality known by the same name. The *Halekalgudda* hills consist of thick and gritty, locally conglomeratic quartzites, with siliceous, micaceous and chloritic schists. No reef or veins show on the northern slope above the gold-washing place, but an area of several acres shows very numerous old dumps, showing that the surface soil had been largely turned over. The washing made here gave a good show of

moderately coarse gold. Some fine large good-looking reefs, running in the strike of the rock, occur, crossing the footpath which leads from Halekal to Gummanur, 3 miles south-west-by-south. West of these is a great flow of dioritic trap intercalated between the upper and lower schists. Though not so promising as Kotemaradi and Honnamaradi, Halekalgudda is yet deserving of the closest investigation.

(*Mysore to Banavar.*)

West-Central Group. — As already stated, the auriferous localities included in this group occur all in small detached strips or patches of schistose rock scattered over the older gneissic series. They are really remnants of the once apparently continuous spread of schistose (Dharwar) rocks which covered great part of the southern half of the Peninsula. After this great series of rocks had been deposited, the crust of the earth on which they rested underwent tremendous lateral pressure, and they were crumpled into a series of great foldings running up and down the Peninsula in parallel directions. After this they were exposed to tremendous erosive forces and in parts entirely worn away, and the underlying old gneissic rocks again laid bare. The small outliers are then nothing more than little patches and strips of the younger schists which have escaped erosion either from the superior durability of the rocks composing them, or from their having been let down by fractures of the earth's crust, technically known as faults, to a lower level than surrounding parts of the gneiss, and thus escaped in some measure the full action of the eroding agencies, whatever they may have been. The most southerly of these outliers in this group is the little gold-field of *Sonnahalli*, 18 miles south-west of Mysore. The shape of this auriferous tract is roughly a narrow oval, forming the flattish top of a low rise running north and south. The workings extend for about 2½ miles north and south. I estimated the length of the oval at 3 miles, but this may possibly be an under-estimate, as the country is much obscured by low jungle, especially to the south and east. The country rock consists of chloritic and other schists overlying very trappoid hornblendic rock. The old workings are numerous but none of very great size, and all seem of great age, judging by the highly-weathered condition of the rocks exposed in their sides. All of them are much overgrown by jungle, and one has to cut one's way through a dense tangle to get right into them. The shape of the working appears in every case to have been due to the run of the reefs worked upon. These reefs very probably contained visible gold, which induced the old miners to take out all the quartz they could raise, leaving only here and there masses which they considered unproductive or, in a few cases, too large and massive to be dealt with conveniently. In many cases, both here and elsewhere, the whole lode has been removed as far as can be seen, and the nature of the lode can only be guessed at from fragments of quartz left behind, and it is at present impossible to fonn any opinion about the value of the property. If the old pits were completely cleared out, the lode would in most cases be rediscovered and could then be properly tested in depth.

Scrapings of the sides of all the principal workings south of Sonnahalli were washed and gave at best but very small shows of gold. Half a mile east of Sonnahalli village, a very large reef is exposed on the top of the ridge; it does not look very promising, but seems worth deeper prospecting than it has yet undergone. I did not attempt a crushing, as I could not find any good-looking stone from a sufficient depth. This reef has a run of N. 5° W. At the foot of the north-eastern slope of the Sonnahalli betta or hill, a large reef has been exposed and to some extent worked out by a series of pits of moderate size. The quartz is white and barren-looking. The line of old workings at *Karimaddanhalli* commences about 1½ miles east of Sonnahalli betta, and extends northward for about a mile. They have been sunk in pale pink gneissic-looking felspathic schists, but associated with them are some hornblendic and ferruginous strata which bear a fair resemblance to characteristic members of the auriferous schist series, and they may, provisionally at least, be regarded as belonging to it. They form a narrow strip about 2 miles in length on the flat top of a ridge east of Karimaddanhalli village. The rock forming the casing of the reefs is generally chloritic near the contact, but not so at the distance of a yard or two. In the most southerly working the reef is not seen in the pit at present and seems to have been entirely removed, but this cannot be decided unless the pit were entirely cleared of jungle and débris. Fragments of quartz remaining are white but much iron-stained, and contain a few scattered small cubes of pyrites. The great working east of Karimaddanhalli village has been excavated along the course of a large reef running very nearly due east and west. In colour this reef is very white, but parts are much iron-stained, and it contains many cavities both cubical and irregular in shape, the latter containing a decomposed chloritic mineral and limonite. A few cubes of pyrites were noticed and some specks of arsenical pyrites. About ⅓ mile to the northward of the great working commences a line of smaller old works which extend right down to the south end of the Gijayanvaddargudi tank, a good mile to the north. Many reefs are exposed running in various directions north, south, east, west, north-east, south-west, &c. &c., and all are white and hungry-looking, and include hardly any accessory minerals, small chloritic and hæmatitic inclusions excepted. Some of the reefs are large, from 6′ to 8′ or 10′ thick. The country rock here consists of hornblendic and chloritic schists, the latter in very small quantity. Many washings were made and gold obtained in nearly every case, but only in small quantity. Not a vestige of free gold was seen in any of the reefs, either here or anywhere else. If it existed, the old miners were very careful to remove every atom of the gold-bearing quartz. About ¾ of a mile north-east-by-east of *Nadapanhalli* is a line of old workings of limited extent, sunk in pale greenish-brown chloritic schist. From the southern working, a fair-sized pit, the whole of the reef has been removed. In the more northerly workings, some shallow pits and a long shallow trench, a good-sized quartz reef is exposed to the depth (at present) of 3 or 4 feet at the utmost. The quartz is white, but shows a fair number of cavities filled with earthy limonite, probably derived from the decompo-

sition of enclosures of chloritic minerals. Pyrites is very rare, occurring only in very minute cubes or specks. Bright spangles and films of red hæmatite are common. Several washings were made from scrapings of the pit sides, and in each case resulted in a small show of rich-coloured gold. This concludes the survey of this group south of the Kávéri.

