BIJÁPUR.

CHAPTER I.

DESCRIPTION.[1]

Bija'pur, between 17° 28′ and 15° 48′ north latitude, and 75° 24′ and 76° 31′ east longitude, partly in the Bombay Deccan and partly in the Bombay Karnátak, has an area of 5757 square miles, a population of 638,500 or 110 to the square mile, and a realizable land revenue of about £120,000 (Rs. 12,00,900).[2]

Boundaries.

This district is the most easterly part of the Bombay Presidency, being separated from the west coast by an average distance of about 130 miles. It forms a belt of land about 110 miles from north to south and varying in breadth from fifty miles in the south and seventy-five miles in the centre to about five miles in the extreme north. On the north and north-east the Bhima river separates it from Sholápur, the Akalkot state, and the Nizám's territory; on the east and south-east it is bounded by the Ságar district of Shárápur and the Ráichur Doab, both belonging to H. H. the Nizám; on the south by the Nizám's districts of Kushtagi and Bhindgal and the Ron sub-division of Dhárwár; on the south-west the Malprabha separates it from Navalgund in Dhárwár and the Rámdurg state; and on the west it is bounded by the states of Torgal, Mudhol, and Jamkhandi, the Athni sub-division of Belgaum, the Jath and Karajgi states, and Mangalvedha in Sángli. Some outlying villages, single or in groups, are scattered in the Nizám's dominions to the east, and in the Jath, Jamkhandi, and Rámdurg states to the west.

Sub-Divisions.

For administrative purposes the district is distributed over eight sub-divisions, of which five, Indi, Bijápur, Sindgi, Bágevádi, and Muddebihál, are to the north, and three, Bágalkot, Hungund, and Bádámi, to the south of the Krishna. As shown in the following statement these sub-divisions have an average area of 720 square miles, 167 villages, and about 80,000 people:

BIJÁPUR ADMINISTRATIVE DETAILS, 1881.

NAME.	AREA.	VILLAGES.											POPULATION.		LAND REVENUE.
		Government.				Alienated.				Total.					
		Villages.		Hamlets.		Villages.		Hamlets.							
		Inhabited.	Uninhabited.	Inhabited.	Uninhabited.	Inhabited.	Uninhabited.	Inhabited.	Uninhabited.	Government.	Alienated.	Total.	1881.	Square Mile.	
															£
Indi ...	871	109	1	2	6	16	...	2	...	118	18	136	71,940	82·59	17,431
Sindgi ...	812	129	7	...	...	13	1	...	...	136	14	150	72,650	89·36	18,823
Bijápur ...	869	83	8	6	1	9	1	...	...	98	10	108	76,896	88·59	12,587
Bágevádi ...	764	111	1	5	...	9	...	...	...	117	9	126	86,743	113·53	20,033
Muddebihál..	564	118	5	2	3	31	...	...	2	128	33	161	65,024	115·29	14,048
Bágalkot ...	683	127	13	3	18	31	3	1	4	161	39	200	96,156	140·78	14,779
Bádámi ...	676	138	12	6	17	56	3	1	3	173	63	236	89,047	131·72	10,291
Hungund ...	518	140	8	3	41	20	1	1	3	192	25	217	80,037	154·51	12,105
Total ...	5757	955	55	27	86	185	9	5	12	1123	211	1334	638,493	110·90	120,097

[1] Except Geology this chapter is chiefly complied from materials supplied by Mr. A. Cumine, C.S.

[2] The population and revenue details are for 1881.

Chapter I. Description.

Aspect.

Bijápur is an excellent example of the influence of geological conditions on scenery. The landscape of Indi is as unlike the landscape of Bádámi as the Indi trap is unlike the Bádámi sandstone. The Krishna divides the two types for some distance, but they meet and run into one another in Muddebihál. Here also is found a third type, the Don valley, a well defined tract, not intermediate between the other two, but closely related to the sterile trap country through which it passes and from which it has been formed.

Northern Belt.

The forty miles north of Bijápur, and the greater part of Sindgi to the east of Bijápur, are much like the worst parts of Sholápur and Indápur in Poona. This tract has all the features of the open Deccan trap country, and has a strong resemblance to the downs on the coast of Banffshire and Aberdeenshire in east Scotland. Hills there are none; on the other hand it can hardly be called a plain for it is not flat. It is a succession of low billowy uplands bare of trees, gently rounded, and falling into intermediate narrow valleys. On the uplands the soil, where there is soil, is very shallow, tillage is mostly confined to the valleys, which, enriched by the earth washed from the slopes, yield fair crops. The top of every third or fourth upland looks down a stream-bed fringed with wild date trees and occasionally with a cluster of *nims* or perhaps some fine old mangoes and tamarinds. Among the trees are one or two gardens and to one side of the gardens stands the village. A little further another grove of fine trees shades the village temple. The whole forms a pleasing oasis in the surrounding desert. The barrenness of the country and the dreariness of upland after upland and valley after valley, each like the last, are most depressing. Even the villages seem to lack character and to be turned out on some standard plan. Though they generally lie on the banks of a stream, except on the best streams, the villages are seldom close enough to be within sight of one another. All are much in the same style; surrounded by a ruined wall with one or more gates, the houses one-storeyed built of trap plastered with mud and with a blind wall running all round; so that, being flat-roofed, they give the impression of being deserted.

In spite of its general barrenness the trap country has excellent water. Many built wells yield a good supply, and streams are common in whose beds water can generally be found even in the hot weather. The only irrigation is from wells by leather-bags watering two or three acres along the stream-beds beside the villages. The only considerable ponds or reservoirs whose waters are used for irrigation are those at Mamdápur and Kamatgi in Bijápur.

In all this monotonous stretch of country there is nothing that can be called a hill. Near the northern borders of Bijápur some uplands or *máls* running east and west stand above the level of the surrounding country, but they are really not so high as the ridge south of Bijápur which makes far less show. During the rains, when the uplands are green and the valleys waving with millet, the effect though tame is not unpleasing. But about March, when the crops are gone, when what spear-grass has not been burnt is bleached to a pale hay colour, when here and there the naked black trap shows

Aspect.

in large patches, when the whole surface quivers in the noon-tide heat and burning blasts sweep across the treeless slopes, the country appears little better than a desert, and recalls the old Musalmán saying that the Adil Sháhi kings chose Bijápur as their capital because the deserts to the north of it prevented any blockading army from besieging Bijápur from that side.[1]

Central Belt.

The Don valley begins close to the south of the old city of Bijápur. This rich tract of deep black soil crosses the district from west to east. The rocky trap uplands disappear, the sweeps are much longer and more gradual, and in many parts there is a true plain. The saltness of the soil is favourable to crops and trees. But except *bábhul* few trees are planted for fear of drawing birds which cause great damage to the crops. The villages are chiefly close to the Don river. They stand on little hillocks of gray earth to which in the course of ages the village buildings have materially added. The Don valley is badly off for water. Wells are scarce and what water there is is brackish. In the valley, as in the Krishna valley further south, tillage is much more careful than in the barren north, and the husbandmen are much better off than their northern neighbours. In the 1876 famine in the Don valley granaries that had been closed for years were opened, and many of the people made large sums. In February when the whole valley is a sheet of magnificent millet, wheat, and golden *kusumbi*, the prospect is extremely rich. By April all is changed. Every crop except cotton is gone, and the valley is a dusty dreary waste.

Southern Belt.

The Don valley and the rich alluvial plain of the Krishna are separated by a stretch of barren trap. After crossing the Krishna by the Sholápur-Kaládgi road the country completely changes. Instead of bare waving uplands is a rich plain crossed from west to east by two lines of sandstone hills 250 to 300 feet

[1] A recent writer, the late Sir David Wedderburn, explained (Fortnightly Review, New Series, XXVIII. 225-227), by the process of exhaustion under British rule the change which had dried to a desert the realm of Bijápur. Sir David Wedderburn's idea that the country between Sholápur and Bijápur ever supported the city of Bijápur is a mistaken idea. That in Musalmán times as at present the granary of Bijápur was not to the north of the city but to the south in the rich lands of the Don valley is proved by the Hindustáni saying *Don pikke kon khdega ; Don ne pikke kon khdega*, that is If the Don bears crops who can eat (them) ; if the Don bears no crops who can eat? Both under the Bijápur kings and under the Maráthás the country to the north of Bijápur was barren. In 1631, during the first Moghal siege of Bijápur, partly because the country round had been laid waste by the Bijápur troops, the besieging force suffered great hardships as 'fetching grass and fuel from long distances was a work of great toil to man and beast.' The siege lasted only twenty days, still men and beasts were so crippled from want of food, that the Moghal army was forced to move from Bijápur to some better supplied part of the country (Elliot and Dowson, VII. 30). Forty years later (1671) the French traveller Bernier described the country of Bijápur on the side of the Moghals' dominions, that is to the north, as very difficult of access on account of the great scarcity of water, forage, and victuals. The city of Bijápur, he says, is very strong in a dry barren land ; there is almost no good water but in the town (History of the late Revolution of the Great Moghal [1671] Translation 171). In 1792 Moore (Narrative, 337) described the twenty miles to the north and west of Bijápur as stony, unarable, and not capable of improvement. In November 1808, five years after the establishment of the English as the paramount power had introduced a beginning of order into the Deccan, Sir James Mackintosh (Life, I. 461, 462), between twenty-five and eleven miles north of Bijápur, saw no living creature but some pretty paroquets, a partridge, a hare, and a herd of deer. In the eleven miles before reaching Bijápur he was astonished by the sight of two men on horseback. The plain was vast naked and uncultivated.

Chapter I. Description. Aspect. *Southern Belt.*

high whose sides seem woody though the produce is seldom more than brushwood and prickly-pear. The plain though rich is bare, and yields little drinking water, so that the villages are almost all ranged along the banks of the rivers or close to the bases of the hills. Both the ranges of hills curve north-east towards the Krishna, so that the great black soil plains in the east of Bágalkot and along the north of Hungund are unbroken by hills. In them drinking water is very scarce, and the villages are almost all along the banks of the Krishna or of the Ghatprabha after it passes through the hills below Bágalkot. South of the second range of hills, in the valley in which Bágalkot and Kaládgi lie, the country is better wooded and the scenery improves. It is at its best during and just after the rains. Then the hills, though low and not covered with anything better than scrub, are all green; the valley, dotted with low trees, waves with early millet; and patches of red freshly-turned soil brighten the green. Further south all over Bádámi and south-west Hungund there are more hills and they are rougher and steeper. The black soil has given place to red sand, and the timber if not fine is frequent. The villages on the light sandy soil of Bádámi are small and poor, but in east Hungund, in the black plain of Bágalkot, and along the rich Krishna valley are many large and rich villages. Within the space between the two ranges of hills lie several beautiful lakes, notably those near Kendur and Mushtagiri. Below the dams of some of these lakes, as at Kendur, are pretty cocoanut and plantain gardens watered by channels fed by the leakage of the lake. Here and there detached masses of sandstone stand out from the hills in jagged and fantastic shapes, or are scattered in huge blocks, bearing temples on their summits. Except the steep and quaintly-shaped sandstone cliffs of Bádámi, most of the hills are rounded and gently sloping. Between them are wide barren tracts of rock and loose stones and many stretches of light land woody and slightly tilled, brightened by patches of deep red, dull red, and white soil. Bádámi, with its bold red cliffs capped with brilliant green, its sheet of water in the gorge between the cliffs, its caves, and its fine old towers is a scene of much interest and beauty.

It is the sudden passing from trap to sandstone that causes so great a difference between the scenery of the north and the south of the district. Some inlying sandstone crops up at Mamdápur to the north, and there is trap west of Bilgi to the south. Otherwise the Krishna divides the trap from the sandstone as far east as Chimalgi about fifteen miles north-east of Bágalkot. Here the metamorphic granite base crosses to the left bank and runs north-east to the Nizám's border. At Muddebihál, Bidekundi, and Basarkod terraces of sandstone run out upon the granite and are in turn capped by the last flows of the Deccan trap. At Tálikoti limestone supplants the sandstone, and in the north-west of Muddebihál the trap flows grow thicker and thicker, gradually covering everything. South and west of the village of Muddebihál, where the metamorphic granite forms a gently waving plain covered with scrub and boulders, the surface is too flat for beauty. But the country south of Ilkal, where the disintegration of the granite has been much more irregular, is very wild and weird. Though Muddebihál has little beauty it

Aspect.

contains the handsomest village in the district, Tálikoti, which is built of the famous Tálikoti limestone. The effect of the sandstone at Guledgud in Bádámi, about twelve miles south-east of Bágalkot, is hardly inferior; and the villages south of the Krishna, though built much in the same style as those in the trap country, have generally an air of more comfort and strength. Though the village sites lie generally along the bases of hills, or on the banks of streams, where it was steep enough to make a fort, they sometimes stood on the hill-top. The new town of Guledgud lies along the banks of a stream at the bottom of a hill and is unwalled. On the hill-top may be traced the battered walls, the fallen houses, and the deserted temples of the old town.

Hills.

South Krishna Hills.

Only in the south and south-west below the Krishna is the plain surface of the district broken by hills of any size, and even in the south there are few hills more than three hundred feet high. The southern hills belong to the limestones, shales, and sandstones of the Kaládgi basin. Though they differ from the Sahyádri spurs in the character of the rock, and are the results of earlier influences, the sandstone hills of south Bijápur form two main ranges which run irregularly east and west and may geographically be taken as continuations of two great ranges, the north Ghatprabha and the north Malprabha hills, which from the Sahyádris stretch east across Belgaum, the north Ghatprabha range forming the water-parting between the Ghatprabha and the Krishna and the north Malprabha range forming the water-parting between the Ghatprabha and the Malprabha. The north Ghatprabha range, the water-parting between the Krishna and the Ghatprabha, begins at the Sahyádris close to the north of Manohar fort about forty miles north-east of Belgaum and passes east across Belgaum. Except in one or two detached fragments the trap ceases to the west of Bijápur limits. Still, though the rock changes, the line of high land is maintained by two flat-topped scrub-covered ridges of sandstone hills, one which passes south of Bilgi about fifteen, and the other which passes through Kundargi and Anakvádi about five miles north of Kaládgi. The Bilgi ridge falls into the plain about two miles to the east of Bilgi. The Kundargi hills stretch east along the north bank of the Ghatprabha about fifteen miles to near Yerkal or Herkal, about five miles north of Bágalkot, where the range is cut by the Ghatprabha. It reappears on the east bank of the Ghatprabha and stretches about ten miles east and eight miles north-east to Sitamani on the Krishna. The last eighteen miles between the Ghatprabha and the Krishna have been named the Sita range. From the Kundargi hills, about five miles to the west of Yerkal, where they are crossed by the Ghatprabha, a range of hills stretches south-east. After about four miles, that is about a mile north-east of Bágalkot, the range is crossed by the Ghatprabha. From the Ghatprabha it stretches about twenty miles south-east to Amingad, the eastern end of the north Malprabha range. This cross line of hills, which thus unites the eastern ends of the north Ghatprabha and the north Malprabha ranges, with its branches and intervening valleys, occupies a great part of the Bágalkot sub-division. In some places the

Chapter I. Description.

Hills.

South Krishna Hills.

hills are rugged and in others present wall-like scarps either with flat tabular summits or narrow-crested ridges.

The north Malprabha range or upland, the water-parting between the Ghatprabha and the Malprabha, starts from the Sahyádris near the Tolkhat pass about thirty miles west of Belgaum. Across Belgaum and close to Bijápur limits it continues trap, and, after the trap ceases, the highland is prolonged by irregular lines of sandstone hills which cross the centre of Bádámi and end at Amingad. At Mutkavi in the south-west corner of Bádámi, immediately after the north Malprabha range enters the district, a spur stretches to the south-east and east, till it is crossed by the Malprabha a little to the south-east of Bádámi. East of the Malprabha the spur reappears and stretches south-east in a broken line which ends abruptly a few miles east of Gajendragad on the western boundary of the Nizám's territory. Of the north Malprabha range the most notable hills are those at Guledgud, about ten miles south of Bágalkot, and those round Bádámi. The Guledgud hills are flat-topped and capped with brushwood. The sandstone is close to the surface, and generally forms a scarp about twenty feet high near the top, whence the steep sides fall to the plain covered with prickly-pear. There is no tillage on the top or sides and there is no special hill population. Pig and panther are common and do much harm. The Bádámi cliffs are perhaps the best example of the steep sandstone hills of the south of the district. They are broken into various shapes, huge masses of many thousand tons being detached or partly detached and rolled over on the plain. Little temples have been built both on the tops and in the chasms of several of the separate rocks and on two of the greater and partly detached masses stand the two forts of Bádámi. The top of the hills is flat, very broad, and covered with beautiful bright green scrub and the sides are red sandstone cliffs. There is no cultivation either on the sides or the top and no special hill population. There are a number of pig and a good many panthers.

About fifteen miles east of the Bádámi hills, in the south-west corner of Hungund, on the right bank of the Malprabha, a striking group of detached flat-topped hills rise 300 to 500 feet above the surrounding country. They are capped with sandstone resting on granitoid gneiss and stretch twenty miles east-south-east parallel with the Gajendragad ridge, and like it end in a bold bluff which overhangs the small town of Hanamságar in the Nizám's territory. These hills are the eastmost extension of the rocks of the Kaládgi series.

North Krishna Hills.

The great plain to the north of the Krishna is unbroken except by a few bare uplands. In the south-west of Indi is a series of uplands covered with spear-grass and a few *bábhul* shrubs, which, beginning in the villages of Sátalgaon, Jagjivani, Inchgeri, and Kanur, stretch through the north of the old revenue division of Horti. In the south-east of the sub-division there are a few bare uplands. South-west of the town of Bágevádi bare trap uplands or downs culminate in two small flat-topped laterite hillocks which are conspicuous within a circuit of ten or twelve miles. In the north-east rise two ridges of low hills. One runs west from Kámankeri to Dindvád;

Hills.

