CHAPTER II.

GEOLOGY.

I. *Archæan Geology.*

Age of the geological formation of Mysore.

THE geological formation of Mysore is confined, almost entirely, to the most ancient epoch in the history of the earth's crust of which we have any visible and tangible record. This epoch which is known as the Archæan Period, was long anterior to all the great sedimentary formations in which fossil records of the gradual evolution of plant and animal life have been preserved and which are so extensively developed in northern India and in other parts of the world.

Order of succession and relative ages of the formations.

The tabular statement given below shows the order of succession and relative ages of the formations composing the earth's crust amongst which the limited range of the rocks composing the Mysore plateau may be noted.

The thickness shown for each formation is the maximum thickness of the sediments so far as known at present and the figures given here have been taken from the Presidential Address to the Geological Society of London, in 1909, by Professor W. J. Sollas, LL.D., D.SC., F.R.S. The age or duration of the various periods is based on the assumption that the sediments have accumulated at the rate of one foot in a century, and although no great accuracy can be claimed for these estimates, they may be useful as afford'ng some idea of the lapse of time covered by the Geological Record.

No figures are given for the Archæan Period as the rocks have been so altered and disturbed that it is not always possible to distinguish between those of sedimentary and those of igneous origin nor to assign a definite order of succession or definite thickness to the sedimentary members. The period is considered to have been a long one, and it has been suggested that the lapse of time represented by the Pre-Cambrian rocks (including the Archæan) may be equal to that from the base of the Cambrian to the present day—about 25,000,000 years according to the scale given. In the remarks column a few of the salient points in the development of life-forms have been noted opposite the formations in which the earliest fossil representatives have been found.

Archæan character of Mysore rocks.

The fact that the rocks of Mysore are confined to the Archæan and that the development of Land Plants and of the Indian coal-measures took place many millions of years later explains why there is little hope of finding in Mysore those supplies of coal which are so badly needed for the industrial development of her mineral resources.

Area of the Archæan rocks.

The area of the Archæan rocks extends far beyond the boundaries of the Mysore State and occupies about 80 per cent of the whole of Southern India south of latitude 16°.

The remainder of the area—chiefly along the coastal strips—is occupied by rocks of later age, and a brief account of the distribution and history of these later rocks will serve to emphasize the distinction between the geology of the Mysore plateau and that of the coastal regions of the peninsula.

Map showing the distribution of rocks in Southern India.

The general distribution of the rocks of Southern India is shown in the special map included in another volume of this work. This map has been compiled from maps prepared by the Geological Survey of India and from the records of the Mysore Geological Survey.

TABLE OF FORMATION.

Formations	Thickness Feet	Total years	Remarks
CAINOZOIC.			
Recent and Pleistocene ...	4,000		Man.
Pliocene	13,000		
Miocene	14,800		
Oligocene	12,000		
Eocene	20,000		Horses and larger mammals generally.
Total ...	63,800	6,380,000	
MESOZOIC.			
Upper Cretaceous ...	24,000		
Lower do ...	20,000		
Jurassic	8,000		Gigantic reptiles, birds and small mammals.
Trias	17,000		
Total ...	69,000	13,280,000	
PALÆOZOIC.			
Permian	12,000		Indian coal measures.
Carboniferons ...	29,000		Reptiles.
Devonian	22,000		Land Plants.
Silurian	15,000		Fresh water and terrestrial invertebrates.
Ordovician	17,000		Fishes.
Cambrian	26,000		Marine invertebrates (many highly specialized).
Total ...	1,21,000	25,380,000	
PRE-CAMBRIAN.			
Keweenawan	50,000		
Animikean	14,000		Organic remains doubtful.
Huronian	18,800		
Total ...	82,000	33,580,000	
(ARCHÆAN COMPLEX).			
Laurentian (intrusive) ...	...		Geology of Mysore practically confined to this period.
Keewatin, etc. ...	?		

II. Post-Archæan Geology of Southern India.

The story of Post-Archæan rocks.

