ON THE UPPER GONDWANA BEDS (SRIPERUMBUDUR AND SATYAVEDU STAGES) NEAR MADRAS

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The occurrence of certain fossiliferous beds round about Madras has been noticed by geologists from time to time; and these beds have been correlated with the well known Rajmahal and Jabalpur stages of the upper Gondwanas. These formations are known locally as Sriperumbudur and Satyavedu stages and are so named since they are best seen round about these two localities. The Sriperumbudur stage is located about 25 miles W.S.W. of Madras, and Satyavedu stage is about 35 miles N.W. of Madras. Both are within easy reach of Madras, since buses ply regularly to these places.

Sriperumbudur Stage

There are a number of localities round about this place where rocks belonging to this stage are noticed. Some exposures are found to the north and others are found to the south of the village. The rocks that are found to the north are a little more gritty and coarse, while those found to the south and south-west are fine grained and are highly coloured. The entire area about 6 to 8 square miles round about Sriperumbudur seems to be made up of grits, fine-grained sandstones and shales; but since the major portion of the area is covered by cultivated lands and dried up tank beds, the real fossiliferous exposures are very few. From a study of certain typical exposures, like the one at the northern end of the tank, another at the P.W.D. Bungalow south of the tank, those near Pondur (79° 56′, 12° 53·5′) and Vellum (79° 56′, 12° 55·5′) and the well-developed exposures at Vellakota, the following points of interest can be made out.

The rocks for the most part are fine grained grits, shales and gritty shales. The grits and gritty shales seem to occupy a lower horizon and the fine grained coloured shales are found at a higher horizon. In some places they are highly fractured. Although several localities were examined, it was not possible to find out the underlying rocks, but from the neighbouring

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geological features, it is possible to infer that the basement rocks are the Archæan Gneisses. The beds are usually dipping at low angles of 10° to 12° eastwards as found at Vellum and Vellakota, although in certain localities the beds are almost horizontal.

A detailed petrological investigation of these rocks under the microscope reveals that the shales are made up of incoherent, loose, sand and clayey particles with flakes of mica in between. Occasionally a few irregular grains of magnetite and garnet are noticed. The shales in particular, especially those from the tank bed and near the P.W.D. Bungalow, are of interest from the point of view of the associated plant remains of large size. These are mostly leaf impressions belonging to such typical upper Gondwana genera like Ptilophyllum, Tæniopteris, Dictyozamites, etc.

Satyavedu Stage

About 35 miles N.W. of Madras are found the well-known Satyavedu and Alicoor formations described by King and Bruce Foote, who considered them as younger than the rocks of Sriperumbudur. They are composed of thick massive conglomerates and quartzites. They form paralle ridges about 200 to 300 feet in height and run in a sinuous manner for a few miles, in a generally N.E. and S.W. direction. A few of these ridges are seen just behind the rest house at Satyavedu where a few typical sections are exposed, either along the water courses or in quarries. These conglomerates are fairly fresh, and consist of pebbles of quartz varying from $\frac{1}{2}$ cm. to 5 cm. in diameter. In some places a few jasper pebbles are also found. Dark ferruginous bodies of varying dimensions are also found as pebbles. These pebbles are cemented together by a reddish brown ferruginous material which often imparts a peculiar jasper red colour to the entire formation. There are a few minor intercalations of gritty sandstones and quartzites associated with conglomerates. King and Bruce Foote mention organic remains (leaf impressions and silicified woods) from these fine-grained intercalations, but a careful examination at the localities mentioned by them did not now reveal any such fossils.

The Satyavedu sandstones are well exposed about a mile from Satyavedu on the Tada road, where a few quarries have been freshly opened for taking the rocks for use as building stones. These sandstones are generally colourless, but sometimes show a very pleasing buff colour. They are hard and compact. They can be recovered from the quarry with considerable ease and consequently have become popular building stones. These sandstones have developed three sets of rectangular joints from which local workers take out blocks of varying sizes. Another interesting feature

about these rocks is that they are rich in water content along the joint planes. These rocks are generally at lower elevations below the thick conglomerates and consequently they can be utilised as sources of under-ground water.