North Krishna Hills.

the other of flat-topped laterite begins at a point a little to the east of Masvinhal, and, stretching as far as Ingleshvar where a spur is thrown out in a northerly direction, ends near the village of Rabbinal. The Ingleshvar upland which overhangs the valley of the Don, running west and east, is flat-topped, and covered with loose stones and good soil. Just at Ingleshvar part of it is capped with laterite. East of Ingleshvar is a small flat-topped hill covered with black earth and small stones. There is also in the south of the sub-division a short curved ridge covered with prickly-pear and scrub, which, rising at a point to the north-east of Devalpur and skirting the town of Nidgundi, ends to the south of Maremati. In the north-west corner of Muddebihál, a few hundred yards south of the village of Alkopa, is a low range of flat-topped sandstone hills. In the south of Muddebihál on the north bank of the Krishna a series of low sandstone terraces run out from under the trap. From the south and west, that is from the granite plain below, the terraces form flat-topped hills, about 100 feet high, their sides and tops scantily covered with scrub and small blocks of stone. They run south-east until, beyond the town of Muddebihál, they take an easterly turn towards the Nizam's district of Ságar. The most remarkable hill in this part of the country is in the Nizam's territory, an outlying cone of trap at Nágarbetta about ten miles east of Muddebihál.

Rivers.

The district is well supplied with rivers and streams. Of these the most important are the Krishna and its feeders the Bhima and the Don from the left or north, and the Ghatprabha and the Malprabha from the right or south. Of these four feeders the Bhima and the Don meet the Krishna outside the district, and the Ghatprabha and the Malprabha meet the Krishna within the district, the Ghatprabha at Maremati about fifteen miles east of Bilgi, and the Malprabha at Kapila Sangam about twenty miles further east. All of these are large rivers flowing throughout the year and during the rainy season crossed only by boats. Except the Don, whose water in the driest weather is too salt to be generally drunk, these rivers supply fair drinking water.

The Krishna.

The KRISHNA rises among the Mahábaleshvar hills on the eastern flank of the Sahyádris. It flows south-east through Sátára, Kolhápur, Belgaum, and the Jamkhandi state, and for seventeen miles forms the boundary between Jamkhandi and Bijápur. It enters the district near Gehnur, and, after a course of about fifty-four miles through the district, separating Bijápur, Bágevádi, and Muddebihál on the left or north from Bágalkot and Hungund on the right or south, it passes into the Nizám's territory. Just before quitting Muddebihál, among the Jaldrug hills about twenty miles south-east of Muddebihál, the river splits into a number of streams which force their way through a low range of granite hills and fall about 300 feet in a quarter of a mile. The banks of the chasm are huge castle-like masses of granite whose red and pink glow among green brushwood and great thorny creepers. In dry weather the river breaks into white threads which wind among huge masses of granite and sharp veins and

Chapter I. Description
Rivers.
The Krishna.

dykes of basalt. When in flood the river is fully a quarter of a mile wide and fills the gorge from bank to bank. The water rushes from rock to rock half hidden by spray with mighty crash and clamour. From large deep holes columns of water and spray shoot high in air and fall roaring back. As it leaps into the wide pool at the foot of the gorge the mass of water, dashing among mighty currents and eddies, rises in crested waves which as they clash and climb hurl their spray into mid air whirling and foaming with inconceivable force and grandeur.[1]

At its meeting with the Ghatprabha in the rainy season (July) the Krishna is about 500 yards broad and the current runs two and a half feet the second.[2] About two and a half miles east of its meeting with the Malprabha at Dhanur, in the rainy season (June-October) the stream from bank to bank is about 600 yards broad, and where the river leaves the district it is nearly 700 yards broad and its current runs two and a half feet the second.[3] The ordinary low-water level is 1617·37 feet and at this point the highest flood level is 1648·54 feet or a rise in extreme floods of thirty-one feet. Mud, silt, and sand gather daily along its banks, entombing the remains of alligators, fishes, and river-shells. During the hot season the stream of water is small and in its black sandy bed may be found pebbles swept from the various rocks through which the river has passed. Among the pebbles brought down by the mountain freshes are occasionally found nodules of a reddish brown and white carnelian jasper, chalcedony, and mocha stones. Ten feet below low water the rock of the river bed is reached.

The fall in the passage of the Krishna through the district is slight. Near Chimalgi, opposite to which it receives the Ghatprabha, the north bank of the river is well marked and the south bank is low and at times is flooded for about 1000 yards from the river bank. The floods here rise to a height of about fifty-two feet and spread over an area of about 1700 yards or nearly a mile broad. Except near Chimalgi the north bank of the river as a rule is much lower than its south bank. During the rains the high-water runs up grooves in the land to the north and round into the river forming temporary islands many of which are covered with *bábhul* bushes. Though its water is not used for irrigation, during the fair weather large quantities of the *vángi* or egg-plant are grown along the north bank. The south bank is generally steep and on or near it are many rich villages. There are many *bábhul* plantations along the banks, which are bordered by quartzite hills with a few large trees. In the fair season carts cross the river at the ford of Baluti about sixteen miles north of Bágalkot. During the rains there are ferries at Tungargi on the Ilkal road and at Kolhár on the Dhárwár road. Besides the main tributaries numerous streams cut the bank on their way to join the Krishna, leaving intervening belts of high ground

[1] Meadow Taylor's Noble Queen, I. 16; compare Memoir Geological Survey of India, XII. 11, 43.

[2] Captain Newbold in Geological Papers of Western India, 347. The temperature of the river one foot below the surface was found by Captain Newbold (1842-1845) in July to be 76° 5'. Ditto.

[3] Journal Asiatic Society Bengal, XI. (2), 936.

Rivers.

The Krishna.

and making the road which crosses them at right angles uneven and difficult especially during the rains when this tract is partially flooded. Before the great flood in the Krishna in 1853 which washed away all trace of it, near the village of Mankini about twenty miles north-east of Bágalkot, was a deep reach called the Poison Pool. At first this pool during the rains formed part of the river, but afterwards it became separated from it. As the water remained stagnant for many months in the year and as the earth and rocks round it were charged with salt, the pool water became discoloured, bitter, and so undrinkable both to man and cattle that it was said to be fatal when drunk for any length of time. At the same time the pool water was said to be healing in cases of skin diseases.[1]

The Bhima.

The BHIMA rises in the Sahyádris near Bhimáshankar and runs east for about 105 miles across the district of Poona. It then turns south-east, and, after separating Poona from Ahmadnagar for about thirty-five miles, and from Sholápur for about sixty miles, flows through Sholápur for about fifty miles. It then turns east, and, after forming the southern boundary of Sholápur for about sixteen miles, touches the Bijápur district at Dasur. Below Dasur it flows east, and separating Bijápur from Sholápur for about thirty miles, receives the Sina from the left, and leaving Sholápur and skirting Bijápur for fifty miles more, enters the Nizám's territory, and falls into the Krishna, to the east of the Ságar district, after a further course of about 150 miles. The banks of the Bhima are overlain by layers of gravel and are 900 feet apart. They rise above high flood level which is about forty-nine feet above the river bed. The highest recorded flood level is 1381·25 feet and the ordinary low-water level is 1332·48 feet, that is a highest flood of forty-nine feet. The ordinary bed of the river is alluvial soil and the rock-bed is about ten feet below low-water level. Numerous streams flowing towards the Bhima from the right afford an ample supply of water for general purposes and in some cases for irrigation. In seasons of favourable rainfall most of these streams continue shallow threads of running water throughout the hot weather. Even after a scanty rainfall they hold water either flowing or standing in deep pools. During the rainy months (June-October) the tributaries of the Bhima overflow their banks for some distance leaving much silt on the flooded land which thus becomes extraordinarily fertile. In Indi the land along the bank of the Bhima is a rolling plain whose monotony is relieved only by the villages with which it is dotted. The portion of the Sindgi sub-division on its banks is a black soil plain with gentle undulations and is dotted with many rich villages. In spite of its size the Bhima can be forded at several places during the fair weather.

The Don.

The DON, with a drainage area of about 400 square miles, rises in the Jath state, about four miles south of Jath, and flows east and then south-east till it turns towards the town of Tálikoti in Muddebihál. South of Tálikoti it enters the Nizám's district of Ságar, and winding through a rocky defile, after a total course of

[1] Transactions Bombay Medical Society, V. (1859), 262.

Chapter I. Description. Rivers. *The Don.*

about 125 miles, falls into the Krishna about thirteen miles east of the Muddebihál frontier. Along its whole course the Don has steep banks of black soil more than ten feet high. Its channel is very winding and seems to have more than once changed its course. The river runs along a narrow valley on the top of the watershed between the Krishna and the Bhima. Taking the planes where the Sholápur-Hubli road crosses the river, the Don bed is 530 feet above the Bhima bed and 230 feet above the Krishna bed. The fall in the Don bed is as a rule very slight and the breadth of the bed is not more than 200 feet. In heavy rains the water cannot get off and sometimes comes down like a regular bore. The highest recorded flood level is 1915·70 feet which with a low-water level of 1895·83 feet gives a highest flood height of about twenty feet. For about thirty feet under the surface the bed is treacherous black mud and can be crossed only in places where there is gravel. Further east in the Tálikoti limestone the character of the river changes. The bed is of thin slippery slabs of limestone, and at one point near Tálikoti the descent is like going down a stair from one bed of limestone to another. During the rains there is a plentiful supply of fresh drinking water. After November the villages near the Don always suffer from want of good drinking water as the water of the main stream and of several of its tributaries, specially of the Little Don near Ukali in Bágevádi, becomes brackish shortly after the rains have ceased.[1] In the fair weather the stream of the Don runs very low. The deep black soil lands on the banks of the Don are famous for their cold weather grain crops. The Don valley was the granary of old Bijápur. Its importance to the old city is preserved in the local saying, 'If the Don bears crops who can eat (them); if the Don bears no crops who can eat?'[2] Especially in the old Tálikoti division the land is extremely rich, and some villages are adorned with gardens of mangoes and other fruit trees.

The Ghatprabha.

The GHATPRABHA rises near the edge of the Sahyádris almost twenty-five miles west of the town of Belgaum. After an easterly course of about 140 miles through Belgaum and the Southern Marátha states, it enters Bágalkot three miles north of Kaládgi.

---

[1] The following analyses of the water of the Little Don have been made by Surgeon-Major I. B. Lyon, the Chemical Analyser to Government:

Little Don Water.

	Flood Water, October.	Cold Weather, November.	Hot Weather, May.
	Grains per Gallon.	Grains per Gallon.	Grains per Gallon.
Chlorine	31·50	95·20	347·90
(Equivalent Chloride of Sodium.	51·90	156·80	573·00)
Combined Sulphuric Acid ...	18·97	75·04	186·62
Lime	10·85	30·38	102·20
Magnesia	4·76	25·41	73·22
Silica	2·10	1·68	8·22
Total dissolved Solids by Evaporation ...	97·30	313·60	965·30

[2] The Hindustáni runs, *Don pike kon kháega*; *Don ne pike kon kháega*; the Maráthi runs *Jar pikel Don, tar kháil kon*; *na pikel Don, tar kháil kon.*

Through Bágalkot it runs nearly east for about twenty miles, and then immediately below the town of Bágalkot turns suddenly north. Between Bágalkot and Yerkal, about five miles north of Bágalkot, it forces its way through two chains of hills, a pretty country with picturesque views of hill and water. Beyond the second range it enters the Krishna valley and falls into the Krishna about fifteen miles to the north-east opposite Chimalgi. At the meeting of the rivers the Ghatprabha is nearly a hundred yards broad and in the rainy season (July) flows about two and three quarters feet in a second.[1] Where it passes through black soil the banks are steep and in Bágalkot are closely studded with villages.

Rivers.
The Ghatprabha.

The MALPRABHA or MALPARI[2] rises near the edge of the Sahyádris about twenty-two miles south-west of Belgaum. After an easterly course of about 100 miles through Belgaum and the Rámdurg state, it enters the Bádámi sub-division of the Bijápur district about three miles south of Mutkavi. From this it flows east about twenty-five miles, forming the southern boundary of the Bádámi sub-division. Beyond Tolachkod, the southern range of the north Malprabha hills forces it about fifteen miles to the north-east where it turns north and for about eight miles flows between Bádámi and Hungund. It then resumes its north-east course and after flowing about twenty miles through Hungund falls into the Krishna at Kapila Sangam. Before passing through the Bádámi hills on its way to the Krishna, the Malprabha receives from the south the Bennihalla or Butter Stream which has its source about twenty miles south of Hubli in Dhárwár. To the east of the Gajendragad hills an open level tract, about eighteen miles long by about twelve broad, is marked by a slight cross ridge which has the appearance of having formerly been the south bank either of the Malprabha or of some other lost stream.[3] Where the Malprabha passes through the sandstone country, as at Aiholi in Hungund, the bed of the river is whitish sand and the water a lovely blue. The country bordering it is hilly, the flat-topped sandstone spurs occasionally stretching three or four miles from the bank. Near Aiholi, as it turns and winds among the hills, the river forms reaches of great beauty. At Nandikeshvar and Pattadkal, about eight and ten miles south-west of Aiholi, the country is again hilly, but the hills are too far from the river to relieve the flatness of the valley. Further south where it forms the boundary of Bádámi, the scenery is marred by the level stretch of the Dhárwár plain. The banks are always steep where the river passes through black soil, and in the north of Hungund are studded with villages. The highest recorded flood level is 1763·66 feet, which with a low-water level of 1742·88 feet gives a greatest flood height of twenty-one feet.

The Malprabha.

In Indi, Muddebihál, and Bágevádi, except in the villages on the

Wells.

[1] In July Captain Newbold (1842-1845) found the temperature of the river one foot below the surface to be 76° 5′. Geological Papers of Western India, 347.

[2] The name Malprabha is the Prákrit form either of the Sanskrit *malaprabha* mud-shining or more probably of *malaparva* full of mud. Malpari is the Prákrit form of *mala-apahári* mud-robbing. Rev. G. Kies' Southern Maratha Country, 14.

[3] Marshall's Belgaum, 111.

Chapter I. Description.

Wells.

banks of the Krishna and Bhima, the water-supply is generally from wells; in Bádámi, Bágalkot, Bijápur, and Hungund it is generally from the rivers; in Sindgi it is chiefly from streamlets and wells. According to the Collector's stock return for 1882-83 there were 6119 wells in the district, of which 3587 were with steps and 2532 were without steps. The wells in the villages on the banks of the Don show that the water-bearing strata are generally within twenty feet of the surface. The water in some of these wells is brackish,[1] but the water is occasionally used for irrigation.[2] Brackish wells sometimes occur outside of the Don valley, especially near Hippargi in Sindgi where the water of one well showed 61·71 grains of salt in a gallon.

Climate.

Except in Bádámi where there is much low bushy vegetation, and in Muddebihál where the ground is marshy, the climate is dry and healthy. Over almost the whole district March and April are the hottest months in the year, the trap uplands of Indi and Sindgi in the north suffering especially from burning winds. In the south the heat is sometimes specially trying near the sandstone cliffs of Bádámi which in the afternoon and evening radiate oppressively hot air. In May the intensity of the heat is slightly relieved by occasional thunderstorms and days of cloudy weather. In April 1820, at Bágalkot and Bádámi, Mr. Marshall found that in the afternoon the thermometer occasionally rose to 110° or 112°. At that time after the rains the tract of land close to the foot of the hills was so unhealthy that there were scarcely any villages. The few inhabitants were afflicted with intermittent fever during more than half of their lives. Near the Bádámi lakes the air was always damp and vapour-laden. And as during the whole year the people had to work knee-deep in mud a yearly epidemic of quartan fever was the result. The fever lasted three to six months and so broke their constitutions that men looked old at forty and few lived to be sixty. Except in the south-east where quartan fever prevailed, Hungund was healthy and hale men of sixty-five were common.[3] The thermometer readings in the shade recorded at Kaládgi civil hospital during the six years ending 1882 give a maximum temperature of 106° in April and a minimum temperature of 48° in January. During the four months

---

[1] The following is Dr. Lyon's analysis of the water of a well at Jumnal in the Don valley:

Well Water from the Don Valley.

	Grains per Gallon.
Chlorine	66·85
(Chloride of Sodium	111·85)
Combined Sulphuric Acid ...	47·95
Lime	23·94
Magnesia	25·67
Silica	3·92
Total dissolved Solids by Evaporation ...	245

[2] Sugarcane is irrigated, but the nature of the water prevents its juice from crystallizing on boiling; it is used only for eating raw and as fodder.