The story of these rocks is fairly well known and has been very lucidly summarized by Sir Thomas Holland in the delightful chapter on the Geology of India in Volume I of the *Imperial Gazetteer of India.* At the close of the Archæan period, Southern India formed part of an extensive land area composed of highly crushed and folded Archæan Rocks. An extremely long period of denudation followed during which these rocks were slowly worn down, the upper covering of Dharwar schists being completely removed in places and the underlying gneisses and granites exposed. In places the sea encroached and permitted the accumulation of a great series of sediments which was subsequently raised to form land, somewhat crumpled in the process. The remains of these sediments, composed largely of shales, sandstones and limestones, now form a patch, about 14,000 square miles in area, in the Cuddapah District—the total thickness being over 20,000 feet. The lower 20,000 feet which includes numerous basic lava-flows and ferruginous jaspers is known as the Cuddapah Series, and this is overlaid unconformably by the Kurnool Series (1,200 feet thick), which is notable chiefly for the occurrence of diamonds in some of the old sandstone and gravel beds at Banganapalle. All of these rocks are unfossiliferous and are regarded as of Pre-Cambrian age and correlated with the Algonkian of North America.

Blank in the geological history of Southern India.

After the formation of the Kurnool series, there is an enormous blank in the geological history of Southern India, extending over many millions of years, during which interval the great Palæozoic sediments from the Cambrian to the Carboniferous were being accumulated in other parts of the world and in India, north of the Peninsula. Of these great formations, in which the earlier records of the evolution of life-forms are preserved, there is no trace in Southern India which appears to have formed an exceedingly stable buttress of the earth's crust, while other portions of the crust were continually in a state of flux, being alternately depressed below the sea and raised again into dry land many times.

The close of the Carboniferous period.

Towards the close of the Carboniferous period, there is evidence derived from the distribution of land fauna and flora that Southern India formed part of a great continental area extending to Africa and on to South America on the one side and on the other side possibly to Australia. This old Continent, which has been called Gondwanaland, formed a barrier between a southern ocean and a great central Eurasian sea extending from Asia across Northern India, where the Himalayas now stand, into Europe and of which the Mediterranean is a small relic.

Towards the close of the Carboniferous period the geological record is again taken up in Southern India. Denudation had been slowly wearing down the old Archæan and Pre-Cambrian rocks and the larger rivers had gradually worn their valleys down to near their base level of erosion with gradual widening of the valleys and the development of slowly moving rivers and large swampy areas. In these areas large tracts of fresh-water sediments were formed which included the debris of the luxurious vegetation of the coal measures. The result was the accumulation of a considerable thickness of sediments, known as the Gondwana formation—from Permo-carboniferous to Jurassic times—of which various small patches have been preserved along the eastern side of the Peninsula. The lower portion of this formation constitutes the coal measures of India, and in the south the most important patches are those of the Godavari valley which include the Singareni coal field.

At the close of the Gondwana epoch, slight alterations in level permitted encroachments of the sea of which records are preserved in small, but extremely interesting, deposits at Trichinopoly, Cuddalore and Pondicherry containing marine fossils of Cretaceous age. After this the record is scanty and uneventful and comprises a few beds of presumed Tertiary age in Travancore, the Cuddalore Sandstones of the East Coast from Vizagapatam to Tinnevelly—of Pleistocene age—and the various recent blown sands, alluvium and soils of the coastal strips.

The close of the Gondwana epoch.

As a contrast to this peaceful story, it may be noted that towards the end of the Cretaceous period the old Gondwana continent began to break up and the land connection between Southern India and Africa disappeared under the sea. In the north of India a great series of movements began about the same time, extending into the Tertiary period, which resulted in the gradual rise of the Himalaya and the driving back of the central sea towards its present Mediterranean limits. These movements were accompanied by igneous action on a gigantic scale of which the most striking memento is to be found in the lava-flows forming the Deccan Trap, the remains of which form a horizontal layer covering an area of 200,000 square miles in Bombay, Central India and Hyderabad.

The end of the Cretaceous period.

In Southern India, therefore, if we exclude the coastal strips, we have an area which is formed almost entirely of the most ancient series of rocks of which any visible record exists, and this appears to have remained uncovered by any more recent formation—and almost without movement—during the whole of the vast period represented by the fossiliferous formations of other parts of the crust of the earth.

Summary.