The well-known *Bellibetta* and its environs contain a considerable number of large and well-defined reefs, to which a large amount of attention had been paid by the old native miners. Bellibetta, or the silver hill, is the highest of a group of moderate-sized hills rising on an outlier of the auriferous series, rather more than 20 miles N.W. of Seringapatam, and 3½ S.W. of Krishnarájpet. The principal old workings are situated on the northern spur of Bellibetta, and consist of several large pits and a variety of smaller ones, with several small shafts and passages. Some are a good deal obstructed by jungle growth and all to a great extent choked up with débris, which makes it quite impossible to be certain as to the depth they were carried to. Dumps are numerous but not proportionate in extent to the size of the workings, so it is probable that much of the auriferous quartz was carried away to be reduced to powder elsewhere. The mass of Bellibetta consists of chloritic schist, the beds of which dip westward at a high angle, the strike being slightly west-of-north. They show considerable contortion. They are underlaid to the east by a bed of very coarse steatitic schist, on which the village of Katargatta stands. The run of the majority of the reefs is a little west-of-north, but one or two run east and west. To the south-west of Katargatta village is a very large reef of pale blue and white quartz which extends north-westward up to the slope and appears to join the set of reefs on top of the northern spur of Bellibetta in which the great workings have been carried on, but a considerable space between them is covered up by débris and talus at present and the connection cannot be proved positively. No workings have been made along the lower part of this great reef, but to the south and south-west of it I noticed a large number of small workings and dumps. A not very important series of old shallow works with dumps occurs on the ridge north of Bellibetta, and here washings gave a very poor show of gold. A large and well-marked reef forms the crest of this ridge, but it is very white and hungry-looking and contains no enclosures but a very little chlorite. The country rock is a curiously felted fibrous hornblende schist, with a small admixture of chlorite. A few hundred yards to the south-west, in the jungle on the left bank of the stream flowing into the little Katargatta tank, a bare sheet of very light-coloured rocks, apparently a quartzite, is exposed, on which are many score of small saucer-shaped holes, evidently made by pounding the quartz to reduce it. None of the "mullers" or hammers used in the process were found here. Half a mile north of Katargatta village lie some important quartz reefs and a large number of old workings. The reefs form the edge of a ledge formed by the eastern ridge of the auriferous rocks, Bellibetta being the western ridge rising out of the outlier. The reefs, which are very large and well-marked, consist of pale blue and bluish-white quartz. I saw no indications of any recent deep prospecting along these reefs, the eastern of which is exposed for nearly a mile and the western for about ¼

mile. About ¾ of a mile to the northward of these great reefs is a line of old workings. They are mostly large trenches, so greatly filled up with soil and grass that no signs of any reef can be made out. They present every appearance of great age. The country rock is also almost entirely masked by soil and vegetation; when seen, it consisted of a talcose hornblende schist. Very little quartz is seen lying about, and it looks as if the lodes had been extracted bodily. I cannot confirm Mr. Lavelle's asserted discovery of silver ore on Bellibetta, having been unable to find any sort or kind of argentiferous mineral there; still there can be no doubt that it is a gold-field of very great promise and deserving of the closest examination by deep prospecting on an ample scale. The great reef on Bellibetta, if proved sufficiently auriferous, could easily be mined to considerable depth by simple quarrying, and for this reason among others I think Dewan Purniah's want of success in mining for silver here was due to the want of ore rather than any other cause. Very near the northern extremity of the Bellibetta outlier is a small group of small shallow pits and dumps. They lie on both sides of the Mysore-Hassan road, about ¾ of a mile north-west of *Pura*. Two small reefs were noted, but neither of them looked promising, they being white and hungry. The country rock east of the road is a remarkable hornblende schist, which shows a very pretty felting of the fibre in stellate points with curved radiations. North of the Bellibetta outlier comes a tract of micaceous granite-gneiss, with some hornblende schist bands and occasional trap-dykes extending up to and beyond the famous Jain temple of S'ravan Belgola, and some four miles further north-east, where what appears to be a tiny outlier of the auriferous rocks shows close to the little village of Kempinkote in Channarayapatna taluq. The *Kempinkote* workings consist of one huge pit close to the village, a small pit about 300 yards to the south-east, and three or four small shallow excavations a mile to the north-east. The great pit, which is by far the largest excavation of the kind I have seen in India, is dug out of hornblendic and steatitic schists, a good deal contorted but having a general strike to the northward. Not a trace of any reef is visible *in situ*, and but very few lumps of quartz remain in the pit. This may very likely be explicable by the fact that it contained free gold, and that every good-looking bit was carried off long ago to be crushed elsewhere. I examined every bit of quartz I could see, but had not the good fortune to find any free gold. A washing of the scrapings of the side near a small exposure of the steatitic schist gave a very rich show of gold in proportion to the quantity of stuff washed. The gold was very fine-grained and of excellent colour. A washing at the small pit to the south-east gave a very poor result. The country rock here is also a steatitic schist very similar to that of the big pit. A few small lenticular masses of bluish-white quartz occur on the east side of the second pit, but are too short to be regarded as true reefs. The small excavations lying to the north-east of Kempinkote have been made in chloritic schist abounding with small cubical cavities full of reddish limonite. It is impossible to offer any positive opinion as to the Kempinkote gold prospects, no reef being visible in the