[3] Marshall's Belgaum, 112, 168.

from February to May the maximum temperature has varied from 77° to 106°, the minimum temperature from 57° to 85°, the mean maximum from 74° to 102°, the mean minimum from 63° to 87°, and the mean range from 7° to 41°; from June to October the maximum has varied from 82° to 100° and the minimum from 65° to 90°, the mean maximum from 77° to 96°, and the mean minimum from 65° to 80°, and the mean range from 3° to 25°; and from November to January the maximum has varied from 80° to 91,° and the minimum from 48° to 75°, the mean maximum from 74° to 84°, the mean minimum from 58° to 75°, and the mean range from 8° to 40°. The details are:

Kaládgi Town Thermometer Readings, 1877-1882.[1]

Year.		Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1877.	Maximum ...	88	91	93	98	100	91	89	87	83	82	81	80
	Minimum ...	67	73	75	78	78	74	75	72	70	71	67	64
	Mean Maximum	80	88	91	96	96	83	84	82	77	79	79	77
	Mean Minimum.	68	74	81	80	79	74	77	77	73	73	70	67
	Mean Range ...	21	18	18	20	22	17	14	15	13	11	14	16
1878.	Maximum ...	86	88	98	98	86	100	97	84	86	85	82	85
	Minimum ...	62	68	68	84	85	90	87	84	83	82	74	75
	Mean Maximum	74	78	88	88	90	96	78	80	82	82	79	78
	Mean Minimum.	62	68	68	74	78	65	76	80	80	78	75	70
	Mean Range ...	24	20	30	14	11	10	10	10	3	3	8	10
1879.	Maximum ...	82	77	95	102	101	86	89	83	88	89	87	86
	Minimum ...	70	70	75	78	83	74	73	71	70	69	61	54
	Mean Maximum	79	74	102	94	92	78	85	79	84	86	76	81
	Mean Minimum.	72	75	87	83	82	73	75	73	71	71	66	59
	Mean Range ...	12	7	20	24	19	12	16	12	18	20	26	32
1880.	Maximum ...	88	93	103	103	103	96	90	91	84	90	85	83
	Minimum ...	48	62	62	75	75	71	70	69	69	68	65	57
	Mean Maximum.	84	85	97	101	101	88	82	83	79	83	82	81
	Mean Minimum.	58	64	74	77	78	74	72	72	71	71	69	61
	Mean Range ...	40	31	41	28	28	25	20	22	15	22	20	26
1881.	Maximum ...	85	92	99	106	105	94	90	90	91	90	88	88
	Minimum ...	54	57	67	74	74	75	74	73	71	65	56	54
	Mean Maximum	81	87	95	102	100	89	85	84	85	85	81	82
	Mean Minimum	60	63	73	80	79	77	76	74	74	71	66	60
	Mean Range ...	31	35	32	32	31	19	16	17	20	25	32	34
1882.	Maximum ...	89	95	103	105	104	95	86	91	87	90	91	85
	Minimum ...	72	69	77	81	81	76	75	75	74	75	74	70
	Mean Maximum	84	91	98	101	98	86	80	84	81	86	83	82
	Mean Minimum	63	63	72	78	77	73	72	72	71	67	68	60
	Mean Range ...	17	26	26	24	23	19	11	16	13	15	17	15

[1] Thermometer readings recorded at Kaládgi from the 1st of January 1855 to the 31st of December 1859 show the following results:

Kaládgi Town Thermometer Readings, 1st January 1855 to 31st December 1859.

Month.	Mean.	Max.	Min.	Month.	Mean.	Max.	Min.
January	76°	89°	60°	August... ...	83°	98°	73°
February... ...	79	92	66	September ...	82	91	73
March	88	101	74	October ...	79	91	68
April	89	104	74	November ...	76	88	63
May	87	101	74	December ...	72	85	60
June	84	96	72				
July	82	91	73	Whole Year...	81	93	69

Chapter I. Description. Climate. *Rainfall.*

The rainfall is extremely irregular varying greatly both in amount and in distribution. In the three northern sub-divisions of Indi, Sindgi, and Bijápur, the average rainfall is about the same as at Sholápur (nineteen to twenty-six inches). The only exception is a tract near Almel about twenty miles east of Indi, where rain falls in greater quantity and more seasonably. In the Kánarese districts as in the Deccan the comparatively rainy belt which stretches fifty or sixty miles east of the Sahyádris is succeeded by a tract of uncertain rainfall, and this again in the extreme east of the Bombay Presidency gradually passes into a country where the rain, though not much heavier, is more seasonable and more certain. The deep rich plains on the banks of the Krishna suffer from want of rain.[1] South of the Krishna and beyond the low sandstone ridges which form the eastern end of the north Ghatprabha range the valley of the Ghatprabha enjoys a better rainfall than the tract to the north of the Bilgi hills. In Hungund the rainfall is even and certain and a failure of crops from want of moisture is rare.[2]

The year's supply of water is drawn partly from the south-west and partly from the north-east monsoon. The south-west rain generally begins during the first half of June, but occasionally showers fall in March April and May preceded by dust-storms and accompanied with thunder. In July the rainfall is uncertain. In some years it is almost as heavy as in June, in other years there is barely an inch. In August the fall is heavier and there is a further increase in September and October when the Madras or north-east monsoon sets in. The rains are not generally over till about the middle of November. The supply from the north-east monsoon is variable. In some years it fails; in other years it furnishes an important addition to the south-west rainfall. In exceptional seasons, as in 1874, the north-east rains extend as far west as the Sahyádris and the Krishna and the Tungbhadra come down in heavy floods. Passing showers and sometimes heavy falls of rain occur in December January and February. Rain returns[3] recorded at Kaládgi during the eighteen years ending 1882 show October to be the wettest month with a fall varying from 9·75 inches in 1880 to 1·7 inches in 1876 and averaging 4·74 inches; September comes next with a fall varying from 12·3 inches in 1877 to forty-two cents in 1879 and averaging 4·68 inches; August comes third with a fall varying from 9·11 inches in 1878 to ten cents in 1876 and averaging 3·93 inches; June comes fourth with a fall varying from 6·83 inches in 1876 to eight cents in 1873 and averaging 3·33 inches; July fifth with a fall varying from 6·81 inches in 1879 to fifty-three cents in 1867 and averaging 1·97 inches; and May sixth with a fall varying from 3·94 inches in 1880 to two cents in 1866 and averaging 1·61 inches. Of the six months from November to April, March is the

[1] Bombay Government Selections, V. 29.

[2] According to Marshall (Belgaum, 168) the rains of the south-west monsoon are unsteady in the periods as well as the quantity of their fall. This is not correct. Hungund is beyond the uncertain belt of rainfall though exposed to exceptional famines such as that of 1877. Mr. T. H. Stewart, C.S.

[3] The rain figures must be received with caution. In several cases the totals of the monthly and the yearly returns do not agree.

driest with an average fall of thirty-three cents; January comes second with an average of forty-four cents; April third with an average of forty-eight cents; November fourth with an average of 1·16 inches; December fifth with an average of 1·19 inches; and February sixth with an average of 1·35 inches. The following table gives the details :

Kaládgi Town Rainfall, 1865-1882.

Month.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.
	In. C.	In. C.	In. C.	In. C.	In. C.	In. C.	In. C.	In. C.	In. C.	In. C.
January ...	...	...	...	...	...	0 32	...	1 5	...	...
February ...	...	...	...	...	...	...	...	...	...	0 30
March ...	...	...	0 39	0 18	0 3	0 59	...	0 24	...	...
April ...	...	0 17	0 30	0 10	0 33	0 45	0 41	0 45	0 74	0 43
May ...	...	0 2	0 57	1 3	2 97	1 55	1 54	1 51	1 67	2 44
June ...	...	...	4 52	3 20	4 54	2 70	3 67	2 70	0 8	2 93
July ...	1 16	2 75	0 53	1 60	0 67	2 18	0 55	2 18	0 73	2 64
August ...	5 20	...	1 23	2 36	8 62	6 17	2 53	6 17	1 95	0 52
September...	...	2 30	...	3 96	6 66	5 61	2 57	5 61	3 33	2 6
October ...	3 65	6 57	...	2 78	3 85	6 20	2 43	6 20	7 19	2 98
November...	2 35	...	...	0 5	0 20	0 13	0 22	0 31	...	...
December ...	0 70	...	...	...	...	0 2	...	0 2	...	...
Total ...	13 6	11 81	7 54	15 98	27 87	25 92	13 92	26 44	15 69	14 30

Month.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	Average.
	In. C.	In. C.	In. C.	In. C.	In. C.	In. C.	In. C.	In. C.	In. C.
January ...	...	...	0 3	...	...	...	...	0 38	0 44
February ...	...	...	...	...	2 40	...	...	...	1 35
March ...	0 56	...	0 3	...	0 26	1 22	0 11	0 6	0 33
April ...	0 14	0 77	1 23	1 7	0 5	0 41	0 70	...	0 48
May ...	1 19	1 10	1 70	0 65	1 42	3 94	3 1	1 2	1 61
June ...	6 46	6 83	5 31	1 85	3 53	2 16	0 76	2 5	3 33
July ...	2 76	1 0	0 63	3 86	6 81	1 67	1 24	2 54	1 97
August ...	2 10	0 10	1 83	9 11	2 81	4 17	3 28	2 60	3 93
September ...	6 69	2 53	12 3	4 45	0 42	4 87	3 78	8 8	4 68
October ...	2 28	1 7	6 48	9 67	4 94	9 75	2 13	2 16	4 74
November ...	...	...	...	1 88	0 51	0 65	5 8	1 43	1 16
December ...	0 58	...	1 86	...	0 3	...	...	...	1 19
Total ...	22 76	13 40	31 13	32 54	23 18	28 84	20 9	20 36	20 26

During the same eighteen years (1865-1882) the average yearly rainfall at Kaládgi was twenty inches. The highest fall was 32·54 inches in 1878 and the lowest 7·54 inches in 1867. It is difficult to fix limits within which the rainfall may vary without doing serious injury to the crops. The amount gauged is not of itself a sufficient test. A heavy fall of a few hours may swell the return but be of little good compared with a gentle continuous fall of smaller quantity. In 1876, though the rainfall in June (6·83 inches) was higher than any recorded in the ten previous years, the want of rain in August September and October caused an almost complete failure of crops. In 1871 the rainfall, though small (13·92), was well timed; and though there were threatenings there was no complete failure of crops. The local opinion is that rain may almost entirely fail in June and on to the middle of July without causing serious injury provided it falls seasonably in August and September. The rainfall up to the middle of August affects the sowing of the early or *kharif* crops; after the middle of August it is the late crops which are affected. If the later rain fails the crops either cannot be sown, or if sown they are burnt. During 1876 the falls of rain were so untimely that they were of no benefit either to the early or to the late crops and the result was famine.

Chapter I. Description.

Winds.

At almost all times of the year most parts of the district are exposed to strong blighting winds. In the Don valley there is almost always a high wind. From November to February it is from the east very dry, and often blighting. In March and April the day wind is generally from the north-east and in May from the south. In the evening there is often a lull and about nine a strong breeze sets in from the west. This, which especially east of Bijápur is at first hot, soon cools and lasts till morning. In the north-east of the district the wind keeps hot till eleven or twelve at night. Sometimes there is a lull of one or two hours and then a rush of wind from the west and south-west, cooler but still somewhat warm till near sunrise. All night except during the lull the wind in the black soil parts is exceptionally strong and continuous and to a great extent prevents sleep. Constant dust and thunderstorms with heavy rain and strong wind prevail in April and May damaging the cotton crop. They sometimes, perhaps generally cool the air and relieve the heat, but occasionally a storm is followed by dull cloudy and peculiarly oppressive days. In Bágalkot and Bádámi early in October after the south-west monsoon is over, for two or three weeks, the winds are variable and the heat most oppressive. Before the beginning of November an almost constant breeze sets in from the north-east and daily becomes colder, especially when it is most from the east. In December and January this east wind is bleak, dry, and disagreeable, injurious to vegetation, and deadly to crops if, as sometimes happens, it lasts till February. In February there is a sudden change from cold to intense heat. The heat increases during February March and the beginning of April. During this season casual squalls often in the form of whirlwinds add to the discomfort of the climate. If at any time a steadier wind sets in, it brings heat rather than coolness and leaves the skin dry and rigid. About the middle of May the south-west wind sets in with a strong breeze, almost a gale. This frequently blows a full month before it brings rain. But even without rain it is always cool and refreshing, and this is perhaps the most agreeable month of the year. In Hungund from November to January the blast of the east wind is often keen.[1]

Geology.

The geology of Bijápur south of the Krishna has been fully described by Mr. Foote of the Geological Survey.[2] Besides south Bijápur Mr. Foote's survey included north Bijápur as far as Bijápur. Of the country north of Bijápur few details are available. All of it belongs to the great Deccan trap area and differs little from the country between Bijápur and the Krishna. An outcrop of sandstone was formerly supposed to occur in some hills north-west of Bijápur, but Mr. Foote has found that this is a mistake.[3]

The geology of the south of the district closely resembles the geology of Belgaum. There is the same belt of gneissic rock in the south, the same quartzites and limestones of the Kaládgi series

[1] Marshall's Belgaum, 168.

[2] The geological sketch of the district has been compiled from Mr. R. B. Foote's Memoir on the Geological Features of the Southern Marátha Country and Adjacent Districts. Geological Survey of India, XII. Part I. of 1877.

[3] Memoirs Geological Survey, XII. 24.

in the centre, and the same stretches of Deccan trap in the north. Besides that the land passes much further north the chief points of difference between the geology of Bijápur and of Belgaum are that in Bijápur the gneissic rocks stretch further north than in Belgaum and that to the north of Muddebihál there are limestone, quartzite, and shale beds and inliers younger than the Kaládgi rocks and known as the Karnál or Bhima series. Bijápur may be roughly brought under four geological divisions, the gneissic in the south-east, the Kaládgi sandstone in the south-west, the Bhima or Karnál sandstones in the east, and the trap region including the whole northern half of the district.

The order of these and other subordinate formations from the surface downwards is :

Post Tertiary or Recent :
- 8. Sub-aërial.
- 7. Alluvia.

Later Tertiary :
- 6. Lake and River Deposits.

Upper Secondary :
- 5. Deccan Trap ; (*b*) Iron-clay ; (*a*) Inter-trappean Beds.
- 4. Infra-trappean Formation Beds.

Azoic :

Sub-metamorphic
- 3. Bhima Series.
- 2. Kaládgi Series.

Metamorphic
- 1. Gneissic Series.

Gneissic Rocks.

Taking these formations in the ascending or geological order, gneissic or metamorphic rocks occupy the south of the district east of a line drawn from near Muddebihál to Aiholi. A narrow irregular belt also passes west along the course of the Krishna to Jainápur, about eight miles north-west of Bilgi. Beyond the main beds three sets of gneiss inliers are exposed by the wearing of younger formations. One set of these gneiss inliers is to the west of the main beds near Amingad about six miles and Kamatgi on the Malprabha about twelve miles west of Hungund ; the second group is in the extreme north-west at Bisnal on the south bank of the Krishna about eight miles west of Bilgi, and at Mamdápur to the north of the Krishna about eight miles north-west of Kolhár ; the third group is in the east in the Bhima series of limestones about ten miles north-east of Muddebihál and about ten miles east of Tálikoti. In the main area of gneissic rocks in the south-east of the district the two chief divisions of gneiss, the schistose and the granitoid, pass in great parallel bands with a north-west and south-east strike.

Granitoid Areas.

East of the Bijápur border, in the Nizám's country, from Mudgal fort about twenty-five miles east of Hungund, to the Jaldrug gorge on the Krishna about twenty miles south-east of Muddebihál, stretches a line of granitoid rocks. West of this a twelve-mile broad belt of schist known as the Hungund band passes north-west till it is covered by the sandstones of the Kaládgi series, and west of this is another parallel belt of granitoid rock. The best example of the weathering of the granite into rugged boulders and cliffs is at Jaldrug, where, near the Krishna, is much

Chapter I. Description. Geology. Gneissic Rocks. *Granitoid Areas.*

beautiful rock scenery, the green of brushwood and great thorny creepers setting off the rich red or pink of the castle-like masses of rock. The commonest type of granitoid gneiss is a porphyritic rock of quartz, felspar, and hornblende. Micaceous granite-gneiss also occasionally occurs. Except at Mudgal, where the true dip and strike of the rock can be measured, the granitoid varieties are not clearly bedded. At the point of transition from the massive crystalline form to bedded and schistose rocks the granitoid gneiss shows a broadly banded structure, the bands being parallel to the true foliation of the less altered rocks and being in fact the true layers of original deposition.

Schistose Areas.

The schistose areas of the gneissic series are of a much smoother surface than the granitoid areas. Even the hills are rounded and rarely rocky. The country is generally bare and the scenery commonplace and monotonous. Within the district, the chief varieties of schist are hornblende, chlorite, and hæmatite. The largest show of hornblende-schist rocks is the Maski band about twenty miles south-east of the Bijápur border. Hornblende also occurs in the south-east of the Hungund schists. Two beautiful varieties of syenite gneiss occur within the Nizám's territory at no great distance from the district border. One of these, on the south bank of the Krishna opposite Jaldrug, is very porphyritic, of a bright red, and highly polished. The other at Gajendragad, about twenty-five miles south-west of Hungund, is a very rich stone, a mixture of dark-green hornblende and dark salmon-coloured or brownish-pink felspar. In the Hungund band at Timápur, three miles north-west of Hungund, and at various other places along its north-west extension, are many chlorite schists generally of a very delicate pale sea-green. They occur interbedded with and passing into a similar pale green massive chlorite rock of semi-crystalline texture which in many places takes a singularly trappoid appearance.[1] A hill two miles west of Amingad in Hungund has a fine show of rich iron-bearing deposits. The rocks are generally full of hæmatite and the beds stand out in curves and vandykes of rich red. Owing to the great spread of cotton soil between them the relations of the Amingad and Hungund hæmatite beds are hard to determine. The beds differ somewhat in character, the Hungund beds except at the Yerkal cliffs being more schistose, less jaspideous, and much less stained with red. Two inliers of the Hungund beds rise within the limits of the Kaládgi basin, one a few hundred yards from the Amingad hill, the other several miles to the west near Kamatgi on the left bank of the Malprabha. At Todihal on the south bank of the Krishna, fifteen miles north-east of Kaládgi, several small beds of pale pinkish white talc rocks are inlaid between hornblendic gneiss.

Granite.