With this very brief glance at the Post-Archæan geology of Southern India we may now turn back to consider the nature of the immensely old Archæan complex as exhibited in Mysore—which comprises an area of about 29,000 square miles—and in doing so we shall endeavour to take the components in the order of their formation, starting with the oldest.

III. The Dharwar System.

The oldest rocks in Mysore.

The oldest rocks recognized in Mysore are the Dharwar schists which appear to possess a close resemblance to the Keewatin formation of North America. In other parts of India certain gneisses and schists—such as the Bengal gneiss and the Khondalites of Vizianagaram—are considered to be older than the great mass of the Peninsular Gneiss and possibly of Pre-Dharwar age. Cléar evidence on the latter point is however lacking, and in Mysore no rocks older than the Dharwars have been recognized.

The Dharwar schists.

The Dharwar schists are largely composed of lava-flows, associated igneous intrusions and their crushed representatives. The base of the system is not visible as it has been removed by the intrusion of the underlying granites and gneisses. On lithological grounds the system can be divided into a *lower* and an *upper* division without any perceptible break or unconformity between them. The lower division is composed essentially of dark hornblendic rocks—such as hornblende schist and epidiorite—which are probably metamorphosed basalts and diabases in the form of lava-flows, sills, etc., and very possibly some pyroclastic accumulations. The upper division is more varied and consists largely of rocks characterized by the presence of chlorite, such as greenstones and chlorite schists and less commonly mica-chlorite schists and mica schists. Many of the greenstones still exhibit igneous characters and appear to pass insensibly into chlorite schists. In places the micaceous members also appear to grade into rocks of recognizably igneous character.

Igneous and other types of the Dharwar schists.

Taken as a whole, the Dharwar rocks afford evidence of very extensive igneous action and many of the more schistose forms can be regarded as highly crushed and altered igneous rocks. Whether amongst the more schistose members there are rocks of sedimentary origin remains doubtful, as clear evidence is wanting, but it does not seem impossible that all of these rocks may have been derived from igneous material by metamorphic action.

Apart from the undoubtedly igneous types and these doubtful schistose types, the system contains a number of other types, the physical and chemical characters of which cause them to stand out more prominently than their actual abundance would otherwise warrant. These are conglomerates, banded-ferruginous quartzites, quartzites and limestones, all of which would usually be regarded as indicative of sedimentary action, and if such action were admitted in the case of these associated types, it would go far towards easing the way for accepting a sedimentary origin for many of the more obscure highly schistose rocks associated with them.

Conglomerates.

The more closely the conglomerates of Mysore are studied the less probable does their sedimentary origin appear to become. In many cases there is satisfactory evidence that they are crush-conglomerates formed in shear zones in the schists or in one of the subsequent gneisses or in both. Other cases which have not been closely studied may still be open to question but, on the whole, evidence favours the view that their origin is autoclastic and not sedimentary.

Banded ferruginous quartzites.

The problem of the banded ferruginous quartzites presents much greater difficulty owing largely to the fact that their contacts with other rocks are very obscure. Owing to their weather-resisting qualities the adjoining rocks are generally weathered and generally also obscured by a talus of quartzite blocks. Contacts are, therefore, seldom observed, and when found are usually non-committal.

These rocks occur in extensive beds or bands in both the lower and upper division of the Dharwars—being rather more extensively developed in the latter. Frequently folded at steep angles, there is little doubt that they were once practically horizontal. On part of the *Bababudan hills* there is a capping of these rocks which is comparatively horizontal, with moderate undulations, and which is still from 200 to 300 feet in thickness. They are composed mainly of alternating bands of finely granular quartz—sometimes extremely fine—and magnetite. *Hæmatite* is usually present and often increases, to the practical exclusion of magnetite, towards the weathered surfaces. This widely distributed series does not appear to be associated with coarser clastic or sedimentary material such as might be expected to occur if it was formed of ordinary sediments with a tendency to become coarse in the neighbourhood of shore lines. On the other hand, bands of it are found to alternate sharply with undoubtedly igneous material in the shape of basic flows and sills. On account of these difficulties, some American geologists consider that the corresponding rocks in the Lake Superior region were formed in tranquil water, mainly as chemical precipitates, and that the associated lava-flows were sub-aqueous flows. This interesting and ingenious hypothesis would tend to render a considerable proportion of the Dharwar flows sub-aqueous owing to the numerous layers of the banded ferruginous rocks and to the absence of conglomerates and coarse sedimentary material in the intervening zones, such as might be expected to be formed during a change from sub-aqueous to sub-aerial conditions. On the other hand, if the series is not of sedimentary or chemical origin, it is extremely difficult to find a satisfactory explanation for it on account of the completeness of the metamorphism and the difficulty of finding good contacts. It is not impossible that these banded rocks represent sills of highly ferruginous character subsequently altered to quartz and magnetite or even, in some cases, sills of a quartz-magnetite rock such as will be referred to later in connection with the Charnockite series. Whatever the origin of these rocks, there can be little doubt that their banded character is largely secondary. As to their sedimentary or aqueous character, definite proof is lacking, but the great consensus of opinion is in favour of such a view.