great pit. The latter should be cleared out to see whether the reef has been entirely worked out or not. The length and width of the great pit is so great that it is quite possible the old miners really descended to a great depth before stopped by water or other difficulties they could not compass with their limited mechanical appliances. The great size of the old working shows, however, that the old miners found the place worth their attention for a long period. Overlying the chloritic schist which forms the main mass of the low rise south-east of *Nuggihalli* is a thin bed of hæmatitic schist, the débris from which forms a wide-spread talus. This iron-strewn knoll appears to be the southern termination of the Tagadur-betta outlier, unless the auriferous rocks make a considerable sweep to the west, for the rocks along the direct path from Kempinkote to Nuggihalli belong to the gneiss. To the northward the hæmatite band thickens considerably, and may be traced for nearly a mile, and may very likely represent the great iron beds which form the crest of Tagadurbetta itself. The rock shown in the quarry about 1¾ miles N.N.E. of Nuggihalli is of doubtful geological age, and is separated from the Tagadurbetta band of the auriferous schists by a band nearly 2 miles in width of granite gneiss. The workings described by Mr. Lavelle as occurring one mile north of the village, were not seen by me, nor are any indications of them given on his maps. Two pits I was taken to at about ½ to ¾ of a mile W. and N.W. by W. of Nuggihalli, appear to me to have been quarries for rubble stone, not excavations made for any mining purposes, for no signs appear either of reefs or dumps in either case. They are situated just within the western boundary of the schist outlier, and lie near the path leading from Nuggihalli to Virupákshipur. A mile and a quarter N.N.W., and just at the head of the valley running north-east from the *Tagadurbetta* hill, begins a set of old workings which occur at intervals through the scrub jungle for rather more than half a mile. The workings are all very shallow and look as if they had been early abandoned. The reefs seen run in the strike of the country rock, which bends about from north and south to north-west and back to north again. None of the reefs here are of any length or great thickness. The quartz they consist of is white and hungry-looking, and the washings obtained were not encouraging in quantity, though not so small as to make me condemn this gold-field as unworthy of further attention, for the country rock, chloritic schists with intercalated hæmatitic bands, is favourable to the occurrence of gold. The crest of Tagadurbetta consists of two good-sized beds of massive hæmatitic rock, which are one source of the great hæmatitic talus which covers the eastern slope of the ridge. The southern extension of these beds is very soon masked by surface deposits, but to the north they extend about a mile as low but conspicuous mural outcrops. How much further they extend I could not say, but it is not all improbable they may run considerably further, or even join the *Mallenhalli* outlier, 8 miles to the N.N.W. These workings lie a mile south of the high road leading from Hassan to Tiptur, and about 10 miles south-west of the latter town No reef is seen in connection with the large pit, nor is the country rock exposed just here, but close by it consists of hornblendic schist underlying a green micaceous gneissoid schist,

and fragments of true quartzite were observed lying about in some quantity, confirming the Dharwar age of these beds. A moderate show of gold was obtained by washing. A little to the northward of the pit is a large reef of rather good-looking bluish-white mottled quartz. The reef shows for nearly 100 yards, and is from 12 to 15 feet thick on the surface. The quartz shows no included minerals, but testing in depth might very probably show good results. The schistose rocks seem to stop near Mallenhalli, and only gneissic rocks were noted between the village and the next auriferous locality, *Jalgaranhalli*, 3½ miles N.W. by N. This consists of a small and rather shallow pit with a number of date-palms growing in and around it. No reef is seen traversing the pit, on the east side of which is an outcrop of the stellately felted hornblende rock seen at the Pura workings at the north end of the Bellibetta outlier. A wash of scrapings from the side of the pit gave a fair show of fine gold, sufficient to recommend that it be more fully prospected and tested than has as yet been done. The *Belgumba* auriferous rocks are, I believe, the northerly extension of the beds seen at Jalgaranhalli, but time did not allow of my examining the intermediate tract of country, and I visited the Belgumba tract from the north. This group of old workings lies 7 miles south-east of Arsikere, and 1¾ miles south of the 99th milestone on the Bangalore-Shimoga road. The highest point of ground due south of the 99th mile is the northern extremity of the Belgumba outlier of the auriferous rocks; the southern end, as above explained, forming to all appearance the Jalgaranhalli auriferous patch. The workings, with one exception, lie along the westerly slope of a low ridge extending S.S.E. from the high point[1] just referred to. The strike of the schist beds is as nearly as possible S.S.E., and they occupy a band about ½ a mile in width abreast of the workings; further south the band seems to widen out. A large but generally white and hungry-looking reef runs along the ridge on its western slope just below the summit, and another similar one crests a knoll a little to the south of the most southerly pit. They run parallel with the strike of the chloritic and hornblendic schists forming the country rock. The northern reef shows bluish colour in parts. The considerable size of the old workings is the only evidence in favour of their having been productive. They are much obscured by rubbish, and in their present state it is impossible to say whether or not the reefs they were worked on continue in depth. The prospects of future success at this place are not very encouraging. The country northward from the Trigonometrical Station hill up to and beyond the Shimoga road is all gneissic. At *Gollarhalli*, about 6 miles to the south-west of Belgumba, is a very large old working, in shape like a very rude horse-shoe, opening northward. The depth of the working is nowhere great, and at the southern part of the curve very shallow. The curve encloses a few small detached workings of no interest or importance. Dumps occur pretty numerously all along the sides of the horse-shoe, but no reefs are visible in any part of the workings except at the southern apex, where a large but very ill-defined reef of bluish-white colour shows up for a few yards; but it is very easy to overlook it, as it is greatly obscured by rubbish. A

[1] This point is crowned by a Trigonometrical Station, 2,982 feet above sea-level.