Granite and syenite veins and intrusions are most numerous in the valley of the Krishna at and around Nálatvád and westward

[1] Early observers took this rock for a true trap. Its position and association with schistose beds convinced Mr. Foote that its traplike appearance was the result of a locally more intense metamorphic action. Geological Survey, XII. 49.

nearly to the Tangadgi ford over that river. None are large, and many are ill-marked, of variable width, and irregular course, and often appear to graduate into the surrounding granite gneiss. The granite seems to be a compound of quartz and pink or red felspar and is very coarsely crystalline. Some of the veins have two varieties of felspar, apparently orthoclase, one peach-blossom coloured with enclosed crystals or crystalline aggregations of a dark salmon colour. The veins seem not to differ in mineral character.

On the slope of the plain which rises gradually to the north of the Krishna lie some scattered blocks of a fine-grained granite composed of crystals of reddish felspar, quartz, and a black glittering mica in minute plates. The overlayer of soil beyond the alluvium of the river is red and quartzose. In the lower or more southerly part of the valley of the Hiri river, which rises near Bágevádi and runs into the Krishna, a felspathic belt several miles broad stretches east. This rock varies in lithological character, in some places assuming the form of a pegmatite, at others that of a protogine, being combined with quartz and chlorite. A few loose and imbedded blocks of a granite similar to that found on the north bank of the Krishna occur, rarely without rising to any considerable height above the surface. The felspathic rock observed in sections presented by deep streams running down the slope of the plain has a pseudostratiform appearance arising from nearly horizontal joints. It continues as the surface rock as far as the village of Gurdini about ten miles south of Bágevádi, near which it is overlaid by beds of a friable trap, approaching wacke, with an obscurely schistose structure and penetrated by veins of an earthy carbonate of lime, calcspar, and quartz in crystals. It rises near the village into a small knoll, down whose slope runs a rivulet in the bed of which the first section of the great overlying Deccan trap is found. Depositions of lime-knobs or *kankar* both in beds on the surface and veins penetrating the fissure in both rocks occur in abundance; it is found in a pulverulent and concrete slate, and the nodules are not so crystalline as those that are seen in the neighbourhood of the older trap dykes.[1]

Of granite veins the most curious occurs at Madinhal, about four miles north-west of Muddebihál. With a close affinity to many metal-bearing veins or lodes, it shows nine or ten separate white and red bands, the white bands being mainly of quartz and the red bands of dark-red felspar with many quartz crystals. A few small needle-like crystals of hornblende or tourmaline occur in the mass, but are too much weathered to be identified. The vein crosses a mass of gray hornblendic granite-gneiss on which stand parts of the village wall. Two and a half miles south-east of the vein occurs a small intrusive mass of syenite of coarse texture and dirty green colour.

Occupying a second rank and resting directly and unconformably on the gneiss is a series of rocks in many respects closely resembling the Kadapa series. Though found underlying the town of Kaládgi

[1] Captain Newbold in Geological Papers of Western India, 314.

Chapter I.
Description.
GEOLOGY.
Kaládgi Series.

and most largely developed immediately round it, the series forms a well-marked basin lying mainly between the Krishna and the Malprabha. Beyond the proper basin are numerous outliers resting on the older rocks and inliers exposed by weathering within the area of younger rock series. On the north of the basin is the Galgali inlier, about twelve miles north-west of Bilgi, and at and near Mamdápur in Bijápur are two small exposures of the Kaládgi rocks which are partly inliers partly outliers, as they both overlie small patches of gneiss and are themselves on three sides overlaid by the Deccan trap. To the south-east of the basin are the Gudur and Hanamságar outliers and a group of outliers between Belur about eight miles south-east of Bádámi and Gajendragad. By far the most important sections are found within the boundaries of the basin itself.

The Kaládgi series may be subdivided as follows in descending order:

B.—Upper Kaládgi Series.

6. Shales, Limestones, and Hæmatite Schists.
5. Quartzites with local Conglomerates and Breccias.

A.—Lower Series.

4. Limestones, Clay, and Shales.
3. Sandstones and Shales.
2. Silicious Limestones, Hornstone, or Cherty Breccias.
1. Quartzites, Conglomerates, and Sandstones.

The greater part of the Kaládgi basin is occupied by the lower Kaládgi series. Of the area they occupy by far the larger part is in its turn occupied by the lower subdivisions, which for practical purposes may be treated as one. They form the whole western and southern part of the basin, the upper subdivision of limestone and shale being restricted to the north-east.

Lower Kaládgi Series.

The following sections show the character of the different members of the Lower Kaládgi series beginning on the east and following the boundary of the basin first north and then west.

Amingad Section.

The narrow spur of Kaládgi rocks which crosses the Malprabha at Kamatgi forms a dip-meeting or synclinal valley which ends in an elliptical curve to the west of the ruins of the old Amingad fort about thirty miles east of Kaládgi. The succession of beds in descending order is: (*d*) upper or chocolate breccia; (*c*) quartzites, brown and red-brown, gritty; (*b*) chocolate or dirty breccia, the setting or matrix locally very rich in hæmatite; (*a*) quartzites, brown gneiss, drab and salmon-coloured, gritty. The base rests partly on schistose hæmatite and talcose gneiss, partly on hæmatite schists. The surface of the brown gritty quartzite bed (*c*) has weathered in parts into great pinnacles unlike anything found elsewhere among the Kaládgi rocks.

Khirsur Section.

The section in the Khirsur hill three miles east of Bágalkot shows the following beds: (*c*) breccia bed of dirty breccia; (*b*) quartzites, a thick series, gray, pink, and drab; (*a*) conglomerates, forming the north scarp of the hill; gneiss.

Adumuranhál Section.

In the Adumuranhál section, in the gorge of the Ghatprabha river, north of Bágalkot the beds exposed are: (*c*) breccia, with

iron-chalk cement; (*b*) quartzites, whitish pale-red and brown; (*a*) conglomerates, coarse and fine, with some beds of quartzite; gneiss, chlorite schists. The conglomerates in this section are remarkable for their great beauty of colour. The setting or matrix is generally a purple or purplish gray gritty quartzite of great density, including numerous pebbles of jasper and hæmatite schist, derived from the beds of those rocks in the gnessic series. The pebbles are all rounded and so firmly bedded that where the rock has been fissured the pebbles have generally split. Along the crest of the ridge, a little west of Adumurunhál, the show of red jasper pebbles is like a bed of red tulips. In many parts where the rock has been freshly broken by weathering and keeps its half-glassy lustre the effect is striking, especially under the midday sun.

Sumurmatti Section.

At the apex of the sharp horse-shoe curve which the basement series makes between the two gorges of the Ghatprabha at Adumurunhál and Yerkal, another capital section shows the succession of beds as in the foregoing, namely: (*c*) breccia, greatly broken and weathered; (*b*) quartzites, drab, buff, and reddish; (*a*) conglomerates, purple with jaspery hæmatite schist pebbles; gneissic series, of hæmatite schist and chlorite schists. In this case some of the conglomerates approach to breccias from the imperfect roundness of the fragments of the older rocks. The setting of the conglomerate, which is richly iron-bearing, consist largely of broken hæmatite joined by an iron cement. The pebbles are generally smaller than those on the Adurmuranhál ridge.

Yerkal Section.

The Ghatprabha river breaks through the boundary ridge for a second time and re-enters the Kaládgi basin at Yerkal or Herkal, three miles north-west of the first or Adurmuranhál gorge, and forms a gorge of much picturesque beauty. The section of the basement series is one of the clearest and most instructive in this region. Little ruin of other rocks hides the several rock-beds which occur in the following order: (*c*) breccia, chalky-iron or dirty breccia; (*b*) quartzites, buff, pink, and brown, with inlaid shaley sandstones; (*a*) conglomerates and quartzites, the conglomerates purple, the quartzites purple and gray; gneiss series, highly contorted beds of jaspery hæmatite schists. Some of the beds of quartzite include thin layers of pebbles. Many of the pebbles and fragments in the conglomerates consist of jasper and jaspery hæmatite which in places form very fine cliffs. The conglomerate beds lie against the north wall of the hæmatite cliff. The rocks in the middle of the river are part of the lowest conglomerate bed and dip north or away from the spectator. The low and rather shelving cliff on the right and east bank of the river is part of another hæmatite schist-bed that runs parallel to the north of the main beds. The low rising ground behind the great grove consists of limestones and shales and the breccia bed (*c*) which underlies them; all are faulted against the gneiss along the northern boundary of this part of the basin immediately behind the rise.

Sitámani Section.

The Sitámani section, like the Yerkal section, is clear and instructive, the various rocks of the basement series being well exposed on the Sitámani hill on the south side of the gorge through which the

Chapter I. Description. Geology. Lower Kaládgi Series.

Sitámani Section.

Krishna forces its way across the north-east extension of the Kaládgi basin. The boundary ridge of the basin has been but imperfectly broken through, and forms a great barrier reef across the river bed. The succession of beds is: (*c*) breccia, a jaspery variety of the dirty breccia; (*b*) quartzites, gray and salmon-red; (*a*) conglomerates and grits; granitoid gneiss. The grit beds are generally coarse. Like the conglomerates they consist of white and grayish-white quartz pebbles and the ruins of red felspar. The setting in both is purplish or gray. At Rámápur, a mile and a half south of the Sitámani gorge, the section differs considerably from the Sitámani section, the conglomerates being absent. The basement beds are grits of no great thickness overlaid by salmon-red and purple-brown quartzites which are greatly rippled in parts. The gritty beds rest on granitoid gneiss crossed by numerous dykes of dioritic trap, both large and small, but all older than the Kaládgi rocks.

Nidgundi Section.

For seventeen or eighteen miles west of Nidgundi, the extreme north-east of the Kaládgi basin, the northern boundary of the basin is formed by a fault by which the rocks of the basement series are thrown down and abut against the gneiss. All the Kaládgi rocks which once lay upon the gneiss northward of the line of fault have been worn away. Though it is nowhere visible there is little doubt that the amount of dislocation is considerable. The succession of rocks in the corner of the basin north of the Krishna differs somewhat from the succession in the sections already given, by the appearance of a thick bed of limestone between the quartzites and the breccia beds. The succession is: (*c*) breccia of chert or hornstone, brown, red, and bluish gray; (*b*) limestone with cherty bands, gray and reddish gray; (*b*) quartzite sandstones, shades of brown; (*a*) conglomerates and pebble beds, pink, brown, and gray; gneiss. Small patches of dark iron-clay, probably of open-air origin, are dotted over all the different formations. The limestone bed is hidden by ruins along the line of section, but shows at some distance on either side. Here, as at Sitámani and Rámápur, the included pebbles are mainly quartz and felspar in a sandstone setting.

Bilgi Section.

The next section worthy of separate notice occurs a little south-west of Bilgi, twenty miles further west. The succession of rocks is normal and the beds seen are: (*c*) breccia bed, jaspery; (*b*) quartzites, drab and red, blue and gray, drab and pinkish; (*a*) grits and conglomerates; granite gneiss. The conglomerates are unusually thin, and the quartzites proportionately thick. The quartzites are quarried, and a remarkable one-stone lamp-pillar on the top of Bilgi hill is said to have been quarried here.

Bisnal Section.

The village of Bisnal lies eight miles north-west of Bilgi. A section which was taken about half a mile south of the village in a south-east to north-west direction, shows the following succession of beds: (*c*) breccia, bands of earthy impure limestone at base; (*b*) quartzites and shaley quartzites of whitish colour; quartzites, red and gritty; (*a*) grits and conglomerates, gray or reddish, of quartz and felspar ruins; granitoid gneiss, red. In the corner made by the bend of the hills about a mile and a half south-east of the village are

four beds of richly hæmatite schist among the quartzites about the horizon occupied by the upper part (*b*) in the Bisnal section. They give rise to four distinct scarps, due to their greater power of standing weather.[1] A line of fault, accompanied by a considerable downthrow on the north side, occurs at the village of Bisnal, the dirty breccia being faulted against underlying conglomerate beds. This fault and downthrow may be traced several miles to the north-east crossing the Krishna to Jainápur and finally disappearing under the Deccan trap about two miles north-east of Jainápur.

Jainápur Section.

At Jainápur the quartzites are faulted against the gneiss, but the contact is hidden partly by an overlap of the Deccan trap, partly by thick cotton soil. There is a good show of red quartzites and dirty breccia in the bank and bed of the river. The breccia which is very jaspideous forms a small island and several reefs in the river. The quartzites have a westerly dip of 45°.

Mamdápur Section.

About four miles to the north of the Jainápur ridge at Mamdápur in Bijápur, are several exposures of Kaládgi rocks which are partly inliers in the Deccan trap area, partly outliers resting on the gneissic series. Seven of these exposures form a row of low hills that run for six miles east and west with only one considerable break. Six miles south-west of Mamdápur is another small exposure of similar character at Kangalgutti; all these consist of purplish grit and reddish quartzites, with pink, chocolate, and drab-white micaceous shales belonging to the basement beds. The usual conglomerate beds are absent.

Galgali Inlier.

Another interesting inlier of the lower beds, one of a group of three occurring at Galgali, is seen in the bed of the Krishna when the river is low. These beds of quartzite form a low, flat, dip-parting or anticlinal ellipse with dips varying from 3° to 7°, by which the river is dammed back and a rapid formed near the northern bank. The rocks are gray quartzites and shaley beds overlaid by light-red rippled quartzites, much cut by a most complex system of jointing. These are overlaid in the right bank by impure gray limestone with bands of chert and of impure red, yellow, or drab ochrey quartz, and some white chalk-like scales or laminæ. The whole is capped by dark-gray quartzite, on which the Deccan trap forms low cliffs on either side of the river. The beds shown in this section are of very small aggregate thickness.

Quartzites.

The base of the long quartzite ridge that stretches from Biddugal, about twenty miles west of Bádámi, where the Malprabha leaves the Kaládgi basin, to Telachkod, where it again enters the basin, is nowhere shown. The thick cotton soil deposit of the black plain stretches close to the hills and is itself covered by the sandy slope caused by the decomposition of the quartzites. The central part of this ridge near Khánápur about ten miles and Banknari about eight miles west of Bádámi, is much more uptilted than

[1] In 1871, a small quantity of iron ore was being collected to be smelted at the neighbouring villages of Siddápur and Jainmatti. Memoirs Geological Survey of India, XII. 84.

Chapter I. Description. Geology. Lower Kaládgi Series. *Quartzites.*

either end. At Biddugal the beds dip 35° north-west, at Khánápur 50° to 60° north-east, and at Banknauri 60° to 75°. The dip falls to 35° at Lakmápur, and to 30° at Chinrasavi, where the quartzite beds cross the Malprabha. Further east the dip falls rapidly to 8° north on the plateau above Belur, and then the strata become horizontal, or roll very slightly, where they form the plateau which caps the line of hills that stretches to Gajendragad. The beds are generally grits or very compact sandstone which assume the character of quartzites where they are even slightly upturned. Conglomerates, though not altogether absent, are not common in this quarter. The same characters hold good in the outliers north of Gajendragad around Gudur. The ruling colours are pale, drab, gray, purplish, reddish, pink, and brown. Here and there, as at Vakand, about six miles west of Gudur, are exceptionally dark beds of sandstone. One of the best sections in the Gudur hills is immediately east of the village on the pathway up to the old fort which is perched on the north-east angle of the chief plateau. The beds exposed in a very steep scarp are pale drab, brown, and reddish-brown, thickbedded sandstones with occasional layers of pebbles, and pebbles are scattered sparsely throughout the mass of the rock. Some of the more gritty beds show much false bedding. The sandstones occasionally have fine scarps, which, like the quartzite scarps in other quarters, show much bright-red iron staining. Such scarps are seen at Parsápur and Hanamságar east of Gudur, at Gajendragad to the south, and in the valley to the north-west of Gudur. Where the sandstones are horizontal or nearly horizontal they are little changed. A very marked example of their changing to quartzites, where upturned to a considerable degree, occurs a few miles west from Gudur at Rangasamudra, a village at the north end of the gorge by which the Nilarvágal river flows across the eastern end of the quartzite sandstone area that stretches from Bádámi across the Malprabha, and may conveniently be called the Vakand plateau.

Sandstone.

The eastern edge of the Vakand plateau is formed of sandstone beds, slightly inclined to the south-west. Very soon the beds dip west some 20° to 25° towards a dip-meeting synclinal axis, while at the north of the gorge they dip south-west 65°, and in both cases take the character of typical quartzites. At the north end of the gorge the change may be traced with perfect ease as the beds form a bare scarp running south-east. The eastward continuation of the same beds forms a horizontal capping to the rather high plateau south of Gudur. The gorge of the Nilarvágal coincides with the axis of the abovenamed dip-meeting curve. The central part is very picturesque from a great mass of chocolate-coloured breccia, which has been worn into high and rugged rocks rising mainly on the left bank of the stream. West of this stream the beds again become horizontal, or roll at low angles, and again present the character of simple hard sandstone.

North of the Gudur stream is another large plateau of sandstones, partly horizontal partly rolling at low angles. This plateau, whose mineral character is much the same as that of the outlying plateaus

of Gudur and Hanamságar, is united with the Kaládgi basin by a narrow strip that branches from its north-west end, and crosses the bed of the Malprabha close to the village of Aiholi or Aivali. The surface of the granitoid gneiss on which the beds forming these different plateaus are deposited is highly irregular. This is well shown in the picturesque valley that runs from Gudur south-east to Murudi. Here the sandstone plateau, while maintaining a very even upper level, shows in the scarped edges very variable thickness, and many of the upper beds are seen to overlap the lower beds and to rest in part directly on the gneiss. Thus the basement beds at Murudi and Ganuduhal form the middle of the series that is exposed on the north side of the plateau.

Quartzite Sandstone.