Quartzites.

We may now pass to the quartzites, some of which are practically all quartz, while some are felspathic and some micaceous. There is considerable doubt to what extent these can be regarded as the metamorphosed representatives of sedimentary sandstones. There is a great variety of types and they appear to be of different ages. Many of the beds originally mapped as quartzite have proved on close examination to be altered and silicified quartz-porphyries some of which retain enough of the porphyritic character to be recognizable. Others, entirely quartzose, are occasionally found to exhibit intrusive contacts with adjoining rocks, while others of a later date penetrate the subsequent granitic gneiss and even pass from the gneiss into the schists.

There can be little doubt that many of these quartzites are crushed and re-crystallized quartz-veins and quartz-porphyries, and possibly felsites, and it is at least open to question whether we have any which are genuine sedimentary rocks.

Limestones.

Finally, there are a number of beds or bands of limestone or dolomite which ordinarily would be regarded as of aqueous origin. They are most numerous in the upper chloritic division, and it may be noted that a large number of the greenstone and chlorite-schist beds are characterized by an abundant development of calcite, dolomite, or ferro-dolomite not only in the doubtful schistose members, but also in those which are distinctly igneous. In addition, some of the gneissic granite bands associated with the schists develop calcite which in places becomes extremely abundant. By development of calcite, chiefly at the expense of the felspars, we get a series of rocks which approach limestone, and near by we have limestone bands sometimes very siliceous or chloritic and sometimes comparatively pure. The association is suggestive, though it is not clear that a continuous series has been detected, and possibly the purer limestone bands have been concentrated along fissures or zones of weakness. The proof that these beds have been so formed is naturally difficult, but there is much to suggest it.

Summary.

To sum up, we have in the Dharwar system in Mysore a great series of lava-flows, sills, etc., and their crushed schistose representatives; associated with these are various doubtful schists which are more usually regarded as sedimentary, but which may possibly be igneous. There are also a number of subordinate bands or layers of more distinctly sedimentary habit, such as conglomerates, banded ironstones, quartzites and limestones which are almost universally regarded as of sedimentary origin, but which are regarded in Mysore as probably formed from igneous material by metamorphic and metasomatic changes. In some cases there is strong evidence for this, but conclusive proofs are difficult to find, and many more instances will be required before such a proposition can be stated in general terms.

Passing now from these components of the Dharwar system, we come next to a series of rocks which may be classed as ultra-basic. These consist of amphibolites —often in the form of actinolite or tremolite schists— amphibole-peridotites, peridotites and dunites with their alteration products potstone, serpentine and magnesite. They appear to be sills, dykes and intrusive bosses in the mass of the schists and are regarded as belonging to the Dharwar system on account of the evidence of their having been cut off and broken up by the subsequent intrusive gneiss. They are of importance for their mineral contents and contain considerable deposits of iron-ore, chrome-ore and magnesite. It is very probable that the Chalk Hills of Salem, which are conspicuous on account of the abundance of veins of white magnesite, belong also to this series.

Ultra-basic intrusives.

Finally, we have some large intrusive masses of diabasic or dioritic character which appear to be later than many of the rocks already mentioned, but prior to the gneiss and so regarded as of Dharwar age.

Other intrusives.