very barren-looking reef of massive white quartz occurs some little distance north of the western branch of the horse-shoe. Neither of these reefs has been tested to any depth. This outlier of the auriferous rocks, if such rocks they are, is a very small one, and gneissic rocks occur all around at very small distances. Very little is seen of the country rock except at the eastern end of the works, where an immensely tough hornblendic rock with a soapy steatitic weathered surface occurs. Small outcrops of hornblendic schist peep up here and there in the workings. The washings that I had made at the western extremity gave only a small show of gold, but from scrapings in the deepest part of the eastern arm of the working I got a very fair show. The locality appears to me to be deserving of closer prospecting than it has yet undergone. Three and a half miles south-south-west of Arsikere are the old *Yellavari* workings, which lie in the low ground half a mile or so east of the village, and are excavated in hornblendic schist with intercalated bands of chlorite schist, which I refer but doubtfully to the auriferous system. The quartz seen is bluish-greyish-white in colour, very saccharoid in texture, and much iron-stained in part from the decomposition of included specks of hæmatite. Specks of powdery kaolin occur, but no visible gold or any sulphides. The reef lies between bands of micaceous and hornblendic bands of gneiss on the east and west respectively. A washing from the casing of the reef gave a very small show of gold. I feel justified in recommending further testings and a search for the reef, which will probably be re-discovered if the working is cleared out to the bottom. Whether there is any connection between the Yellavari and Gollarhalli patches of auriferous rock I cannot say ; the country is too jungly, and the rocks at both places seen in such very small outcrops that the eye can only follow them for a few yards. I noted no sign of any extension of the schists northward or north-westward past Arsikere. *Karadihalli* is the last of the auriferous localities included in the west-central group. The workings lie on the north and south-east slopes of a low ridge, the centre of which is formed by a small granite gneiss hill, locally called the Chotnare Maradi, around the hase of which lie beds of steatite and hornblendic rock of doubtful age, geologically speaking. As to reefs, only one small one was noted near the southern set of pits, and this is a white and hungry-looking one running for some 60 paces N. 5° W. Northward of the Chotnare Maradi are two large reefs deserving of further examination. The first, which lies due north of the hill, runs north and south, the second, which shows much more conspicuously, lies a couple of hundred yards further north-east and runs N. 20° W. The great wealth in gold which Mr. Lavelle ascribes to this part of the country has, I think, yet to be proven. The auriferous tracts already known are very small in extent, and, as far as surface study of them goes, they do not appear to be of the highest class.

(*Tarikere to Dâvangere*)

Western Group.—No old workings or unworked auriferous localities were brought to my notice in the southern part of the western band, but since

the completion of my tour I have seen a statement[1] that a vast number of old workings occur all over the hills to the north-west of Halebid. These old workings should certainly be looked up, both on geological and economic grounds. The western group is numerically far poorer in auriferous localities than either of the others, and they are scattered widely apart. The sands of several of the small streams running down from the hills west of the village of *Chiranhalli* in Tarikere taluq are auriferous. A washing in the stream flowing through the little tank known as the Huggisiddankatte gave a good show of rather coarse gold. A very fair show was next obtained at the junction of the same stream with another coming in from the north, and a small show from the bed of the northern stream, which is crossed by a good-sized quartz reef running N.N.E. This was the only reef seen, but other reefs doubtless occur among the hills west of the Huggisiddankatte. The country rock consists of steatitic and very pale chloritic schists, full of cubical crystals of pyrites, some of which are replaced by pseudomorphs in limonite, and others are quite fresh and bright. Well-shaped octohedra of magnetic iron are also to be found in the schists. The geological features are all favourable to the occurrence of gold, and the locality is worthy of very careful prospecting. At *Malebennur*, the sands of the little stream which falls into the Komaranhalli tank next beyond the ridge underlying the south end of the tank bund are auriferous, and from a washing I made here I obtained a very good show of coarse-grained gold of excellent colour. The little stream drains the western slope of the ridge for about a quarter of a mile, and its whole catchment basin must be less than 100 acres. The greater part of this consists of chloritic schists which in their upper part contain many laminæ and small nests of crystalline limestone. The chloritic schists are underlaid by trap, to all appearance a contemporaneous flow. This trap extends westward far beyond the basin of the small stream. To the east the chlorite schist is overlaid by a hæmatitic quartzite bed of considerable thickness, beyond which I did not follow up the series. No reefs are to be seen within the basin of the little stream, but many small veins of blue quartz occur traversing the chlorite schist and also the overlying hæmatite bed. Some of the larger of these veins on top of the ridge have an east-to-west run. The western slope ought to be very closely tested by costeaning in order to ascertain the source of the gold dust found in the stream. Trenches carried through the talus-covered parts of the slope may also be tried in order to find, if possible, any larger reefs. As already stated, a trap formation occupies the bottom of the valley west of the auriferous stream. This trap is much obscured by soil and talus, and the sequence of the rocks is not to be made out near the road. Where the ground begins to rise westward, and rocks crop out, is a quartzite so much altered by crushing and weathering that it has in parts assumed quite a gneissoid appearance. Underlying this comes a thick band of dark schist, chiefly argillitic, and this in its turn is underlaid by a great thickness of pale green and grey schists, chlorito-micaceous, in variable character. A few

[1] In an exhaustive work on the Occurrence and Extraction of Gold, by A. G. Lock.

beds of quartzite are intercalated here and there, and many very irregular veins of white and pale bluish quartz are to be seen traversing the schists. Gold occurs at *Anekonda*, a little over half a mile N.E. of *Davangere* travellers' bungalow, in form of dust obtained by washing the red gritty soil lying against the rock, which here forms a ridge rising only 20 feet (if as much) over the surrounding country. The rock is a brecciated quartz run, not an ordinary reef. Runs such as these are common in many parts of the gneiss in the Ceded Districts and elsewhere, but I have never met with one within the auriferous (Dharwar) series, nor have I ever come across such a brecciated quartz rock that had been regarded as auriferous by the old miners and mined as such. A washing of the red soil exposed in the shallow bed of a small stream falling into the Anekonda tank, a few hundred yards further south, also yielded a small show of gold. The source of this gold I believe to lie in the high ground to the south.