Turning west and recrossing the Malprabha a remarkable plateau of quartzite sandstones and gritty beds is reached to the east of Bádámi. These beds may be best studied at Bádámi itself. In the two fortified hills to the north and south of the town, is one of the few beautiful spots in the eastern Bombay Karnátak plain. It occupies the mouth of a horse-shoe bay in the hills, the space behind the town and the surrounding cliffs being taken up by a deep lake and a not very wide bank sloping to the water's edge. The cliffs are chiefly formed of pale buffy thick-bedded quartzite sandstone with in many places purple scales outwardly stained red. The beds dip west at a low angle, and parts of them seem to have slid west a few feet towards the plain, being separated from the main mass by great joints which now form deep chasms that sever parts of the hill from the rest. If these chasms were formed by the sliding of the front of the cliffs, the slip was probably due to the presence of some softer thin shaley bed which was acted on by springs, and the overlying masses moved down the slope forced on by their own weight. These great chasms serve as the inner approaches to the upper parts of both forts. The gritty beds which form the top of the plateau are admirably shown along the path that leads from Bádámi to Nandikeshvar in the Malprabha valley, past the very picturesque old Jain temple of Magandi, within the precincts of which is a very fine spring. The gritty beds show such extensive false bedding that the actual lie of the beds is very difficult to make out. Beds of similar character, the unquestionable extension of the Bádámi set, occur to the north-west and north, at Alludkatti, Karadigudda, Belgiri, Hudgal, Kutenikeri, and Rugkápur. Further west the character of the beds becomes more sandy or even shaley. North-east of the Bádámi plateau, the beds being more often disturbed and upturned, quartzites are common. About a mile east of the great reservoir at Kendur, the boundary between the quartzites and gneiss is formed by a line of fault which runs for about three miles. Some fine cliff scenery in which the quartzites are exceedingly well shown occurs near the east end of the fault.

The boundary of the Kaládgi basin in this quarter is extremely winding, the wearing of the basement beds showing the gneissic rocks in various deeply cut valleys, which form bays running far into the area of the basin. The lie of the basement beds along this part of the boundary is generally waving, but considerable areas of

Chapter I. Description.

Geology. Lower Kaládgi Series. *Quartzite Sandstone.*

rather disturbed strata alternate with equal undisturbed areas in which the strata are horizontal or very slightly inclined.

North of the town of Guledgudd the variation of position of the strata is well marked. The very waving surface of the high plateau between Sirur and Guledgudd agrees over a large area with the true surface of the exposed beds. Within a mile of Sirur the beds suddenly roll north and dip under the limestone and shale, which here come near to the edge of the Kaládgi basin. The hills west of the plateau form a low dip-parting arch which stretches several miles west and dies away under the limestone and shale at Kattigiri. East of Sirur the basement series forms a ridge of considerable height with a dip of 30° to 35° north which stretches to and crosses the Malprabha at the village of Ramdhal. Here beautiful rippled reddish quartzites rest on beds of very handsome purple breccia. This breccia in turn rests with marked unconformity on gneissic rocks of gray and reddish-brown schists and jaspery hæmatite schists, which doubtless are the source of the materials seen in the breccia. A remarkable set of breccia beds forms the very base of the Kaládgi basin where the new high road between Sirur and Guledgudd passes on to the gneiss area. The Ramdhal breccia beds join those which lap round the great hæmatite hill on the south boundary of the basin about half-way between Ramdhal and Amingad. A great number of bright red or banded fragments of jasper make the beds equal in beauty of colour to the beds of the Adumurunhál section. This section concludes the series in the circuit round the boundary of the basin. Several sections are to be noticed lying within the area of the basin. In some of these the horizon relative to the series as a whole is very doubtful, partly from the imperfection of the section, partly because the space between that and other sections is hid by overlying formations. The westward extension of the Bádámi quartzite sandstone beds has already been mentioned. By their weathering they give rise to a vast amount of extremely sandy soil forming a considerable slope at the base of the different groups of cliffs and isolated rocks. The quartzite sandstone beds lying in the triangle between the villages of Nidgundi, Bilgiri, and Kerur form a rolling plateau so deeply cut by streams as to make the country very rugged. As they stretch west the beds become more sandy, often indeed passing into friable shaley sandstones, which in some places are overlaid by a thin bed of reddish quartzite. This arrangement is well shown in a flat-topped hill crowned by a little hamlet called Yenklápur, two or three miles south-east of Kerur, and again in a low hill north-east of Malgi. In the Malgi hill the upper quartzite is capped by gray limestone, and this again by an outlier of Deccan trap. The limestone is unquestionably an outlier of the great limestone series, which is largely developed a few miles to the north. Both at Yenklápur and to the north of Malgi the shaley sandstones are mostly grayish, drab, or pale-gray. They are well seen further north-west in the Kallubenkehri stream and to the west at Fakir Budihal and Hoskatti. They also cover a large area to the south of the low and irregular dip-parting or anticlinal which forms the watershed between the valley of the Malprabha on the south and that of the Ghatprabha and of the Kerur-Guledgudd stream on the north.

Shaley beds form numerous low hills and rolling stretches in the triangle between the villages of Reddi-Timápur, Halgiri, and Somankop. Their rapid weathering near Reddi-Timápur and in the sides of the Hehvulkode valley to the north, has given rise to much falling in of the overlying quartzites. The same has been the case with the drab shaley beds and overlying quartzite sandstones north and north-west of Voglápur. The drab shaley beds are seen underlying the local upper quartzite at Mudiánur south-east of Voglápur, and at Khánápur in the Torgal state.

The reddish quartzite sandstones that form the Naganur hill, about twelve miles south-west of Kaládgi, are fully 100 feet thick, and but slightly disturbed, the northern dip being only 15° and the southern dip 5° to 10°. North of the hill is an apparently overlying drab and purple quartzite, some beds of which are strongly ripple-marked. Their high dip of 55° north seems connected with some noteworthy features in the overlying limestones. From Naganur eastward, about seventeen miles to Jalgiri, the boundary is much obscured, the Kaládgi limestones presenting every appearance of dipping under sandstones and quartzites, which, from their position and rock character, belong to the lower or basement series. Actual contact of the two sets of rocks could nowhere be found, even with very laborious search, owing to the thick covering of cotton soil or sandy slope. The relative positions of the rocks show a series of complicated faults. The quartzites and sandstone beds seen along the obscure boundary are almost entirely conglomeratic and have a more or less southerly dip at low angles. The most marked signs of disturbance are at Anival. From Jalgiri eastward the boundary is normal, the quartzites and conglomerates dipping north under the limestone series. West of Kattigiri, about eight miles south of Bágalkot, the quartzites form a dip-parting ellipse, corresponding to that on which the village itself stands, while southward from the ellipse the boundary trends south-west to the Kerur stream, and makes a wide sweep to the south and east, eventually returning north-west, and enclosing a large shallow bay occupied by limestones and shales belonging to the third section of the lower Kaládgi series. The only case of a fault-rock noticed within the Kaládgi basin was a large vein or reef of distinctly brecciated quartz running along the line of the dislocation caused by the fault north of Bisnal, eight miles north-west of Bilgi. It can be traced for about a couple of miles.

Limestone.

From no point can the limestones be better studied than from the town of Kaládgi, which stands upon limestones, nearly in the centre of the basin. The limestone beds are much twisted, and the dips and strikes are very variable. The average dip is about north-east from 35° to 40°. The commonest colour is gray of various shades, banded with very wavy belts of gray chert which generally weather drab or yellow. A very handsome variety occurring north of the cantonment is grayish-black banded with green. It is a very impure, highly clayey variety, overlaid by gray and underlaid by dirty pink, and this by banded gray limestone. A very beautiful pink and pale-green banded or clouded variety was found by Dr. Thorp, the civil surgeon, at the north end of the market-place,

Chapter I. Description. GEOLOGY. Lower Kaládgi Series. *Limestone.*

and several large masses were raised. The greatest exposures of the rock are to the east, south-east, south, and north-west of Kaládgi. The streamlets in the neighbourhood afford good sections of limestone and its associated shales which are beautifully marked by white, blue, green, yellow, and red bands, and seamed with sandy layers. The open seams of the rock are often encrusted with a limestone soaking.

Capital limestone exposures occur about two miles south-east of Kaládgi in the Sillikeri stream, where purple, pink, and white banded, dark, gray, and almost black beds crop out with a dip of 30° to 40° north-east by east, the dark upper beds being the most clayey. Another exposure, one of the largest in the basin, occurs between the two villages of Sillikeri. Here the gray chert-banded variety of limestone is very largely exposed on either side of an important dip-parting, which stretches for some distance, east and west, crossing the Khaleskop stream to the west, where it is traceable some hundred yards till hidden by cotton soil. Similarly, the eastward extension of the dip-parting is lost about two miles south-east of Hire-Sillikeri. South of the village of Chik-Sillikeri, and on the southern side of the dip-parting axis, some very clayey beds appear among the limestones. Two of these are specially noteworthy, because highly prized for economic purposes. The first is a bed of coarse black rock of rather gritty texture and exceedingly tough, quarried for flags, which are formed by rude, imperfect cleavage-joints running nearly at right angles to the bedding. The second is a bed of very tough and strong gray slatey shale, formerly largely quarried for roofing slates for public buildings at Belgaum. The rock shows no signs of true cleavage, but, in a similar bed, if not the extension of the same bed, which shows about a mile south-east of Hire-Sillikeri, the true cleavage, as contrasted with bedding, may be well studied. The cleavage is strong and dips 65° to 70° east, while the bedding forms a low flat dip-parting whose axis lies south-east and north-west.

Silicious Limestone.

To the south of Sillikeri near Yendikeri, the gray beds above described reappear from under the Khaleskop quartzite hill with a northerly dip of 45° to 65°. A mile south of Yendikeri the beds again roll south, and the lower beds are well repeated. They are dark and extremely silicious besides being full of cherty bands. Some of these cherty bands have an oolitic structure, which in some cases shows distinctly on weathered surfaces. Some others show a texture indistinguishable from a true quartzite. The southern part of the section is obscure, but the limestones and overlying chalky shale dip south against the faulted boundary of the limestone basin to the west of Anival. It has already been pointed out that the ruling colour among the limestones is gray of various shades. Even where other colours occur they are much less developed than the grays especially the paler shades of gray. The other colours are red, pale-green, purple, whitish pale, drab, cream, and blue. Besides the shows of limestone round and to the south of Kaládgi, in several other places large surfaces of the rock are exposed under circumstances favourable for study. The following are the most important

of these exposures to the east of Kaládgi and to the south of the Ghatprabha river:

At Bágalkot to the south-west of the town is a great exposure of beds dipping southward 35° to 40°, among which are gray, brownish-gray, greenish-gray, pale-gray, green, brownish-pink, pinkish, white streaked with shaley bands in part, also one bed showing a markedly brecciated structure. Some of the beds show considerable concretionary masses and veins of calcspar of white or grayish-white.[1] In some cases, particularly in the beds close to Gaddankeri five miles west of Bágalkot, these are quarried for the sake of the spar, which is used for various ornamental purposes.

At Nirligi, five miles south of Bágalkot, a great show of gray beds forms a low anticlinal with east-west axis to the south of the village. South of Kattigiri the limestone basin forms a deep bay that crosses the valley of the Kerur-Guledgudd stream. The greater part of the bay is occupied by chalky or clayey purple or chocolate shales interleaved with pale-blue or greenish white bands of limestone from a quarter to one inch thick. These are largely shown in the two streams that drain the slope east of Mannagad. In the lowest part of the bay near the banks of the big stream at Hungurgi these shaley beds are overlaid by much crumpled gray and drab limestone.

At Kakkalgaon, three miles north-west of Kattigiri, are banded gray, grayish-white, and whitish limestones, the latter associated with purple-gray clay rock. At Hulgiri, twelve miles south-east of Kaládgi, a great number of beds crop up north-east of the village, showing nearly as great a variety of colours as the Bágalkot beds.

To the north of the Arrakeri or dip-meeting synclinal valley east of Kaládgi and north of the Ghatprabha is a great show of highly faulty limestone full of cherty bands which often completely hide the chalky parts of the beds. Much of the chalky matter has been removed by weather and the surface of the country is greatly

[1] At the east gate of the fort of Bágalkot an impure limestone is seen in a streamlet dipping south at an angle of about 15° or 20°. To the south of this limestone schistose clay is exposed, but the succession of the strata is not clear owing to the covering of broken rock and black soil. The limestones near the parallel of Bágalkot are either impure granular limestone or a slatey marble of a compact texture with thin plates and a coloured veining of chlorite and occasionally talc. In a streamlet south of the fort the limestone has a gnarled and twisted appearance and has no trace of bedding. Between Bágalkot and Sirur, a pink or salmon-coloured limestone occurs. The same variety of limestone rarely appears on the same line of strike, owing to the many changes which the beds have undergone, the metamorphising agent acting transversely to the strike. About seven miles west of Bágalkot at the village of Gaddankeri is a calcspar breccia, composed of schists and limestones. The limestone on the east side of the town is fissured north-east by north, and the fissures, which do not exceed a quarter of an inch in breadth, are filled with strings of calcspar. Further west these strings of calcspar increase in size and become thick veins, with the limestone rock still predominating. These veins send branches in all directions and pieces of limestone are isolated as it were in calcspar. More to the west the fragments of limestone and schist are confusedly thrown about in a setting or matrix of calcspar, and these fragments decrease in number until the rock becomes pure calcspar. The calcspar rock is covered with several feet of fine alluvial soil and does not appear on the surface. Lieutenant Aytoun in Bombay Geographical Society's Transactions, XI. (1852), 44, 45.

Chapter I. Description.

GEOLOGY.

Lower Kaládgi Series.

Silicious Limestone.

masked by chert ruins. The more chalky beds are best seen along the Sholápur road near the Sanagi lake.

Many of the cherty scales show delicate concentrically waving dark lines, which give the chert the appearance of containing an organic structure. The same kind of structure was observed in chert occupying a relatively identical position on the south side of the Kaládgi basin, a little north-west of the Tolachkod ford across the Malprabha and in several other places.

Three or four miles east of Sanagi lake is another rather important show of limestones chiefly in the bed and on the banks of the Tolanmatti. These rocks are gray, green, and pinkish-white, banded and purple in colour, the latter earthy in texture. Six miles east of Tolanmatti, at Tuglihal on the right bank of the Ghatprabha, are purplish-gray beds together with some purple beds banded with bluish-white. At Hudelur, three miles north-east of Tuglihal, is a widespread show of gray cherty limestone. Immediately north-west of the village a large sheet of rock presents a somewhat strange appearance as weathering has formed a band of chert an inch to an inch and a half thick, which passes as a capping beyond the unbroken sheet to various detached patches of the underlying chalky band. At the bend of the Ghatprabha, a little south-west of the village, an out-crop of massive, gray, chertless limestone with concretional structure has given rise to a very singular appearance in the weathering of the rock. The whole surface is thickly studded with low conical bosses that rise out of small hollows and are much like large rough-shelled limpets or the top valves of Hippurites. Each boss is a concretional cone, one and half to two or more inches in diameter and about one inch high. They look like weathered cones of percussion, but it is hard to see what could have caused percussion in such a position at the end of a very long still reach of the river where, even in the highest floods, no large shingle would be borne with force enough, and such cones of percussion are not seen where other limestones are exposed to very strong currents.

The two outlying patches of limestone north of the Krishna at Chimalgi and Devlápur consist mainly of the gray cherty variety, but their stratigraphical relation to the beds in the limestone basin proper is very obscure owing to the immense masses of ruined matter and surface soil which mask the face of the intervening country. What evidence there is points to their not belonging to the limestone basin, but to their being a set of beds that occupy a similar position to those occurring in the valley of the Malprabha north of Manoli, which lie between the upper and lower subdivision of the basement quartzite series.

North of the Ghatprabha and west of Kaládgi, on the bank of the Krishna, a little east of Galgali, and in the river north of Yedhalli, are two beds of limestone, the upper dark-gray the lower light-gray. The upper is very flinty with the cherty concretions arranged vertically like so many rude organ pipes. A great show of very cherty dark-gray limestone is seen in the bank of the Krishna south of the village and stretching across the river to Budihal. At Gulabal, a mile to the south-west, the chert limestone has lost nearly all its

chalky matter, which has apparently been replaced by a pale-yellow ochrey mineral, and the bed assumes in parts the appearance of a dirty-looking semi-cherty quartzite. North of Galgali in the river, and resting on the quartzite which forms the great barrier across the Krishna, are some thin beds of impure limestone with thin bands of chert quartzite and the ochrey mineral above mentioned. Some scales of white satin spar with very brilliant fracture also occur. The ochrey bands, which are dirty red, yellow, and drab, and certain white chalky scales which accompany them are most likely merely decomposed shale beds. A layer of gray quartzite caps this peculiar succession of beds.

In returning within the limits of the limestone basin, little or nothing is seen of the limestones north of the Arrakeri synclinal or dip-meeting valleys; the country is masked by cherty ruins and cotton soil. South of the valley and north of Khátarki gray limestones occur with a northern dip. Close to the village there is a dip-parting or anticlinal axis, on the south side of which the beds are gray, gray and white, and white with pale green and pinkish banding. These beds stretch to the east and west. To the east they cross the Ghatprabha south of Sirugumpi; to the west they show very widely between Kop and Chik and Hire-Algundi. The variety of tints is even greater than at Khátarki and Lingápur, with bands of pale-green, pink, white, and bluish-gray. The rocks are well seen over large bare areas, and offer sections of crumpled bedding of very great beauty and interest.

There can be little doubt that the great show of beds at Antápur and to the east of the Vajarmatti double curve of the upper quartzite series is the continuation westward of the beds described at Algundikop and Khátarki. Besides the other shades a purplish-gray occurs at Antápur.