At the close of the Dharwar age, the whole of Southern India was covered with a mantle of these Dharwar rocks several thousand feet in thickness, but successive intrusions of granite from below gradually penetrated or ate into the over-lying mantle and this, combined with folding and faulting, caused the lower surface of the mantle in contact with the granites to become a very uneven one. Subsequent denudation for many millions of years removed the greater portion of the mantle of Dharwars, with the result that we now see the underlying granite and granitic gneisses exposed at the surface. The comparatively narrow strips of the Dharwar schists which still remain are but the deeper fragments of the one thick, continuous layer.

Distribution of the Schist Belts.

The total area of the Dharwar schists in Mysore is nearly 5,000 square miles representing approximately one-sixth of the area of the whole State and is distributed mainly as follows:—

(1) *Kolar Schist Belt.*—This is situated near the eastern side of the State in the Kolar District. It extends north and south for about 40 miles, with a maximum width of 4 miles, the total area being about 100 square miles.

It is composed entirely of the dark hornblendic rocks of the *lower* division of the Dharwar schists with some banded ferruginous quartzites close to its eastern and western edges and some bands of amphibolite some of which are intrusive.

The Kolar Gold Fields is contained within a length of 5 miles towards the southern end, and the workings have now gone a vertical depth of over 6,000 feet below surface.

Indications of gold have been found further north at various points, but successful working has not yet been established.

(2) *Chitaldrug Schist Belt.*—This runs through the middle of the State with a N. N. W. trend in the Chitaldrug District, where it has a maximum width of 25 miles, and passes southwards through the Tumkur and Mysore Districts in which it becomes split up into narrow bands finally disappearing a few miles south of Seringapatam. The belt extends north of the State into the Bombay Presidency, the total length in Mysore being about 170 miles and the area nearly 2,000 square miles.

The main portion of the Belt is composed of chloritic schists of the *upper* division, but at the sides and in some of the narrower bands in the Mysore District there are considerable masses of the dark hornblendic schists. Numerous bands of ferruginous quartzite occur throughout the belt and quartzites are abundant in places.

Towards the western side, in the Chitaldrug and Tumkur Districts, are numerous bands of limestone—chiefly magnesian—and numerous bands and patches of iron and manganese ores. The iron ores are mostly soft hæmatites and limonites and the manganese ores are mostly highly ferruginous.

(3) *Hassan Schist Belt.*—Sundry small bands and patches of the older hornblendic schists occur in the Hassan District and are noticeable chiefly for the number of sills, dykes or intrusive masses of amphibolite and peridotite with which are associated iron and chrome ores and magnesite. The better classes of chrome ore and magnesite occur further south in small patches of peridotite and dunite in the Mysore District.

(4) *Shimoga Schist Belt.*—This occupies a large part of the Kadur and Shimoga Districts and extends northwards through the Dharwar District of the Bombay Presidency. In Mysore it is broken up into a number of large irregular patches separated by the later granites and gneisses, the total schist area being between 2,500 and 3,000 square miles. The dark hornblendic schists occur chiefly along the Western Ghats and around the Bababudan hills while the areas around Ubrani, Koppa, Kumsi and Shikarpur consist very largely of chlorite schists and greenstones with some mica schists.

Quartzites of various kinds are abundant and very noticeable, and numerous bands of magnesian limestone occur in the Ubrani, Channagiri and Kumsi schists. Banded ferruginous quartzites are abundant and large quantities of hæmatite and limonite occur along the eastern hills of the Bababudan chain. Gold is widely distributed but the lenses or veins of ore, though often rich, are small and lack continuity, and successful mining has not been established.

Manganese ores are widely distributed in the chloritic schists, but many of the deposits are small. Some of the deposits, however, are of considerable extent and some 300,000 tons of ore have been mined and exported already. The ore is of fairly high quality and there are also very large quantities of more highly ferruginous ores which cannot be exported or utilized at present.

(5) *Other Schists.*—In addition to the above, small shreds, patches and fragments of the various schists—chiefly those of the lower hornblendic division—are widely scattered throughout the later intrusive gneisses and granites.

IV. Granites and Gneisses.

Preliminary.

With this brief notice of the Dharwar system, we may pass on to the subsequent granites and gneisses which now occupy by far the greater part of the whole area.

Champion gneiss.