The elevated tract of the auriferous rocks of which the Bababudan mountains form the centre is one well deserving great attention both from the geologist and the mining prospector, it being an area of great disturbance, the rocks being greatly contorted on a large scale, and on the north and south sides at least of the area much cut up by great faults. Regions of great disturbance are in many cases extra rich in minerals, and it is very likely that such may be the case here. It is only of late years, owing to the extension of coffee-planting, that this mountain region has become accessible. Before that it was covered by vast impenetrable forests which hid everything. These are now penetrable in many directions, and the modern prospector has opportunities which did not exist before. The eastern part of the mountain tract culminating in the Bababudan mountains consists of huge flows of trap-rock (diorite) with intercalated beds of dark argillitic schists capped by quartzites and hæmatites, which two latter form the summit of the Bababudan mass. Mr. Lavelle mentions magnetic iron ore and "chrome" (presumably chromic iron) from the Bababudans, but unfortunately does not give any localities, so it was impossible to inquire further into their occurrence. The chromic iron would be valuable if found in good quantity and easily mined. The most southerly of the auriferous localities in the western set is *Suladamaradi*, a small hill 2 miles south-east of Tarikere. The hill consists of chloritic schist in highly contorted beds. The great white reef on top of the hill participates in the contortions, and is bent into a very remarkable flat sigmoid curve. This and the other reefs occurring on the north side of the hill are very white and hungry-looking. The only enclosures in the quartz I noted, after careful search, were small spangles with rich green chlorite. There were no sulphides, nor any other mineral, the chlorite excepted. The indications of the Suladamaradi rocks are anything but favourable, and the old miners evidently thought so too, for there are no signs of old workings. On the left bank of the Bhadra river, 13 miles south-east of Shimoga, on washing in the rain gully draining the south side of *Honnehatti* hill (Trig. Station), I obtained a very good show of moderately coarse gold. The mass of the hill consists of chloritic schist having a N.N.W. strike, and the beds may be seen extending for

miles in that direction, after which they trend N.E. Several large reefs are to be seen running N.N.W., or in the line of the strike of the country rock. Their only apparent fault is their great whiteness. No workings are seen on the south side of the hill, but on ascending the Honnehattimaradi on its eastern side, I came upon several unknown old pits and one shaft, which from their bearing had evidently been sunk to follow one of the reefs. The workings had evidently been continued to some depth, and were therefore in all probability fairly remunerative. Honnehatti appears to me to deserve very marked attention from earnest prospectors. *Palavanhalli* :—This well-known auriferous tract, which with the adjacent Kudrikonda tract constitutes the Honnali gold-field, was first visited by me in 1881 and its geology very carefully worked out and reported on (see above, p. 41). My opinion of the *Kudrikonda* tract was published in the paper just referred to. I believe my geological inferences to have been correct, and that the temporary non-success of the mine has been due mainly to want of capital wherewith to push on the works in depth. So long as sufficient quartz was raised to keep the stamps at full work, the mine paid its expenses. Should more capital be raised and working be resumed, I fully expect the yield of gold will improve in depth, as has been the case in so many deep mines in Australia. Without having the plans to refer to, and the mine itself being full of water owing to the stoppage of the works, and therefore inaccessible, I could not form any opinion as to the merits or demerits of the plan of work which had prevailed, but I cannot help thinking that if a new engine of sufficient power be provided to keep the mastery over the great volume of water flowing through the mine, it will soon be possible to sink an exploratory shaft to find the lode, which has been thrown by a fault in the country rock. It would be a great mistake to abandon further work without having made an earnest search for the missing lode, as from the structure of the country it is very unlikely that the throw of the fault can be a great one.

Non-Metallic Minerals.

The pure gold-prospecting work left me no leisure to devote to any non-metallic minerals, excepting such as actually fell in my way.

Emery.—Near Nadapanhalli a few small masses of dirty brown rock, measuring less than 2 cubic yards in the aggregate, are seen by the side of a field road. There are no signs of any working, so I suppose only loose pieces were taken away to test its commercial value, which cannot be great. The emery is very impure and of poor quality, and with good corundum obtainable in quantity in various other parts of the country is not deserving of any attention.

Asbestos.—Only one asbestos-yielding locality came under my notice, to the west of Bellibetta. The matrix rock in which the asbestos really occurs is not seen in the little pit from which the stone had been dug. The surface of the country just here consists of reddish kankar underlying red soil. The asbestos I saw had been included in the kankar, having apparently been weathered out from its original matrix, whatever that may have been. The