Rocks from both Sriperumbudur and Satyavedu formations have been studied for their heavy mineral contents and palæontological remains. The results of these studies are given below.

Heavy Mineral Analysis.—The specimens collected from the different localities of the two stages mentioned above have been subjected to heavy mineral analyses. The results have been tabulated in the accompanying charts. Finely crushed material (about a hundred grams) was selected in each case and treated with dilute hydrochloric acid to remove calcium carbonate. The material was then washed and decanted several times with water to remove all finer particles. It was then passed through a 30-mesh sieve to get uniformity of grain size. 25 grams of this prepared material was selected for final treatment with Bromoform of 2·8 sp. gr. The following heavy minerals were recorded from the material selected from both the stages:

Magnetite, Ilmenite, Tourmaline, Zircon, Kyanite, Staurolite, Rutile, Garnet, Andalusite and Hornblende.

Magnetite and Ilmenite.—These occur as fractured grains with irregular borders frequently agglutinated with quartz. Usually dirty brown or greyish due to alteration to Limonite and Leucoxene. But the minerals are steel grey in colour when ever they are fresh.

Tourmaline.—It occurs as fractured grains, in prismatic form; pale yellow, but occasionally pinkish in colour. It contains inclusions of dark rounded opaque bodies. This tourmaline is strongly pleochroic from pale yellow to deep yellow. Basal sections are isotropic.

Zircon.—This mineral occurs in different forms; one a colourless variety, another pink in colour, and a third yellow in colour. The colourless variety occurs in all samples and is generally prismatic with pyramidal terminations. Fractured or pellet-like grains are also common. These are full of dusty inclusions. The pink variety is confined to samples from Sriperumbudur and is characteristically absent from those of Satyavedu. They are usually prismatic with pyramidal terminations. They are pleochroic and are frequently zoned. The yellow and yellowish brown varieties are confined to Satyavedu samples and are typically absent from Sriperumbudur rocks. They are generally distorted prisms with pyramidal

terminations. They contain inclusions of smaller Zircons and some dark opaque bodies. Frequently these coloured Zircons are pleochroic.

Kyanite.—This is rather a rare mineral and shows two distinct types of occurrence: (1) as long blades with vertical cleavages parallel to '*c*' axis with transverse partings and generally devoid of inclusions; (2) as fractured grains full of carbonaceous inclusions and kaolinitic alterations. They are generally colourless, but are sometimes pale bluish or greenish.

Staurolite.—It occurs as fractured grains with irregular borders, generally showing a rich golden yellow colour, containing vermicular inclusions of a colourless nature. They are pleochroic from golden yellow to yellowish brown.

Rutile.—There are two kinds of Rutile; one a reddish brown variety and the other slightly yellowish in colour. They are usually irregular grains, but often shows distinct prismatic forms with fine pyramidal terminations. The yellowish grains are distinctly pleochroic.

Garnet.—It occurs as irregular or rounded grains, mostly colourless, often showing kaolinitic alterations.

Andalusite.—It occurs in colourless fractured grains full of carbonaceous inclusions, occasionally showing three sets of cleavages of which one set is more prominent and bisecting the angle made by the other two. The mineral exhibits straight extinction along this more prominent set. It is pleochroic from colourless to pale pink.

Hornblende.—It usually occurs as irregular fractured grains showing a greenish colour. It is pleochroic from yellowish green to pale green.

A general idea of the size and shape of these mineral grains may be obtained from Plates I and II.

Conclusions

A study and comparison of the above observations reveal the following interesting features:—

(1) The total mineral assemblage is generally common to both the stages.