The earliest of these is a comparatively fine grained micaceous gneiss with bands and veins of coarser granite, pegmatite and quartz. It is usually highly crushed and frequently contains zones of conglomerate composed not only of round to sub-angular fragments of the various granitic materials but also patches and lumps of the adjacent Dharwar rocks including the banded ferruginous quartzites. This gneiss was first recognized as a wide band near the eastern edge of the Kolar hornblendic schists into which it intrudes in tongues. Some distance south of the Mysore mine, the gneiss extends across the strike of the schists and then continues southwards near the western edge of the schist belt. From south of the Mysore mines it sends some tongues northwards into the schists which are soon lost on surface but some of them have been recognized in the deeper workings of the Mysore mine a mile or so to the north of the outcrops. The gneiss is often characterized by the presence of grains or blebs of opalescent quartz, the colour varying from a slight bluish milkiness to brown or dark grey, and has been referred to as *opalescent-quartz gneiss.* As a less cumbersome name and on account of its intimate and probably genetic connection with the auriferous veins of the Champion *lode* of the Kolar Gold Field, it is proposed to call it, for the time being, the *Champion gneiss.* Other patches of what is believed to be the same gneiss have been recognized more recently in the Shimoga, Chitaldrug and Kadur Districts, and several of these contain or form friction-breccias or agglomerates which at one time were regarded as undoubtedly sedimentary conglomerates.

The Champion gneiss represents a very early period of granitic intrusion into the Dharwar schists. Many of the highly crushed quartz-porphyries or fine granite-porphyries which have been alluded to as occurring in bands among the Dharwar schists also contain similar opalescent quartz-blebs or phenocrysts and may very possibly be genetically connected with this early Champion gneiss. It has been observed, however, that a considerable portion of the Dharwar schists in Mysore is composed of schistose rocks which are the derivatives of the Champion gneiss. So, the Dharwar system should be made to include the Champion gneiss as well.

The remnants of the latter are not very extensive, and there is evidence of their having been intruded and cut off by the next succeeding formation which is the great gneissic complex of Mysore and probably of Southern India as a whole.

Until recently this gneissic complex has usually been regarded as the oldest formation of Peninsular India and the term "fundamental" which has been freely applied to it, has usually carried with it the idea that it is the basement rock on which all the others—including the Dharwars—have been laid down. Detailed work over the greater portion of Mysore has shown that this is not the case and that this great gneissic complex is everywhere intrusive into the Dharwar schists and the Champion gneiss. It seems desirable, therefore, to avoid the use of the word "fundamental" and as the complex is probably the most extensive formation of Peninsular India, it is proposed to call it the "*Peninsular gneiss.*"

Peninsular gneiss.

This Peninsular gneiss which underlies and intrudes the Dharwar system and the Champion gneiss is a complex of various granites, but so protean that no adequate description can be given here. It is the most extensive and widely distributed rock in the State and is used largely for building and structural purposes. The various granites, of which three are often distinctly recognizable, give evidence of successive intrusion and the fact that the earlier forms contain their own pegmatites, which are truncated by subsequent forms, points to a long continued period of plutonic activity. Frequently, the various members mingle either by repeated injunction or absorption or crushing and shearing, and we get zones or areas which are highly banded or crushed or with complex flow structure. Other portions are more homogeneous and appear as granite masses. Amongst these latter are some which may be definitely later in age than the gneiss as a whole, but it is often difficult to decide one way or the other.

Evidence of the intrusion of the Peninsular gneiss into the Dharwar schists is abundant and the former bristles, to a variable extent, with lenses, patches, and fragments of the Dharwars chiefly, as might be expected, belonging to the lower or hornblendic division.

It would occupy too much space to enter into any account of the evidences of intrusion or of the contact metamorphism of the schists, and we may pass on to the next formation succeeding the Peninsular gneiss.