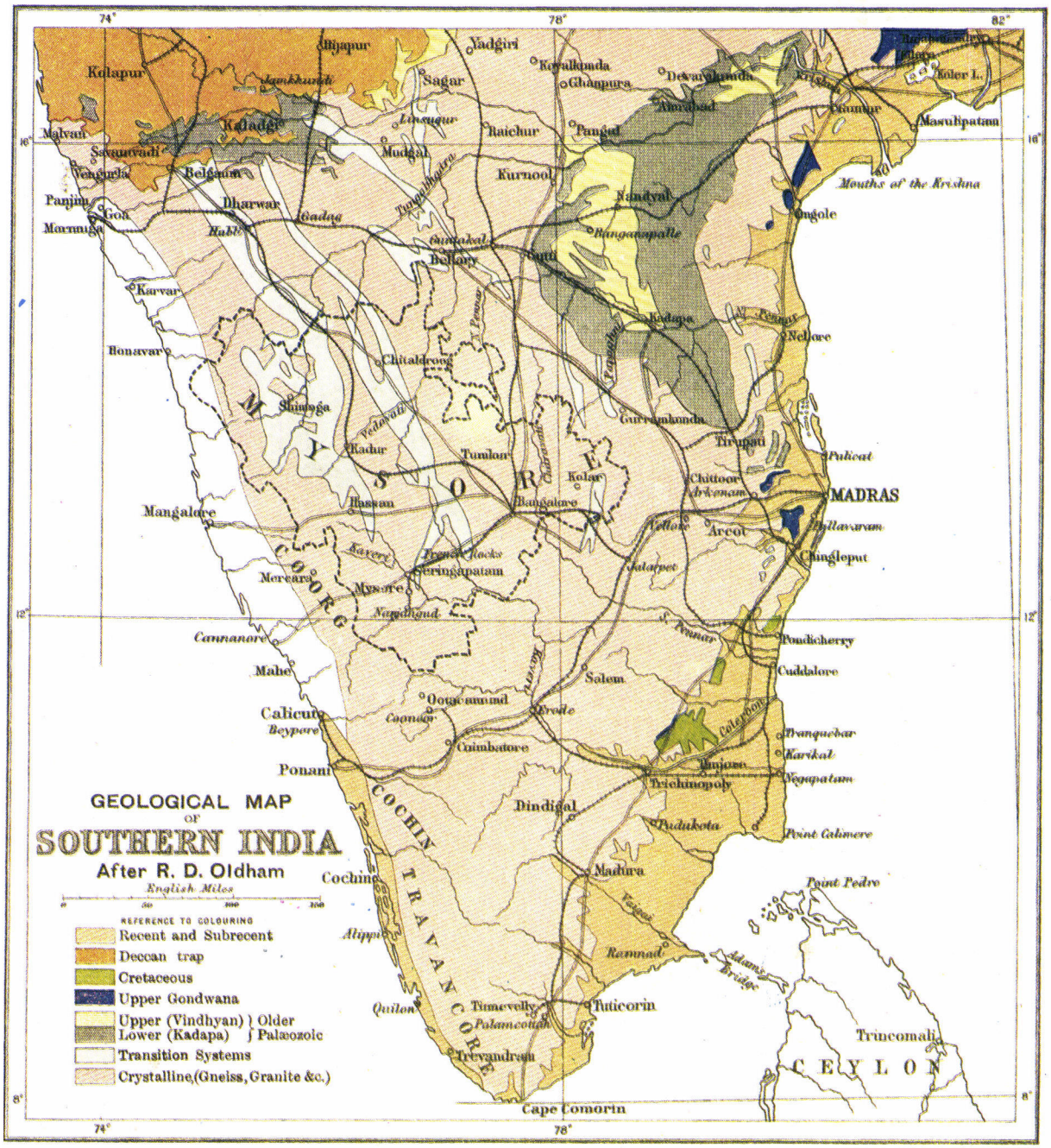
show of asbestos at the pit was very small and of inferior quality. The largest pieces showed a coarse fibre, 4 to 5 inches long, cream-coloured, and of dull lustre. I only noticed one piece with fine silky fibre and silvery-white colour. In the present condition of the pit, it is impossible to form an opinion as to the capabilities of the place.

Kaolin.—Kaolin is mentioned by Mr. Lavelle as occurring in several places and of good quality and colour, but he does not state whether it is available in large quantities. To be of real value commercially it must be of the highest degree of purity and free from all iron-mould or stain. To raise it on a large scale requires the presence on the spot of a large supply of *perfectly limpid water*, with which to work the rock by hydraulic sluicing, and facilities for the construction of large settling pits, which must be protected from the influence of ferruginous dust of any kind. In Europe, china clay works are found to pay only where the industry can be carried out on a really large scale. I have never yet seen in India a place combining the two most essential requirements for a successful industry, namely, a large development of kaolinized granite and a sufficient supply of limpid water. The limpidity of the water is a *sine qua non* for success. There is no demand for large quantities of kaolin in India, and speculators would do well to make sure before starting such an industry in India that they could find a profitable market for their produce in Europe or elsewhere.

Marble.—I noticed a good bed of grey crystalline limestone running north and south across one of the gullies near the main gold pit at Holgere. The limestone lies half way down the slope to the Holgere tank, and is of good quality, and would be a useful stone for decorative and monumental sculpture. Immense quantities of grey crystalline limestone, divided by partings and small beds of quartzite, occur on the east side of the main ridge lying between Chiknayakanhalli and Dod-Rampura. The limestones are several hundred feet thick and deserve to be prospected, for they may very likely contain beds of other colour than grey which would be valuable in sculpture.

Granite.—A very beautiful variety of granite gneiss, eminently fitted for cutting and polishing on a large scale, forms the mass of Chotnaremaradi in the little Karadihalli gold-field, two miles east of Banavar. The rock is remarkably free from joints, and monoliths of great size could easily be quarried. It is by far the handsomest granite I have seen in Mysore.

Porphyry.—A great dyke of beautiful porphyry traverses the hills east of the Karigatta temple overlooking Seringapatam. The porphyry, which is of warm brown or chocolate colour, includes many crystals of lighter coloured felspar and dark crystals of hornblende. The stone would take a very high polish, and for decorative purposes of high class, such as vases, panels and bases for busts and tazzas, etc., it is unequalled in South India, and deserving of all attention. If well polished it fully equals many of the highly prized antique porphyries. The dyke is of great thickness and runs for fully a mile, so is practically inexhaustible. Blocks of very large size could be raised, and, from the situation of the dyke on the sides of two steep hills, it would be very easy to open up large quarries if needful.


GEOLOGICAL MAP
OF
SOUTHERN INDIA
After R. D. Oldham
English Miles
0 50 100 150
REFERENCE TO COLOURING
Recent and Subrecent
Deccan trap
Cretaceous
Upper Gondwana
Upper (Vindhyan) } Older
Lower (Kadapa) } Palæozoic
Transition Systems
Crystalline,(Gneiss, Granite &c.)
MYSORE
COORG
TRAVANCORE
COCHIN
MADRAS
CEYLON
Bijapur
Yadgiri
Kulapur
Sagar
Kowalkonda
Ghanpura
Devarkonda
Nellore
Kaladgi
Raichur
Pangal
Masulipatam
Belgaum
Mudgal
Kurnool
Mouths of the Krishna
Dharwar
Gadag
Nandyal
Ongole
Karwar
Bellary
Gutti
Banganapalle
Kadapa
Bonavar
Chitaldroog
Shimoga
Gurramkonda
Tirupati
Pulicat
Radur
Tumkur
Kolar
Chittoor
Mangalore
Hassan
Bangalore
Arcot
Chingleput
Seringapatam
Mercara
Mysore
Pondicherry
Cannanore
Mahe
Salem
Cuddalore
Calicut
Beypore
Coimbatore
Tranquebar
Karikal
Ponani
Trichinopoly
Negapatam
Dindigal
Pudukota
Point Calimere
Cochin
Madura
Point Pedro
Alipi
Ramnad
Adam's Bridge
Quilon
Timevelly
Tuticorin
Palamcottah
Trevandrum
Trincomali
Cape Comorin
74°
78°
82°
16°
12°
8°