South of the Ghatprabha river and west of Kaládgi is the greatest unbroken area occupied by the limestone series. Great stretches are entirely hidden by thick beds of cotton soil. Along the south bank of the river, the first beds of limestone occur west of Shedudhal two and a half miles north-west of Kaládgi. They are pale pink and green with whitish bands, very like many beds at Kop and Chik-Algundi to which set they probably belong. At Chottarband Kota flinty beds occur very largely, and form the western end of a dip-parting or anticlinal axis or stretches south-east nearly to the village of Kajádoni, and is very likely continuous with the Khaleskop dip-parting mentioned before. Some of the flinty bands are cherty, others cannot be distinguished from thin bedded quartzites. North-west of Naganur, twelve miles south-west of Káladgi, are some handsome, purplish, dove-coloured, and greenish banded beds. Some have rippled surfaces, the crests of the ripples showing a flinty framework with fish-scalelike markings. To the north of the dip-meeting, these gray and bluish banded limestones are largely exposed both east and west of Lokápur, where they make the largest show in the whole limestone basin. These two sets of beds are unquestionably the western extensions of those seen at Yendikeri and Khaleskop and Sillikeri, and of which a large display occurs intermediately in the

Chapter I. Description. GEOLOGY. Lower Kaládgi Series. *Silicious Limestone.*

valley of the Kajádoni to the south of the village of that name. At this village on the top of rising ground limestone is exposed for about a hundred yards on one side of the road. The limestone has a strike nearly east and west and dips south at an angle of 45°. It is granular in texture and slatey in colour, and overlies a broken schist. The planes are covered with talc and are often green with copper.[1] Faint traces of copper in the shape of thin films of malachite occur in some gray limestone quarried in the bed of the stream about three miles south of Kajádoni. Great quantities of limestone, much of it highly cherty, occur in the valleys of the different streams which unite to form the Kajádoni, especially to the west and north of Chipurmatti. About a mile to the north-west of Chipurmatti are signs of brecciated limestone, pale red or pink fragments included in a dull red setting, also of a variety with a purplish-brown setting, including fragments of gray slate and limestone. Neither variety was seen in place, but numerous blocks had been used as fencing-walls on both sides of the path leading north to Kaládgi. Along the west side of the Yendikeri stream are numerous beds of limestone which dip south at high angles. Among these are some gray beds with occasional thin veins of bright cherry-red calcspar. In the bed of the stream is a layer of pinkish limestone with delicate green stripes, which have been twisted into most elaborate vandykes, and give the stone a very handsome pattern. These beds join those in the Yendikeri valley.

The shales which accompany the limestone series are much less exposed and apparently much less developed than the limestones. They are most largely developed above the limestones, and show an approaching return to littoral conditions in the sea or lake in which they were formed. The littoral conditions, when fairly at work, have given rise to the overlying conglomerates and quartzites, whose ruins in most places hide the shales. The most striking and one of the commonest forms of shale is a soft earthy, chalky variety, light purple, violet, chocolate, or lavender in colour, which is generally seen between the upper beds of the limestones and the overlying quartzites. These occur in numerous sections, as on the west face of the Cromlech hill close to Kaládgi, at Govindkop south-east of the same place, at Truchigeri east of Kaládgi, and at Anathilli five miles north-west of Bágalkot. At Arrakeri, underlying the northern quartzite wall of the dip-meeting or synclinal valley, violet and chocolate shales are also seen. South-east of Kaládgi the purple shales are seen north of Kerkalmatti where they are richly charged with red hæmatite. At Kakkalgaon, half-way between Keralmatti and Kattigiri, they are again of the ordinary pale purple and form two small outliers capped by thin plateaus of the upper quartzites. They occur largely to the north and north-west of Kattigiri and also show at Anival and Batkurki abutting against the faulted boundary of the lower quartzites.

Chalky Shales.

Purple chalky shales occur in two or three places at the base of the limestones as at Bágalkot and in the north-east corner of the basin between Jerramkunta and a little to the north of Anagvádi. They

[1] Lieut. Aytoun in Bombay Geographical Society's Transactions, XI. (1852), 55.

are probably very largely developed in the eastern corner of the Kaládgi basin, north-east of Sirur, for they are rich in iron, and in weathering give rise to a quasi-laterite, which, both gravelly and conglomeratic, occurs in immense abundance near Sirur, and completely masks the boundary between the limestones and the underlying quartzites.

Lower Kaládgi Series.

Shaley Beds.

Shaley beds of uncertain position occur in the Kaládgi stream. They are buff, yellow, and orange and roll at low angles. It is doubtful whether this shale underlies the whole limestone series, or whether it holds some position intermediate between the different sets of limestone. Other shaley beds of uncertain position occur half-way between Hulgiri and Kerkalmatti. They are in colour bright red, reddish, purple, chocolate, gray or ochrey yellow, and are partly chalky and partly sandy. They roll greatly within a small area dipping from 15° to 60°.

Quartz Reefs.

Few reefs or veins large enough to demand notice occur in the Kaládgi limestone basin; even small reefs are by no means common, and none offer any points of special interest. The largest reef occurs at Kakkalgaon, ten miles south-east of Kaládgi, and forms two low ridges that, divided by a break, run east-by-south in the axis of an anticlinal roll in the limestone. A considerable number of small quartz veins occur close together in a patch of doubtful schistose rock which stands among the limestones a little north-east of Naganur hill. The schists which have a strongly gneissic aspect appear to be argillo-talcose, and are full of small rhombohedral crystals of limonite, pseudomorphous doubtless of some other mineral, perhaps calcite. The quartz veins also enclose some of the crystals in question. No section could be found showing the relation of the schists to the surrounding limestones, as thick cotton soil covers all the margin of the schist area. It is therefore doubtful to what age to assign them. It is not impossible that the schists are a protruding mass of gneiss surrounded by the overlying limestone. It may also be that the schists are merely highly altered shales belonging to the Lower Kaládgi series. The quartz veins which offer no peculiarities worthy of note stretch a little further north-west among the limestones south-east of Hoskatti, and are finally lost under the great covering of cotton soil. Another set of rather irregular veins with a north-east and south-west course occurs among the limestone spreads in the Lokápur dip-meeting valley south-west of Hoskatti.

Upper Kaládgi Series.

Quartzites.

Resting conformably on the lower series come the quartzites and overlying limestones, clay rocks, and shaley beds which belong to the Upper Kaládgi series, and, as at Shimákeri and Anathili, occupy a number of small dip-meeting valleys. The most important of these is the Arákeri valley north of Kaládgi. Nearly all the outliers of these quartzites are the remains of former dip-meeting foldings. The long westerly extension of the south side of the Arákeri dip-meeting is remarkable for its many sharp curves. The upper series contains two sections, shales limestones and hæmatite schists above and quartzites with local conglomerates and breccias below. The quartzites show great uniformity. As a rule they are pale-coloured and often conglomeratic. A strong degree of parallelism between

Chapter I. Description. Geology. Upper Kaládgi Series. *Quartzites.*

the axes of the several dip-meeting basins shows that they owe their origin to a set of great foldings formed by forces acting mainly north-east to south-west. All the basins and ridges formed by the upper series of limestone are broken by small streams that flow north into the Ghatprabha. The height of the upper quartzite ridges shows that the valleys must have been formed when the wearing forces had not cut so deeply into the lower limestones nor formed the longitudinal valleys that now run parallel with the quartzite ridges. So hard is the quartzite that the drainage would not have passed across them unless through lines of weakness caused by excessive jointing.

In the stream that drains the Anathilli basin, this weakness of the southern wall of the quartzites is clearly shown. A close examination of the lines of jointing discloses the following systems, which are either wanting on the ridges east and west of the hollow through which the stream flows or are much less developed than in the valley between. Three systems of jointing are especially marked: first a joint running north 5° east to south 5° west, with an average dip of 45° west by north; second a joint striking north 15° to 17° east to south 15° to 17° west and dipping 55° east by south; and third a joint striking north-north-west to south-south-east, with a dip of 30° west-south-west. The joint fissures are mostly close together, so that the rock is cut into fragments too small to offer any great resistance to a rush of water. The brecciation of the quartzites at the points of sharp bends is in part due to ordinary jointing and in part to systems of cleavage planes. Irregular conchoidal fracture may also be seen in numerous fragments. The largest of the dip-meeting basins may be called the Shimákeri basin after the village of that name, about five miles west of Bágalkot. The basin measures sixteen miles by two and a half, and except at its south-western end is a simple dip-meeting ellipse. At that corner the quartzites, instead of forming a simple ridge as they do almost everywhere else, roll over and form a small elliptical basin of no great depth, a large dimple, as it were, on the edge of the larger basin. The other spot where the quartzites do not form a simple ridge is a yet smaller dip-meeting dimple, formed as it were by the curling of the edges of a small lappet-like extension of the quartzites on the south side of the basin immediately east of the new Sholápur road. In both cases the rolling of the strata gives rise to a small knot of hills. In this basin the best sections of the upper quartzites are those of Muchkandi on the south and of Shiágeri and Truchigeri on the north side of the basin in the gorges cut by different streams that drain the basin and the country to the south of it. They offer no points of special interest.

The south side of the Arákeri dip-meeting valley shows a clear and well-marked case of inversion of the beds. The beds shown at the Baluti curve have a dip of only 25° to 30°, but as soon as they trend west they become vertical, and at little more than a mile from the curve they lean forward to the north, so much as to present the appearance of having a true dip of 85° south. This continues west for some distance past Kundurgi when the beds again become vertical and gradually return to a normal northerly

dip, but at very high angles, which they maintain for several miles. These highly raised and inverted beds show a great deal of brecciation. They are also in many parts conglomeratic containing pebbles of quartz, jasper, and occasionally of older quartzite. In one conglomerate bed east of the Sholápur-Kaládgi road on the north wall of the dip-meeting, small subangular fragments of transparent green quartz, like pale bottle-glass, occur pretty numerously, but only over a small area. No such quartz was noticed in any of the gneissic rocks of that region. The setting or matrix is a brownish-purple gritty conglomerate overlying the bed which locally forms the crest of the ridge.

At most of the curves of the several synclinals or dip-meetings the bedding is greatly broken by jointing. This is the case at Govindákop, at the north-west end of the Shimágeri basin, at the west end of the Anathili basin, at the Baluti curve, and at the east end of the Arákeri valley. This great breaking of the bed surfaces is mainly due to the presence of rude cleavage joints caused by great pressure.

Limestones and Shales.

The chalky series that rests on the upper quartzites consists almost entirely of purplish or gray chalky shales overlaid by purplish and gray clayey shales. Limestones show only occasionally and generally in their bands. In some parts the purple shales are richly charged with earthy red hæmatite. As a rule, the surface of this series is thickly covered with cotton soil or with thick, red, iron-bearing gravelly soil formed by the decay of the hæmatitic shales. Large patches of this red soil occupy various parts of the Shimágeri basin. In the Arákeri valley no distinct limestone beds were seen, but there is a great thickness of purple or gray chalky shales with occasional thin plates of limestone. On these rest shaley beds of the same colours, which show very imperfect slatey cleavage parallel to the line of dip-meeting. In the Anathilli basin chalky shales only were noted. Among them various very thin beds of rippled shaley quartzite hold the centre of the basin. The beds that rest immediately on the upper quartzites are hid by superficial deposits or cotton soil. No limestones were seen in the Shimágeri basin, probably because they were masked by great spreads of cotton and red soil. In the Gaddaukeri stream to the south of Shimágeri, gray and drab chalky shales stretch south to the quartzites on which they rest. These shales are much but very irregularly cleaved parallel to the strike of the line of dip-meeting. The planes of cleavage are nearly vertical, but the dip is invariably north or south. In a rock section at Shimágeri a gray clay rock with silvery talcose surface occurs and probably overlies the chalky shales. East of Shimágeri a large area is covered by purple iron-bearing shales, with which occurs a bed of very rich hæmatite sandstone quartzite of dark purple colour. The section is obscure, but this iron-bearing bed most likely belongs to the upper quartzites which have been brought to the surface by a small local dip-parting or anticlinal curve. Similar beds, but much poorer in iron, occur in two or three places in the small dip-meeting valley at the south-west corner of the basin. Hæmatite occurs also in the shales in the western corner of the basin, and has been smelted to a small

Chapter I. Description.

GEOLOGY.

extent. Traces of rich hæmatite beds were also noticed on the south side of the Arákeri dip-meeting east of the high road to Sholápur.

Intrusive Rocks.

The only intrusive rocks which occur within the Kaládgi basin are trap dykes. Though sparingly distributed and occurring only in the upper part of the series there is one in the Arákeri dip-meeting valley. These trap dykes consist of compact green diorite weathering in concentric ellipsoidal masses unlike any of the older diorites seen in the gneiss area. Their course is north-west by west to south-east by east, and they show only in the centre of the valleys among the shales.

Bhima Series.

In the extreme east between the gneiss and the trap, stretching from Muddebihál across the eastern border of the district and appearing in two small outliers a few miles to the north-west, is a small area of azoic rocks which differ in character from the Kaládgi series. These rocks, which have been correlated with the Karnal series, and named the Bhima series, have two divisions, an upper and a lower. The rocks that form the upper division are, in descending order, red shales, flaggy limestones, buff shales, quartzites, and limestones, the last locally known as the Tálikoti beds. The rocks forming the lower divisions are red, purple, and green shales and shaley sandstones, and quartzites, grits, and sandstones.

Shaley Sandstones.

Beginning with the lowest beds, in the west the sandstones and shaley sandstones of the lower series show endless shades of colour. As a rule reddish brown and purple prevail near the upper part of the formation, followed by drab and greenish beds, while near the base yellowish green or brown and dirty-gray predominate. One bed of a purple gritty sandstone at Jambaldini, seven miles north-east of Muddebihál, is very unusually massive, the partings of the sandstone being two to three feet apart.[1] Besides a decided purple matter the sandstone contains a number of small bright green grains. Occupying the same horizon in the Karnal series as the Jambaldini bed is a similar purple gritty bed at Bulehvar, five miles north-west of Jambaldini, and another that forms the base of the Karnal series at Kavrimatti, five miles south-west of Jambaldini. About two and a half miles south-east of Havrimatti a sandstone bed of the same variety, though almost quartzite in texture, caps a table-topped hill. The south side of this tableland is well scarped and shows a total thickness of about 100 feet of lower Bhima rocks in the following order: Purple gritty sandstone, drab, olive and purple and dark-green shaley sandstones, white or drab pebbly grit, and below this gneiss. The shaley sandstones form more than half the thickness of the whole section. Much pisolitic laterite gravel occurs strewn over the surface of the purple sandstone.

The basement beds of the Bhima series consist of pebbly or gritty sandstones, thirty to fifty feet thick, resting directly on the highly uneven surface of the gneiss, great hummocky masses of which as at Sálvargi about eight miles east of Tálikoti may be seen surrounded by

[1] The bed is largely quarried by Vaddars for high-class hand-mill stones.

Shaley Sandstones.

the younger rocks. The material of which the conglomerates are composed was evidently taken from the neighbouring granite-gneiss hills. The ruling colours of the conglomerate beds are pale brown, pinkish, or reddish brown, white, and purple. About a mile south-east of the Nágarbetta hill the sandstones in a white bed resting on very thin white pebbly conglomerate, are rippled and occasionally approximate in closeness of texture to true quartzites. West of the Don, along the south side of the long spit of sandstones which stretches east of the road from Nálatvád to Tálikoti, the pebbly basement is overlaid by beds of gritty and fine sandstones of a brown or reddish colour. Near the village of Kavrikánahal, eight miles east of Tálikoti, the conglomerate is purple in colour with very numerous broken crystals of red felspar. At Hokarani two miles south of Jambaldini a similar purple pudding stone occurs. Gritty sandstones with fine sandstones resting on them are seen at and north-west of Muddebihál, the pebbly conglomerates being seen almost everywhere in the several patches of the Bhima rocks. In the Balvantarkatti valley north of Muddebihál the beds, which are frequently a little broken and upturned, roll in all directions generally at low angles. The sandstones between Karvimatti and Muddebihál are of drab and pale brown. The sandstones that form the outlier which caps the Sirur hill are white, drab, and purplish, the white beds being rather unusually massive and compact, but showing many small shallow conchoidal cavities. The beds are horizontal. To the north-west of Muddebihál the prevalent colour of the sandstone is a pale reddish brown weathering into a cinnamon brown. At the extreme south-west corner of the plateau a white very saccharoid sandstone occurs. Between Muddebihál and Bilibhávi south-east of Tálikoti shales and shaley sandstones are in places well displayed.

Tálikoti Limestones.

The only representative of the Upper Bhima series is the Tálikoti limestone, named after the small town of Tálikoti which stands upon and is entirely built of this beautiful rock. The limestones, for they are divisible into several beds of varying colour and texture, are mostly very fine-grained, dense, and waxy-lustred, and often approach to true lithographic limestone.[1] The prevalent colours are blue-gray, gray, drab or cream, pinkish, and purple. They generally occur in this order in downward succession: the purple beds resting on the purple shales or sandstones of the Lower Bhima series. The beds are generally undisturbed from their original position of formation. Like the Kaládgi series, the Bhima series had undergone much wearing before the beginning of the great Deccan trap period. In a deep well at Munjghi, two miles west of Tálikoti, limestone occurs in stratified masses, with a very slight dip varying according to the rise of the plain. In the well the dip is only $2\frac{1}{2}°$ east 5° south. Dividing the limestone from the surface to the bottom of the well is a fissure, a foot wide, the direction south 5° west

[1] They occur in flaggy beds, the individual flags having a thickness of three to eight inches. In a few places the beds are two to three feet thick and do not separate into flags. The total thickness of the limestone near Tálikoti, as estimated at Salvárgi where the almost universal covering of cotton soil is absent, is eighty feet.