The next formation is itself highly complex, but, thanks to the labours of Sir Thomas Holland, it can be recorded and summarily dismissed with the name Charnockite. It is a huge plutonic complex, characterized chiefly by the presence of hypersthene, in which the alternating bands, frequently steeply inclined, vary from an acid hypersthene-granite through various intermediate forms to hypersthene-norites and hypersthenites. These rocks form the great mass of the Nilgiris to the south of Mysore and come into Mysore on its eastern, southern and western borders where they are found distinctly penetrating the Peninsular gneiss, both as tongues and as basic dykes. An interesting addition to the series has been identified in Mysore in the form of dykes or narrow intrusive tongues of quartz-magnetite ore. Gradational forms have been found in which the proportions of magnetite and quartz gradually increase with corresponding elimination of felspar, hypersthene and amphibole, until we get to a rock containing 50 per cent of magnetite, the remainder being quartz with subsidiary amounts of hypersthene and garnet. **Charnocl**

The last formation of any considerable magnitude is the Closepet granite. It occurs as a band about 20 miles in width running right through the State in a north and south direction from the southern boundary on the Cauvery river near Sivasamudram to Molakalmuru in the extreme north of Chitaldrug, a distance of over 200 miles. Doubtless it extends much further both north and south into British territory. Topographically it is usually striking, as it forms a great chain of rounded bosses or domes many of which are bare rock and form conspicuous features amongst which may be mentioned the Closepet Hills, Magadi, Shivaganga, Devarayadurga, and the continuation of the chain northwards through the Tumkur and Chitaldrug Districts. Like most of the **Closepet Granite.**

plutonics of Southern India it also is complex and is composed of a mixture of red and grey granites, sometimes coarse, sometimes porphyritic, and sometimes so intermingled or deformed as to become gneiss. It intrudes all the previously mentioned formations including the Charnockite. It is probable that other isolated masses in Mysore—for instance, Chamundi Hill and the Arsikere and Banavar masses—may belong to the same age, and it is possible that the ornamental porphyry dykes of Seringapatam may be phases of this intrusion.

This completes the distinct members of the Archæan complex which have been definitely recognized in Mysore,—with the exception of various hornblendic and other basic dykes which need not be referred to here.

Dykes.

Subsequent to the formation and folding of the Archæan complex, the whole country has been traversed by a series of basic dykes —chiefly dolerites—which from their freshness and the absence of deformation are regarded as post-Archæan, and it has been suggested that they may be of Cuddapah (Animikean) age.

Laterite.

The only other rock formation in Mysore is laterite which is of comparatively recent (possibly Tertiary) formation and forms a horizontal capping on the upturned edges of the much denuded Archæans. There is little doubt that it is mainly an alteration product of the underlying rocks, but the subject is too complex and variable to permit of further reference to it here.

Tabular view of Mysore rocks.

The foregoing sequence of events in the history of the rocks of the Mysore plateau may be exhibited in the following tabular statement :—

Possibly Tertiary	...	1. Recent soils and gravels.
		2. Laterite. Horizontal sheet capping Archæans.
Pre-Cambrian (Animikean)		3. Basic Dykes. Chiefly various Dolerites.

Great Eparchæan Interval.

ARCHÆAN

4. Felsite and Porphyry dykes.
5. Closepet Granite and other massifs of corresponding age.
6. Charnockite, Norite and Pyroxenite dykes.
7. Charnockite massifs.
8. Various hornblendic and pyroxene granulite dykes.
9. Peninsular gneiss. Granite and gneissic complex.

Eruptive Unconformity.

DHARWAR SYSTEM (PROBABLY KEEWATIN)	10. Champion gneiss ...	Granite porphyry, micaceous gneisses, felsites and quartz porphyries usually containing opalescent quartz and frequently associated with autoclastic conglomerates.
	11. Upper (chloritic) division. (Green stones and chlorite schists.)	Including also:— Amphibolites, peridotites, etc., mostly intrusive. Conglomerates (autoclastic). Banded-ferruginous quartzites; origin doubtful, possibly igneous. Quartzites and quartz schists, mostly intrusive.
	12. Lower (hornblendic) division. (Epidiorites and hornblendic schists). (Unknown.)	Limestones: probably secondary. Mica schists: metamorphic igneous. Intrusive masses of dioritic and diabasic character.

V. Earthquakes.

Their occurrence in the State.