METEOROLOGY

The Hindus divide the year into six seasons. Of these the first, *vasanta ṛitu* or spring, commences with the opening of the Hindu year in March. It is the season of love and pleasure, and is a favourite theme of Indian bards. The weather is serene and clear, the farmer's occupations are mostly over, and he has time to celebrate the yearly festivals of his gods and the marriages of his kinsfolk. The mango is then covered with blossom, and the landscape is gay with the beautiful and sweet-scented flowers of the *kakke* or Indian laburnum. The southerly breezes that blow during the night are the voluptuous zephyrs of this vernal season. The *grishma ṛitu*, literally sweating season, is the second. It is the hottest part of the year, the sun being nearly vertical. The dust of the arid fields is frequently carried up in small whirlwinds, forming what are called *pisáchis* or devils. Nightly illuminations of the ghats and hills are seen, the result either of spontaneous combustion from the friction of bamboos against each other, or of a spark blown into the long withered grass which covers the slopes. The heat is intense and the air often still and stagnant. The sunset sky glows with the most fervid tints. It is the time of cyclones. Thunder-clouds suddenly gather, and—preceded by storms of dust, which sweep impetuously over the surface of the ground, obscuring the view for miles,—the rain, accompanied with vivid flashes of lightning, close followed by startling claps of thunder, descends in large and distant drops, often mixed with hail. These short-lived tempests prelude the grateful bursting of the monsoon, and introduce the *varsha ṛitu* or rainy season. The south-west monsoon blows steadily during this period and should bring with it abundance of rain. The rivers are swollen and sometimes impassable for days. The face of nature is clad in green and the ploughed fields receive the precious seed. The *s'arad ṛitu* or autumn next succeeds, during which the sun being again vertical in his southern declination but shedding a moderate heat, the fruits of the earth ripen. This season closes with the change of the monsoon, which is marked by the loudest thunder and heaviest rain of the year, the wind settling steadily in the north-east. The largest tanks are often filled in a few hours and a store of water obtained that will last over the succeeding dry months. The *hemanta ṛitu* or winter next sets in, with chilly foggy mornings and bright sunny days. The fields are reaped and the grain stacked. The *s'is'ira ṛitu* or cold season concludes the circle of the year. Piercing north-east winds dry up all trace of moisture, and clouds

of dust arise from every movement over the thirsty ground. The skin is parched and feverish. But the larger trees put forth new leaves or cover themselves with a mass of gorgeous blossom.

The year in Mysore may, however, with sufficient accuracy be divided, according to another Hindu system as old as the Vedas, into three seasons—the rainy, the cold, and the hot. The first commences with the bursting of the south-west monsoon, at the end of May or early in June, and continues with some interval in August or September to the middle of November, closing with the heavy rains of the north-east monsoon. It is followed by the cold season, which is generally entirely free from rain, and lasts till the end of February. The hot season then sets in, towards the beginning of March, and increases in intensity to the end of May, with occasional relief from thunder-storms.

The close of the rainy season in November is marked by dense fogs which prevail all over the country during December and January. They begin about three in the morning and last till seven, when they are dispersed by the heat of the sun. But in some parts fogs or rather mists follow the earlier rains. Thus about Chitaldroog from August to October the hills are obscured till nearly ten in the forenoon.

The temperature is the most equable during the rainy months, the range of the thermometer at Bangalore at that season being between 64° and 84°. In the cold season the mercury falls there as low as 51° in the early morning, and sometimes rises to 80° during the day. The minimum and maximum in the shade during the hottest months are about 66° and 91°, or in extreme seasons 96°. The observations registered in the several Districts are given in Vol. II.

Situated midway between the eastern and western coasts, Mysore shares in both monsoons, the south-west and the north-east. The rainfall ranges from 200 inches or more[1] a year in the Western Ghat regions, to little more than 10 inches in the north centre. But these are extremes that apply only to limited areas. The excessive rain of the Malnád rapidly diminishes eastwards, and from 30 to 36 inches may be accepted as the general average for the greater part of the country. The least quantity of rain falls throughout the tracts lying north-east from the Baba Budan range along both banks of the Vedavati or Hagari to the Chitaldroog frontier of the Province. Compared with the rest of the country this may be termed a rainless district, and the scanty fall is attributed, no doubt correctly, to the influence of the towering mass of the Baba Budan chain intercepting the moisture with which the south-west monsoon wind is charged.

[1] Mr. R. H. Elliot mentions that no less than 291·53 inches fell between April and the end of September (1893) at a cardamom plantation on the crests of the ghats.

The annual rainfall may be conveniently distributed into four periods, namely :—

The cold weather rains	...	December to March.
The hot weather rains	...	April and May.
The south-west monsoon	...	June to September.
The north-east monsoon	...	October and November.

The *cold weather* rains are insignificant, scanty in quantity, and not much needed for the standing crops. But they are useful in keeping up the pasture supply of the country. The *hot weather* rains (sometimes called mango showers) are of the accidental kind ; heavy short storms from the east. They are very important to successful agriculture, as a copious fall replenishes the tanks and enables the cultivators to prepare the land for the following *south-west monsoon* rains. These are perhaps the most essential for the country, which, on account of its general dryness, requires the steady drizzling and persevering rains of this season to make the soil productive. The *north-east monsoon* rains are especially important for filling the tanks and providing a store of water that may last over the rainless months.