Chapter I. Description. GEOLOGY. Bhima Series. *Tálikoti Limestones.*

filled with buff-coloured earthy lime-knobs and angular fragments of limestone rock. The limestone in mineral character resembles the limestone of the Kadapa series, but is generally lighter in colour varying from dark-blue to pale-buff or cream, and has few traces of pyrites. The minerals associated with it are hæmatite in small nodules, often occurring scattered like strings of beads through its structure which, falling out, leave regular lines of small holes that resemble the perforations of boring insects and the tubular sinuosities in the laterite. Angular fragments of a buff-coloured jasper are strewed among those of the limestone and from their variolated that is spotted exterior appear to have been in contact with basalt, possibly limestone, passing into jasper.[1]

Infra-trappean Rocks.

Underlying the trap and resting sometimes on gneiss and sometimes on the Kaládgi or Bhima limestones and quartzite are certain sedimentary deposits of small thickness and extent. These deposits are usually of soft marly or clayey grits with or without included pebbles of the older rocks, especially of quartzite. Soft sandstones in thin beds and pure clays are much seldomer seen. In many places weather has worn away the setting which enclosed the hard quartzite pebbles, and the pebbles remain as beds of loose shingle on the surface of the older rocks, their presence still showing the former existence of the pre-trappean deposits.

The most easterly occurrence of these deposits is at the village of Nágarbetta to the south of the hill of the same name which stands at the meeting of the lowest trap-flow with the gneissic beds. Here the hollows in the surface of the gneissic beds are filled with red and white unconsolidated grit. Higher up the sloping ground, south of the village, where an outlier of the Bhima beds appears, this mottled and sometimes clayey grit was not seen. These Bhima beds have doubtless yielded the few quartzite and hard grit pebbles that are enclosed in the washed-up beds. The beds are rarely more than a couple of feet thick, and rest on decomposing pink granitoid gneiss with many veins of coarse salmon-coloured granite, whose broken pink felspar crystals form the greater mass of the washed-up beds. The pebbly unconsolidated grit that occurs below the trap on the south side of this Nágarbetta outlier, and is seen in the rain gully sections immediately south of the village of Murála, occupies the same position. At Murála the grit has a thickness of over seven feet and rolls at low angles, as do the overlying trap-flows. No sign of organic remains was found in these beds.

Drab-coloured chalky tufa, with one or two thin beds of drab friable sandstone, are exposed in a small network of rain gullies on the west side of the little outlier of trap that lies two and a half miles south-east of Muddebihál. These beds are totally different in appearance from any noticed in describing the rocks of unequivocal Bhima age. They occupy only a few score square yards, and apparently fill a small hollow in the gneiss.

Holding a similar position with reference to the trap-flows is a bed of gritty marly clay that is exposed to the depth of five to six feet

[1] Captain Newbold in Geological Papers of Western India, 323.

in the banks of the stream that runs east from Dehvar-Hulagbál, a village about half-way between Muddebihál and Tálikoti. In its red and white mottled colour this gritty marly clay greatly resembles the loose washed-up grit seen at Nágarbetta.

Infra-trappean Rocks.

West of Itgi, about nine miles north-west of Muddebihál, at the meeting of the trap and gneiss, the surface of the slope is largely covered with patches of massive whitish limestone breccias. The included fragments are many small broken crystals of pink felspar, lumps of gneiss, and a few quartzite and banded jasper pebbles. No trap was found among the included fragments, which could hardly be the case were the lime breccia younger than the trap. This breccia seems to pass under the trap. The tufa is remarkably massive and very close-grained. Its thickness, as it lies exposed on the rising slope, may be estimated at four or five feet. This remarkable deposit had no trace of organic matter. Other sections showing gritty marly clays or clayey grits were noted at Galgali on the right bank of the Krishna to the north of Kaládgi. At Guddgomanhal, Rokatkatti, Rajunhal, and Jangvari, lying on the long east and west spur of trap which stretches south of Kaládgi and to the south-east of Aksurkop, red-mottled gritty or clayey beds occur associated with coarse quartzite shingle.

Deccan Trap.

Over about two-thirds of the district the surface rock is trap. North of the Krishna a strip of gneissic rock runs along the bank of the river varying in breadth from two miles in the west to about ten in the east. And, north of the gneiss, for about ten miles north-east of Muddebihál are the sandstones of the upper and lower Bhima series. With these exceptions the whole of Bijápur north of the Krishna is trap. There is also a small trap outlier among the gneiss at Nágarbetta, about five miles south-east of Muddebihál. South of the Krishna trap appears in two places. There is a small patch in the north-west between Jainápur and Bilgi. And in the south-west, stretching from the west border to near Kerur, is the eastern end of the great belt of trap that forms the water-shed between the Ghatprabha and the Malprabha. The general characteristics of the Bijápur trap area are very monotonous and uninteresting low rolling downs and shallow valleys. This sameness of scene is greatly increased by the large development of black soil and the almost utter want of trees in the high grounds.

A little to the north-west of Sindgi, twenty-five miles east of Bijápur, the summit of a ridge is covered with globular masses of a compact basaltic trap underlaid by a bed of fine red clay imbedding a profusion of zeolites, also heliotrope, plasma, geodes of chalcedony lined with quartz, crystals, semi-opal cacholong, agate and calcspar, resting on a greenish-gray wacke. Both rocks are veined and interstratified with lime-nodules. The horizontal layers of lime-nodules are often ten to twelve inches thick. The softer wacke and amygdaloid in weathering often leave the harder layers of lime-nodules standing out from the surface. At Hippargi, about fifteen miles to the south-west, the trap assumes the rich brownish-purple or chocolate hue of the trap of Bijápur and is seen in the bed of the rivulet resting on a red

Chapter I. Description. Geology. Deccan Trap. *Varieties.*

zeolitic amygdaloid. The line of contact is marked and distinct. Heliotrope and plasma are less common. From Ingleshvar to about eleven miles south-west of Bágevádi trap wacke and amygdaloid form the basis of the plain where its southern limit is again crossed by the hypogene area. From Bágevádi to Mangoli the route to Bijápur lies over plains the lowest stratum of which as seen in wells to the depth of twenty to fifty feet and in the beds of streams is the overlying trap.[1] About two miles north-west of Bágevádi the trap is overlaid by a sheet of a conglomerate composed of a nodular and pea-like iron ore and fragments of iron-bearing clay imbedded in a paste of carbonate of lime coloured a light ochre-brown by oxide of iron. The bed of the stream presents the only section of this stratum. It is here four feet thick covered by a layer of black cotton soil and resting immediately on the concentric exfoliating trap which is penetrated by seams of a whiter and more earthy carbonate of lime. Large masses of a laterite rock cemented by chalky and iron-laden matter and having a glazed surface occur in the chalky conglomerate. This conglomerate occurs at various places between Bágevádi and Mangoli, and it continues almost uninterruptedly overlying the trap, for about twelve miles. Near Mangoli the trap again appears as the surface rock, seamed and almost broken by the immense quantity of chalky matter which passes between the layers. The lime is seen to take up some of the colouring matter of the augite or hornblende of the trap and is stained a mottled green and brown. The trap shows surface branch marking generally dark-brown with a yellow or brownish ground on the smooth surface into which it readily divides on being struck with the hammer. This facility of division arises from natural microscopic fissures existing in the substance of the rock, sometimes visible to the naked eye. The fragments are of different shapes, but almost invariably angular and frequently prismatic. The trap varies from a compact black and phonolitic basalt to a loose light gray wacke, specked with minute iron-caused spots, and is formed both in layers and in balls. Reddish veins cross it without any definite direction. Except in holding more iron their composition does not seem to vary much from the dull brown gray rock that forms the prevailing colour of the trap in the neighbourhood. Deep and nearly vertical fissures dipping generally to the west 70° south cleave its tables in a direction north 25° west. A number of small bag-like hollows pervade its structure, the line of whose longest diameter is generally north and south. This may be accepted as a sign of the course here taken by this great flow of trap.

The city of Bijápur stands on a large sheet of overlying trap with a wavy surface, though here and there may be seen small step-like descents characteristic of trap formations, but none high enough to disturb the general level. The surface of the plain is strewed with fragments of trap, amygdaloid, quartz, chalcedony, opal, cacholong, calcspar, and zeolites, lime-knobs, nodular iron ore and a conglomerate iron clay and iron ore imbedded in

[1] Captain Newbold in Geological Papers of Western India, 81-83.

compact lime-knobs. These weathering in unequal proportions form an overlayer of light brown soil, in which small crystals of a pearly calcspar and zeolite glitter like particles of silvery mica or talc, in soils formed by the decomposition of gneiss and granite. Beneath the soil the trap in public roads and other places liable to abrasion is often seen in a state of concentric decomposition. In deep sections such as wells and quarries the rock assumes a tabular appearance splitting almost horizontally into thick stratiform masses, which are again intersected at right angles by almost vertical fissures, imparting a columnar structure. The fissures though nearly vertical dip irregularly and do not seem to show any line of disturbance. At Bijápur the fissures have a direction north 20° east the joints dipping 5° east to 20° south. Calcspar occurs in thin discoloured seams lining the fissures. A number of empty bag-shaped hollows pervade the rock occasioned probably by gas when the rock was liquid. Their direction, though not uniform, is generally south-west agreeing with the line of the trap's direction. At Torve, about four miles west of Bijápur, basalt rests conformably upon a bed of amygdaloid into which it passes. Large beds of amygdaloid occur in the trap, rising above its surface as seen near the Alhápur gate of Bijápur. Volcanic ash beds are seen here, which seem at first sight to be amygdaloid flows, but are made of fragments volcanic ashes and dusty particles of bag-shaped trap cemented by the deposition of calcite and zeolitic matter in strings and films between the fragments as well as in the shoe-shaped hollows. The volcanic ashes are mostly reddish or purple and much red bole is diffused through the mass. The rock at Bijápur varies often in the space of a few feet from a compact grayish black basalt having a granular structure and conchoidal fracture with streaks of ash gray, to a soft wacke speckled with brownish decaying crystals of augite and amphibole. The trap in this neighbourhood has a blush of red traceable in the darker portions and becoming stronger in the wacke and amygdaloid, the latter having for its basis a fine red clay. The dark compact variety melts into a black glass and is faintly translucent at its edges, showing a dull green; the rest are opaque and melt with difficulty into a greenish black glass. Some varieties which seem to contain much silicious matter are infusible. The less compact trap has an uneven fracture.[1]

Trap, generally covered by a bed of reddish lime-nodules on which rests the cotton soil, passing into a reddish amygdaloid, reticular and porphyritic, containing calcspar and zeolites, continues to Ukli, about twelve miles south-east of Bijápur. About two and a half miles east of Bágevádi a large amount of basalt, partly on and partly imbedded in the soil, covers a long swell, probably a basaltic dyke through the surrounding trap. The basalt is amygdaloidal and bag-shaped and contains small globules of calcareous spar, zeolites, and

[1] When reduced to a coarse powder a few of the fragments are taken up by the magnet; the fine powder is of a dull greenish gray. It does not gelatinize when treated with acids. Its specific gravity is 3·35. Captain Newbold in Geological Papers of Western India, 318.

Chapter I. Description. Geology. Deccan Trap. *Varieties.*

chalcedony. The bags or vesicles are usually empty; some of them contain a brownish-yellow earth into which zeolite and calcareous spar are found to decay. The fracture is conchoidal, the fragments are faintly translucent at the edges, and the streaks are grayish white. It melts before the blow-pipe into an intense green glass. It contains little amphibole and seems to be composed almost entirely of augite and felspar. Passing south-east from Bágevádi by Javaneghi and Narsinghi to Alkopa, a village ten miles south-east of Bágevádi, the road lies diagonally across the low trap swells which have generally a south-westerly direction, though their lines sometimes cross each other at obtuse and acute angles. The tops of the swells are mostly slightly convex, though often terrace-like, and are composed of the more compact and globular trap. In the banks of rivers the trap and amygdaloid may be seen alternating and passing into each other; when they occur horizontally the trap is generally the surface rock. The amygdaloid contains irregular bits of decaying felspar and numberless hollows often filled with green earth and crystals of carbonate of lime.[1]

The village of Alkopa is near the south-eastern foot of a slope on the top of which the trap has the usual compact and globular form, while at the base it is tabular, schistose, and amygdaloidal. A few hundred yards to the south of the village the trap formation ceases at the foot of a low range of flat-topped sandstone hills. In the bed of a stream about 300 yards from the village the trap is found overlying the sandstone and penetrating some of the numerous fissures by which the sandstone is cleft. The existence of trap in the bed of the river can be inferred from a little disturbance in the sandstone rock which occurs in tabular horizontal masses having a rhomboidal shape by being crossed by fissures with a varied direction, but generally north 65° west crossed by others trending south 20° west. Where the trap penetrates the fissures the two rocks are not found adherent or passing into each other. They are perfectly distinct and separate, a thin calcareous seam occasionally intervening. Both the trap and sandstone seem to be slightly altered by the contact, the trap becoming less crystalline and more earthy, but often extremely tough and splitting into small fragments, with numerous microscopic fissures seaming its structure. The colour of the sandstone from a few lines to several inches distant from the contact is generally reddish, passing into a deep reddish-brown. There is no appearance of semi-fusion or intermixture, nor are any masses of sandstone entangled in the trap. In structure from a loose and variegated grit it approaches a compact quartz rock containing disseminated portions of decomposed felspar, which falling out leave a number of minute oval cavities.[2] No veins penetrate the sandstone. Pegmatite occurs in the scattered blocks, and judging from the sharpness of the angles of these fragments, the rock cannot be far distant. In the

[1] The green earth in moist situations assumes a black or deep brown colour in decomposition, giving a speckled appearance to the rock. Under the blow-pipe those dark spots turn to black slag. Geological Papers of Western India, 322.

[2] For building villagers greatly prefer this sandstone to trap.

bed of a stream a few hundred yards north-west of Kunkal, a mile north-east of Alkopa, are slender prismatic crystals of carbonate of lime in sheaf-like bunches, with dark pieces of chert in a friable mass of the amygdaloid, the radii of the calcareous crystals being three inches long and of a faint amethystine hue. East from Alkopa the trap stretches to the village of Mudkeysur nine miles from Alkopa, when it is succeeded by the Tálikoti limestone beds.

In the bed of the Hiri stream near Umblánur, about two miles north-west of Alkopa, trap is found undergoing many changes in texture and colour, even in the space of a few yards from a compact heavy basalt to a friable wacke, from globular to schistose, from black to red and a light brownish-speckled gray. The layers of the schistose variety are often seamed by cross fissures which divide the rock into rectangular and rhomboidal prisms similar to those observed in clay slate near the line of contact with a basaltic dyke. These again splitting into scales often become five or six-cornered and by further scaling become round. The road from Umblánur to Beylhal, three miles to the south, is literally paved with the boules of trap, which pealing off in concentric layers, leave circular and oval centres. Even the centres, however hard and compact, show signs of pealing. Where the rock is uncovered by dust the road looks as if it were paved with pebbles of compact basalt set in concentric rings of wacke. The centres remain prominent from their superior hardness. Calcspar of various shades of white, green, and pink, chalcedony in pierced and hollow nodules showing concentric ring markings and lined with minute crystals of quartz, semi-opal, and jasper, occur in veins imbedded in wacke. At Umblánur the centres consist of hypersthenic felspar, imbedding crystals of augite; the fracture is small-grained and uneven and the streak is of grayish-white. A trap dyke running to the east is crossed a little beyond Muddur on the left bank of the Krishna. On the ascent of a low hill a little beyond the small hill-fort of Haverighi, five miles east of Dhanur ford, a dyke of basaltic greenstone cuts the gneiss running nearly due east and west and slightly distorting the layers of the latter rock. Several branches are thrown off, one of which has a south-westerly direction. The trap here splits into prismatic fragments with smooth planes.

Trap Flows.

At Nágarbetta, about four miles north-west of Nálatvád, the trap seems to be made of several flows, the two uppermost of which form distinct bands or narrow traces round the hill which is capped with a porcelanoid iron-clay. The whole vertical thickness of these flows is probably between 300 and 400 feet. The basement beds consist of an earthy dirty pale-green mass of nodular trap broken by spherical weathering. The concentric layers are very friable, but the centres which are generally small consist of hard and tough bluish or greenish basalt enclosing a few grains of a bluish white quartz-like mineral. This flow forms a plateau resting partly on the gneiss partly on the basement beds of the Bhima series which here consist of grits and conglomerate sandstones. The two upper flows are of hard basaltic trap, the division between them being formed by a band of extra hard and compact basalt. Small chalcedony or quartz amygdaloids are rather common in these hard

Chapter I. Description. GEOLOGY. Deccan Trap. *Trap Flows.*

beds and leave many small pittings on the surfaces of the weathered blocks. This Nágarbetta is the highest large outlier of trap. Another section occurs on the north side of this outlier immediately south of Hiremurál about three miles west by north of Nágarbetta. The succession of beds in the sides of a deep ravine are earthy trap much weathered into spheroids, green-gray to yellow-brown in colour; bluish gray clayey trap ten inches to a foot thick; and clayey trap with waxy lustre apple-green and brown mottled one and one-third feet thick. The last bed rests on an unconsolidated pebbly grit which is in parts marly. Seven feet of this pebbly grit are here shown, whose surface had been irregularly worn before the deposition of the trap-flows which have filled the irregularities of the surface. All the beds exposed in this section roll at low angles. The general surface over which the trap was poured was highly irregular. The Bhima rocks were much worn away at an early period and were themselves deposited over a large sea bottom of gneissic rock. In the east of the area, on the border between Bijápur and the Nizám's dominions, at Lukundi, Shellugi, Pirápur, and Talihalli to the north-east of Tálikoti the prismatic tendency is seen only where the trap has been stripped to an approximately flat surface when it resembles an extremely rude tesselated pavement, the tesseræ forming rather irregular polygonal figures. When broken from the mass the prisms are found not to be longer than their average diameter. The trap is black with many rusty spots and of gritty texture with a fairly metallic ring when struck. To the east of Pirápur two flows of hard black basalt seem recognizable on the sides of the scarp in which the trap plateau ends. One of these forms the basement bed and none of the earthy pale-green weathered trap is seen along the scarp.