Dr. Heyden has remarked that the observations of Indian earthquakes recorded during the past nine years, combined with the past seismological history of India, confirm the conclusion that the Peninsula is remarkably stable. Earthquakes tend generally to be more frequent in the regions of Extra-peninsular India, where the rocks have been recently folded, than in Southern India. Destructive earthquakes of the kind which have recently occurred in Assam (1897) and in the Kangra Valley in the Punjab Himalayas (1905) are altogether unknown in the State. The few that have occurred in it have been of the harmless type. From an inscription at Nelamangala, it appears that an earthquake occurred there in July, 1507. "I felt one at Tumkur," writes Dr. Benjamin Heyne, "on the 23rd of October 1800. It is remarkable that at the same time a violent hurricane raged along the coast from Ongole to Masulipatam. The shock was felt at Bangalore and in most other parts of Mysore; and it was stronger in the south than where I was. It seemed to come from the north, proceeding southward along the inland range of hills, and to be guided farther by those of which Sivaganga and Savandurga are the most conspicuous." Another earthquake was felt at Tumkur in 1865. Colonel Welsh says with reference to a shock that was experienced at Bangalore in 1813:—"On the 29th of December (1813), we experienced a pretty smart shock of an earthquake, which was very general in its effects all over the cantonment; it was accompanied by a rumbling noise, like a gun-carriage going over a drawbridge, and appeared to come from the westward. Our roof cracked as if a heavy stone had been thrown upon it, and every part of the house shook for some seconds. Some older and weaker buildings were actually shaken down, and the walls of others separated or opened out." Several shocks were felt at Bangalore on the 31st of December, 1881, at about 7 A.M. There was also an earthquake at Bangalore on the 13th April 1882 at 9-30 P.M. In recent years, a sharp shock was felt in Bangalore on the 8th February 1900, in the early hours of the morning, at about 3 hours 10 minutes, Madras time. A sort of rumbling sound was heard and it appeared to proceed from south to north. Houses actually shook for a few seconds, causing considerable alarm to the inmates, many of whom ran out into the streets fearing danger. Another slight shock was recorded in the Bangalore Observatory at 3-13 P.M., Madras time, on the 17th December 1913.

VI. Aerolites.

Recorded instances with details.

Aerolites or meteoric stones sometimes fall. On the 21st of September 1865, at about 7 A.M. one weighing

$11\frac{1}{2}$ lbs. fell in a field near Maddur in the Mysore District. About half a mile from the spot where it fell, in another field, another stone fell at about the same time. This was found broken into several pieces. It would appear from the report submitted on this fall that the stones, in both cases, had fallen slantingly from towards the north and not perpendicularly. Just before the fall occurred, a report "just as if a cannon had been fired three times had been heard in the neighbourhood. Also, at the time of the fall, the sky was reported to have been clear with no clouds on it but, it was added, dew had fallen in the previous night. A cultivator who was some 200 yards from where the first stone fell declared that immediately it fell his eyes were closed up from the rush of the smoky dust which had risen from the earth directly after the fall of the stone." The first of these stones is deposited in the Museum at Bangalore. Another stone (a fragment) which fell at Chetnahalli near Challakere in the Chitaldrug District at 10-10 P.M., on the 6th of September 1880 is also in the same Museum. Nothing is known about the chemical composition of these stones.

It may be noted, however, that of every 1,000 meteors, as shown by the observations of Denning, about 30 will be as bright or brighter than Jupiter, and would be called fire-balls. Professor H. W. Pickering notes in his *Popular Astronomy* that four of these 30 will move appreciably slower than the others, while a very minute proportion of the four, reaching the Earth's surface, will be found as stony meteorites. The remaining 996 move in cometary orbits with high velocities, and are not likely to reach the Earth's surface, the occasional one that does so being found to consist mainly of iron and nickel. Statistics indicate that 32 stony meteorites are seen to fall to one of these iron ones. Of the stony ones, perhaps, 10 per cent contain iron in appreciable quantities, and the remainder are composed mainly of silica combined with magnesium, aluminium and calcium. They arrive in excess in May and June, being otherwise quite uniformly distributed throughout the year. The cometary meteors, on the other hand, arrive chiefly from July to November inclusive, when the orbits of Jupiter's comets approach most closely. The stony meteorites fall most frequently between 4 and 5 P.M.; cometary meteors are most abundant after midnight. Seeing that both the falls recorded in the State were in September—*viz.*, between July and November as noted by Professor Pickering—the meteors that fell here must be reckoned to be cometary meteors. The time of their fall—one fell at 7 A.M. and the other at 10-10 P.M.—seems confirmatory of this view.

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