The following averages for each District have been calculated for each season, based on the registered fall in the various taluqs in inches and cents for twenty-four years, from 1870 to 1893 :—

District.	Cold Weather. Dec.—Mar.	Hot Weather. Apr.—May.	S.W. Monsoon. June—Sept.	N.E. Monsoon. Oct.—Nov.	Annual Average.
Bangalore	1·32	4·80	15·64	7·88	29·64
Kolar	1·08	3·69	13·53	7·06	25·36
Tumkur	0·85	4·38	13·66	6·69	25·58
Mysore	1·63	6·98	10·21	8·36	27·18
Hassan	1·32	6·42	19·37	8·15	35·26
Shimoga	1·03	5·58	48·96	7·50	63·07
Kadur	1·29	6·29	43·96	9·39	60·93
Chitaldroog	1·10	3·72	10·40	6·69	21·91
Average for the Province	1·20	5·23	21·96	7·72	36·11

There seems to be a periodicity in the rain-fall, particularly well marked at Tumkur, which is situated at an equal distance from either coast and between the eastern and western mountain systems. A reference to the observations there recorded will show that for a considerable period every sixth year was one of abundant rain. This rule is not exhibited with equal precision in the register of other Districts. But there seems to be a general impression that about one year in five is a

good season for rain. And this accords to some extent with scientific discoveries; for a connection or correspondence has been traced between the terrestrial rainfall and the solar spots which gives a period of five and six, or of eleven, years during which the mutual variation is more or less constant.[1]

A special department has now (1893) been formed for meteorology in Mysore, with a well-equipped Observatory at Bangalore, where reports will in future be received from 151 rain-gauge stations. But meanwhile the following information from Mr. H. F. Blanford's book[2] is of interest. Writing of the summer monsoon, he remarks that "in Mysore, the Ceded Districts of Madras, the Deccan and Hyderabad, more rain falls when the strength of the monsoon to northern India relaxes, than when the interior plateau of the peninsula is swept by a strong current from the west coast." The mean annual relative humidity of the Mysore Province is set down as 66, that of Malabar and Coorg being 79, and of the Carnatic 67. The mean monthly rainfall at the following stations, based on the records of 50 years, is thus given, in inches and cents. :—

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Bangalore...	0·2	0·1	0·6	1·3	5·0	3·2	4·0	5·9	6·3	6·4	1·9	0·7
Mysore.....	0·1	0·1	0·7	2·2	5·6	1·9	2·3	3·2	3·9	6·4	1·6	0·5
Shimoga ...	0·1	0·1	0·3	1·8	3·3	4·7	6·6	4·2	3·1	5·0	1·2	0·4

The maximum is 25·9 at Shimoga in July, 19·5 at Bangalore in October, and 15·3 at Mysore in July.

Another important item is the estimated mean rainfall, as follows, on the several river basins. The figures, it must be remembered, include the portions that are beyond the limits of Mysore. Pennaur (N. Pennár), 26 inches; Pálár, 36; Panar (S. Pennár), 38; Kávéri, 44; Krishna above junction, 59; Tungabhadra, 43.

"Earthquakes"—Dr. Heyne observes—"are never violent and by no means frequent in this country, occurring only about once in five years." My own experience does not enable me to confirm this latter statement, but shocks have been occasionally felt in the neighbourhood of the hills running from Kankanhalli to Madgiri. From an inscription at Nelamangala, it appears that an earthquake occurred there in July, 1507. "I felt one at Túmkúr," writes Dr. Heyne, "on the 23rd of October, 1800. It is remarkable that at the same time a violent hurricane raged along the coast from Ongole to Masulipatam. The shock was felt at Bangalore

[1] Generally speaking, there appears a tendency with maxima (of sun-spots) to anticipate the middle time between the consecutive minima, the interval 11·11 y being divided into two unequal sub-intervals of 4·77 y and 6·34 y.—Chambers, *Astron.*, 17.

[2] "Climates and Weather of India," pp. 211, 50, 353, 284.

and in most other parts of Mysore; and it was stronger in the south than where I was. It seemed to come from the north, proceeding southward along the inland range of hills, and to be guided farther by those of which Sivaganga and Savandurga are the most conspicuous." Colonel Welsh says, with reference to Bangalore:—"On the 29th of December (1813), we experienced a pretty smart shock of an earthquake, which was very general in its effects all over the cantonment; it was accompanied by a rumbling noise, like a gun-carriage going over a drawbridge, and appeared to come from the westward. Our roof cracked as if a heavy stone had been thrown upon it, and every part of the house shook for some seconds. Some older and weaker buildings were actually shaken down, and the walls of others separated or opened out." An earthquake was felt at Tumkur in 1865, and several shocks at Bangalore on the 31st of December, 1881.

Aerolites or meteoric stones sometimes fall. On the 21st of September, 1865, one weighing 11½ lbs. fell near Maddur in the Mysore District. It is deposited in the Museum.

Cyclones in the Bay of Bengal occasionally extend their influence far inland. One of the 2nd of May, 1872, was very destructive in its effects; it blew a hurricane that overturned large trees even so far west as Coorg, and was accompanied by a deluge of rain. Again on the 4th of May, 1874, when a cyclone was raging on the Madras coast, a steady rain poured at Bangalore, which continued without intermission for about forty-eight hours. It had been preceded for several days by a still and hazy appearance of the atmosphere. At the end of November, 1880, just at the beginning of the ragi harvest, when but little was cut and the bulk of this most important crop was all but ripe, a great part of the State was visited by a storm of wind and rain of unusual severity, which did very considerable damage to the crops, and was the cause, moreover, of the breaching of a number of irrigation tanks. On the 16th of November, 1885, again, there was a continuous downpour lasting for more than forty-eight hours, but this was not of a violent character.

"Next to its sunny skies and its notorious and somewhat oppressive heat, perhaps no feature of the Indian climate," says Mr. Blanford,[1] "is more characteristic than the prevailing lightness of the wind." And to this cause, rather than to want of mechanical skill on the part of the cultivators, he attributes the absence of windmills in India. The average daily movement of the wind at Bangalore is put down at from 82 (Feb.) to 92 miles from October to March, 128 to 183 in May and August to September, 203 in June and 208 in July.

[1] *Loc. cit.* p. 30.