Agates.

Agates are found in large numbers on the weathered surface at Hanmápur five miles south-west of Batkurki; red bole at Torve near Bijápur; and large crystals of green glassy-looking olivine united with the porphyritic variety of the Deccan trap. Between Dadiheri and Batkurki minute vesicles or hollows give a few amygdaloid beds the appearance of speckled grit. In the trap area to the north of the Krishna, augite is not much seen in the red amygdaloid rock. Pits or vesicles are seen in all varieties both empty and containing green earth which becomes brown or black on long exposure, chalcedony, cacholong, calcspar, quartz, zeolites chiefly radiated stilbite, heulandite, and mesotype when it assumes an amygdaloidal stamp. These minerals also occur in veins and are most abundant in the red amygdaloid to which they give a reticulated or porphyritic appearance as they chance to occur in veins or crystals. Geodes or hollow nodules of chalcedony are seen containing crystals of quartz and of zeolite enclosing crystals of carbonate of lime. Veins of crystalline quartz are found splitting in the centre, in a direction parallel to the sides, containing all these minerals on their inner surfaces. Grayish crystals of glassy felspar occur in the semi-compact varieties; also small nodules of a compact cream-coloured opaque zeolite with a faint tinge of buff, and marked with concentric

annular delineations resembling in shape those in orbicular granite.[1]

Between some of the lava flows of the Deccan trap are limited sedimentary beds whose fossil contents in various cases show that they gathered in fresh-water lakes or swamps. The organisms in these beds are Physa prinsepii, a small Lymnæa, and Unio deccanensis. They are the same as those in corresponding formations in Central India and elsewhere. Unlike the Central Indian inter-trappeans, which are chalky and cherty, the southern beds are chiefly sandstones, conglomerates, grits, clays, and occasionally sandy marl. The three typical fossils named above were found in sandy marl at Todihal, on the right bank of the Krishna fifteen miles north-east of Kaládgi. The bed of marl varying in thickness from six to eight feet underlies a flow of ordinary trap, but rests upon gneiss. The form of the ground seems to show that the overlying trap is not the lowest of the series, but has overlapped an older flow, and that the inlaid lake bed is truly inter-trappean. A large percentage of the shells are much twisted from the heavy pressure of the overlying rocks. In the west of the district at Supadla six and a half miles north of Rámdurg are a well-exposed set of inter-trappean beds without any fossil remains. The beds lie horizontally and are about twenty feet thick. The succession is in descending order, trap, red bole, red sandy marl, sandstone, conglomerate, and again trap. Cherty deposits belong to the class of inter-trappean beds. One bed of this kind occurs about seven miles north-east of Tálikoti and one mile west of the village of Shellugi and occupies the highest ground in the neighbourhood stretching about three miles north and south with a maximum width of about a mile. The bed forms a small irregular plateau, in great part thickly covered with cotton soil. The chert is of variable colour from mottled whitish gray to yellowish brown. Some blocks show a more chalcedonic character with patches of delicate whitish blue or peach.

Laterite.

On the road from Hipargi, about twenty-five miles east of Bijápur, to Ingleshvar in the south, indications of laterite or iron-clay are seen in beds of its wearings cemented by a brown ivory and chalky paste. Fragments of chert and a variety of limestone porphyry also occur. Laterite is found capping a ridge of trap and wacke a little to the south-west of Ingleshvar. This hill is chiefly composed of wacke penetrated by flattish apparently compressed veins of fibrous arragonite. On the top of the hill are scattered globular and angular fragments of basaltic trap, while partially imbedded in the soil covering its sides are rough blocks of a light-coloured rock, resembling altered limestone passing into chert. These blocks are mostly angular, generally six inches to two feet thick, and have a whitish exterior so rough as to resemble trachyte. When fractured

---

1 Some of these nodules are earthy and have a powerful clayey odour. Under the blow-pipe they swell and phosphoresce slightly. They gelatinize when treated with nitric and muriatic acids. Some of them contain acicular, microscopic, and minute crystals, of a mineral resembling chabasite. Captain Newbold in Geological Papers of Western India, 319.

Chapter I. Description. GEOLOGY. Deccan Trap. *Laterite.*

the small glistening red and white chalky crystals they imbed might at first sight be taken for those of glassy felspar. The softer and more crystalline portions of this rock effervesce with acids. It also occurs in detached blocks on the wacke at the base of the laterite cliffs south-west of Ingleshvar. The rock here is more compact, homogeneous, less crystalline in structure, and shows dark dentritic delineations. Some fragments are partly coated with a thin bluish white enamel, which is apt to assume a grape-cluster form; on its surface are numerous small white globules of white enamel. Among the decayed laterite which is mixed with these blocks are strewn numerous nodules of a black ashy-looking mineral containing cavities. About seven miles from Ukli between Musibináhal and Bágevádi, a flat-topped hill about a mile to the left of the road, is composed from base to summit of a tabular lateritic rock. Further east, about a mile, runs a low ridge of laterite hills with a north-east and south-west direction and flat contour. About twelve miles to the south of these rise two other flat-topped hills at Nagarvár, which, along with the small hill of Hori Math near Ingleshvar, are entirely composed of lateritic rock. The lateritic rock near Hori Math appears generally to contain more iron than the Malabár and Kánara laterite and is consequently of greater specific gravity. The specimens found do not contain lithomargic earth, nor so much quartz as the Malabár rock; the tubular sinuosities like those of the Malabár variety, are frequently lined with an ochreous earth arising from the decomposition of quartz and felspar and tinged of various shades of brown and yellow by the oxide of iron; the earth forms a compact paste cementing the component parts of the rock and in this respect exactly resembles portions of the Malabár laterite. It is not so soft interiorly. The more compact parts of the rock forming the coating of the tubular cavities become magnetic under the blow-pipe and turn to a dark-gray slag. All these lateritic hills rise above the low trap elevations amid which they are situated, and are the only hills of any height for miles around. This is the result of the wearing of the subjacent trap, the beds of laterite being once probably continuous over its surface. The trap is seen in the valleys and streams at their base on which the lateritic rock rests in tabular horizontal masses. A silicious porphyritic rock, having cavities lined with minute brown crystals, is associated with this rock and is found in loose blocks on the surface. The imbedding paste is a light coloured highly indurated jaspideous clay. Under the blow-pipe the crystals lose their colouring matter, and fuse with carbonate of soda into a white enamel.

There is an outlier of the Deccan iron-clay in the shape of a small capping to the trap on the top of the Nágarbetta hill. The iron-clay rests conformably on the horizontal flows of the Deccan trap. This capping of iron-clay is about 200 yards long and is rudely elliptical in plane. It is of deep yellowish brown and is more compact than the ordinary Sahyádri iron clay. The texture also is more porcelain-like; in some parts it is almost jaspery, and in others earthy and dull. There is no trace of any organism in this

rock, but in several places it shows polished parallel markings on different exposed surfaces. Another patch of compact iron-clay lies about a mile south of Bantánur, seven miles north-east of Tálikoti. Here numerous blocks of a more typical iron-clay conglomerate of the usual deep brownish red occur on the same level as and mixed with numerous blocks of whitish chert. The iron-clay blocks of from two to three tons weight are of worm-like structure. The knoll occupied by this mixture of blocks is of small size, hardly more than an acre in area. Beyond the limits of the trap area are two outliers of iron-clay which were probably at one time connected with the trap series. Of these outliers one is near Bellegunti, three miles south-west of Kerur in Bádámi, and the other forms a very marked truncated cone that caps a quartzite plateau five miles south-east of Kerur. Two outliers resting on trap occur a mile south-east of Batkurki. In the case of Hulikeri hill, south-east of Kerur, the iron-clay is a very distinctly vertically tubulated variety, but both the Bellengunti and Batkurki patches consist of vesical and vermicularly tubulated iron-clay.

Later Tertiary Deposits.

Lake Formations.

Among the later tertiary and recent alluvial deposits are sedimentary rocks whose constitution and position seem to show that they are the remains of ancient fresh-water lakes. Few observers cross the long valley from Amingad past Bágalkot to Kaládgi without being struck by the idea that it must have been a lake before the rivers had cut their beds to their present depth. An examination of the lie of the sedimentary iron-clay which occupies a great part of the surface of this old valley supports this lake theory, and the theory also accounts for the peculiar position of the old iron-bearing mud banks at which the iron-clay was deposited. The sources whence the whole or most of the iron-bearing mud was obtained lie close at hand in the vast beds of hæmatite and hæmatitic silicious schist of the gneiss area. A minor supply would in parts be derived from some of the conglomerate beds of the Kaládgi series which are mainly composed of the remains of the great hæmatite beds. Yet another source of iron not much inferior in richness to those in the gneiss is found in the hæmatitic jaspery schists that belong to the Kaládgi series, and occur in the hill ridge west of Bilgi. Another source of the iron in the laterite is in the Deccan trap, which in many parts contains numerous grains of magnetite. The greatest development of the laterite occurs at the east end of the valley, where the iron beds of the gneiss overhung the margin of the supposed lake, or rose as islands from its surface. Much laterite shows also in the central part, on both sides of the river, near the Anagvádi ford over the Ghatprabha. This hypothetical lake serves to explain the rounded water-worn fringe of quartzite fragments along the southern base of the Lower Kaládgi quartzites east of Bágalkot and a similar fragment of fringe noticed at Sirur, eight miles to the south-east, on the south side of the supposed lake basin. The banks of iron-bearing mud which afterwards assumed the laterite character were deposited upon this marginal fringe of coarse quartzite shingle. The extent of the old lake appears to have been considerable, but its limits cannot be precisely fixed owing to the presence of open-air lateritic rocks, as well as of

Chapter I. Description.
GEOLOGY.
Later Tertiary Deposits.
Lake Formations.

immense spreads of cotton soil over great part of the Kaládgi limestone basin. Its eastern shore was probably the edge of the basin formed by the upraised lower quartzites of the dip-meeting or synclinal valley east of the Malprabha. The continuation of the northern side of that dip-meeting line formed the northern boundary of the central part as far as Anagvádi, where the quartzites trend to the east, and here the lake probably had a great arm stretching as far as the eastern base of the Sita Dongar hills. For five miles west of Sirur itself the southern boundary was formed by the Sirur hills and then trended north along the line of the hills that form the north side of the Shimágeri dip-meeting valley. It is doubtful whether the lake spread within the area of the dip-meeting valley; probably it did not. West of Kaládgi the limit of the lake basin is very doubtful, though it most likely included the lateritic knolls for a couple of miles south of the cantonment. Still further west the lake may have reached as far as Chattarband Kota, eight miles west of Kaládgi. At Badnur and Bantur a thick bed of laterite gravel with numerous fragments and chips of quartzite covers a wide area at a level much above the Ghatprabha valley. This bed is also in part conglomeratic.

The Kaládgi laterite or sedimentary iron-clay rests on a very uneven limestone surface and is of various thickness. South of the cantonment near the cemetery it is a very compact rock, enclosing considerable fragments of quartz. In the section shown in the jail well, thirty to forty feet of impure earthy laterite or gravel are exposed. But it is doubtful whether this is not of much later origin than the conglomerate to the south and east of the town. A few miles east of Kaládgi a laterite conglomerate forms a distinct terrace which abuts against the upper quartzite ridge west of Truchigeri. A similar conglomerate at about the same level forms an outlier on a sharp-cut little hill north of the village, and here rests on violet shales. Another patch of conglomerate of the same character and in a similar position caps a small hill about one and a quarter miles north-west of Anagvádi, on the north bank of the Ghatprabha. Here the laterite cannot be less than sixty to eighty feet thick, and is exceedingly compact in texture, showing a very few worm or sack-like hollows. Fragments of quartzite that have apparently been weathered out of it lie on the surface. This conglomerate rests against the apex of the anticlinal or dip-parting ellipse to the north of Anagvádi and stretches to Tumurmatti at a corresponding level. It seems to have once been continuous with the outliers that cap the Anagvádi and Truchigeri hills and also with the Truchigeri terrace before mentioned. Where the laterite lies upon shelly beds, the latter have been affected to a considerable depth by the soaking of iron-laden water.

In many parts of the valley the surface is generally of a rich deep purple-brown, the rock where broken and crushed, as in the wheel tracks of some cross country roads, showing the deep red streak of the nearly pure hæmatite. The massive laterite is often of extreme toughness; when broken it shows a hæmatitic setting with many angular grains of quartz enclosed, and presents an appearance as if the old hæmatite of gneiss had been ground by surf to a perfect

mud, which, on drying, gathered round the grains of sand and hardened its present consistency. The surface of the laterite often shows worm-like hollows, but to a less extent than the conglomeratic coast laterite. Much of the laterite occurs as gravel of various degrees of coarseness. This is sometimes pure, but oftener contains rolled fragments of quartzite. In some cases the proportion of quartzite pebbles becomes so large as nearly to hide the laterite. In the centre and west of the old lake valley either less iron mud was formed or it has since been more thoroughly worn away. Still well-marked patches of laterite remain in these parts of the valley. The outlying laterite patches to the north-east of Yárkal in the corner enclosed between the Ghatprabha, the Krishna, and the Sita Dongar hills seems also to have been formed in shallow water, probably in an arm of the large lake. One section in this corner at Jerankunti shows twenty to thirty feet of worm-like conglomeratic laterite exposed in the village well. The rather widespread lateritic conglomerate that occurs to the south-west of Bádámi seems to mark the site of another shallow lake. This lake or another of similar character occupied the valley of the Banknari immediately to the west. No organic remains have been found in any of these supposed lake beds. But in spite of this strong objection the shape of the country and the position of the shingle and iron mud deposits favour the hypothesis, as they explain the presence of these deposits in many places where they could not be referred to open-air changes of iron-bearing rocks, as, for example, where the laterite rests directly on unaltered quartzite.

River Deposits.

A dark reddish-brown clay occurs frequently in the banks of the Don. This red clay passes upward into the black regur-like alluvium. High lying gravels are often found along the banks of the Krishna. A large gravel and shingle bed consisting almost entirely of quartzite occurs at Girgaon, sixteen miles north-east of Kaládgi. A similar coarse quartzite shingle bed shows a little to the east of Svuna. A deposit of quartzite shingle resting partly on the trap, partly on the gneissic rocks, occurs a little to the north-east of Baloti ferry on the Kaládgi-Sholápur road. A very large quantity of quartzite and quartz shingle covers the slope of the high ground from a little east of the Tangadgi ford at intervals as far east as Islámpur. Cementation of the gravels into true conglomerates by deposition of carbonate of lime takes place on a large scale in the bed of the Krishna at Ballur, six miles north-west of Bilgi. This local alluvial conglomerate is overlaid by a thirty feet thick clayey alluvium chiefly consisting of re-deposited black soil. A similar conglomerate in the Don river below Tálikoti and still lower down the stream contains pebbles of the Tálikoti limestone. Another instance of conglomerate formed in a river-bed by cementation of gravel and shingle with iron-clay is seen a little below the ford over the Ghatprabha at Anagvádi. Great beds of gravelly limestone with quartzite shingle and a few well-shaped clipped and large-sized quartzite tools occur at Kaira on the left bank of the Malprabha five miles south-east of Bádámi, at the place three miles south of the meeting of the Bennihalla and the Malphrabha and between Hira and Chik-Mulingi, about twenty miles above Kaira.

Chapter I. Description. Geology.

North of the basement quartzite ridge north-west of Kaira and between Somankop and Chamankatti red lateritic subsoil, most likely in part of open-air and in part of lake origin, is exposed. Gravel beds of lake or river origin occur at Tolanmatti, thirteen miles north-east of Kaládgi. These gravel beds consist of quartzite pebbles and yield clipped stone tools occurring in place and imbedded about three feet below the surface.

Sub-aërial Formations.

Of the sub-aërial formations due to the reproductive action of atmospheric agencies there are deposits cemented together by the chemical precipitation of calcareous matters and tufas. Of calcareous tufa formations two classes occur, the first in which the tufa forms solid masses of rock, and the second in which the calcareous matter occurs in detached gravel-like nodules. An example of the first class occurs a little south of Bánshankari two and a half miles south-east of Bádámi. An area of several acres is here covered with large irregular masses of a perfectly concretionary tufaceous limestone unlike anything belonging to the older limestones of the district. No section is seen showing the relation of this tufa to the underlying rock, but it very likely covers a thin bed of chalky shale such as occurs further west or from which the calcareous matter was brought down by the streams. Of the second class of tufaceous deposits an accumulation of limestone gravel lying on the Deccan trap occurs on the high ground six miles north-east of Muddebihál and covers a large stretch of ground. The lime-nodules are pale red and form banks of unconsolidated gravel.

There are very few of the rain aggregations which are not uncommon in the hill country to the west. In some places, especially to the north and west of Bádámi, large tracts are covered with almost pure sand.

Soil.

As in Belgaum the two leading varieties of soil are the red, a directly decomposed trap, and the black, decomposed trap sandstone and gneiss mixed with organic matter. There are also the sands mentioned above and a half sandy soil pale drab or olive green formed of decomposed basalt. This form of weathering seems almost as characteristic of basaltic rocks in the eastern plains as iron-clay weathering in the western hills. Of exceptional soils, soda and potash soils are rare. Large quantities of alkaline salts occur in other soils, especially in black soil. The most marked instance of these salt soils is the valley of the Don whose water is so salt as to be almost undrinkable during the hot weather. The large stream which flows into the Don from the north-east at Tálikoti is even more brackish and parts of its bed when dry are crusted with a thick layer of impure salt. The source of the salt must be deep-seated for the soil which fills the main part of the valley is famous for its richness.