(2) A close scrutiny reveals that Rutile and Tourmaline are mutually exclusive of each other. Rutile occurs abundantly in Sriperumbudur stage showing a maximum frequency of 5 and Tourmaline being generally absent or represented by one or two grains; whereas in the Satyavedu stage Tourmaline is abundant and shows a maximum frequency of 5 and Rutile represented by a few grains.

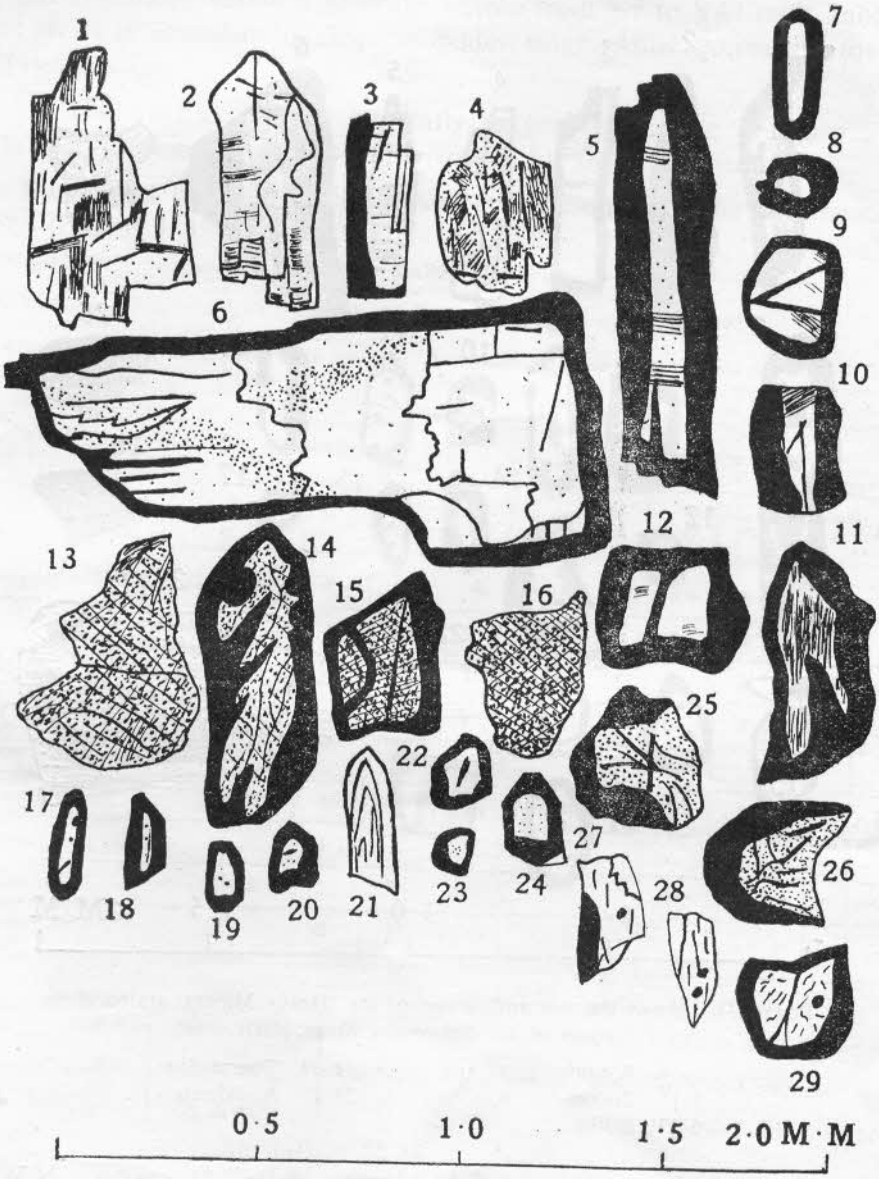

PLATE I. Shows the size and shape of the Heavy Mineral grains in the rocks of the Sriperumbudur Stage.

1- 6 Kyanite
7–12 Rutile
13–16 Andalusite
17–24 Zircon
25–26 Garnet
27–28 Hornblende
29 Staurolite

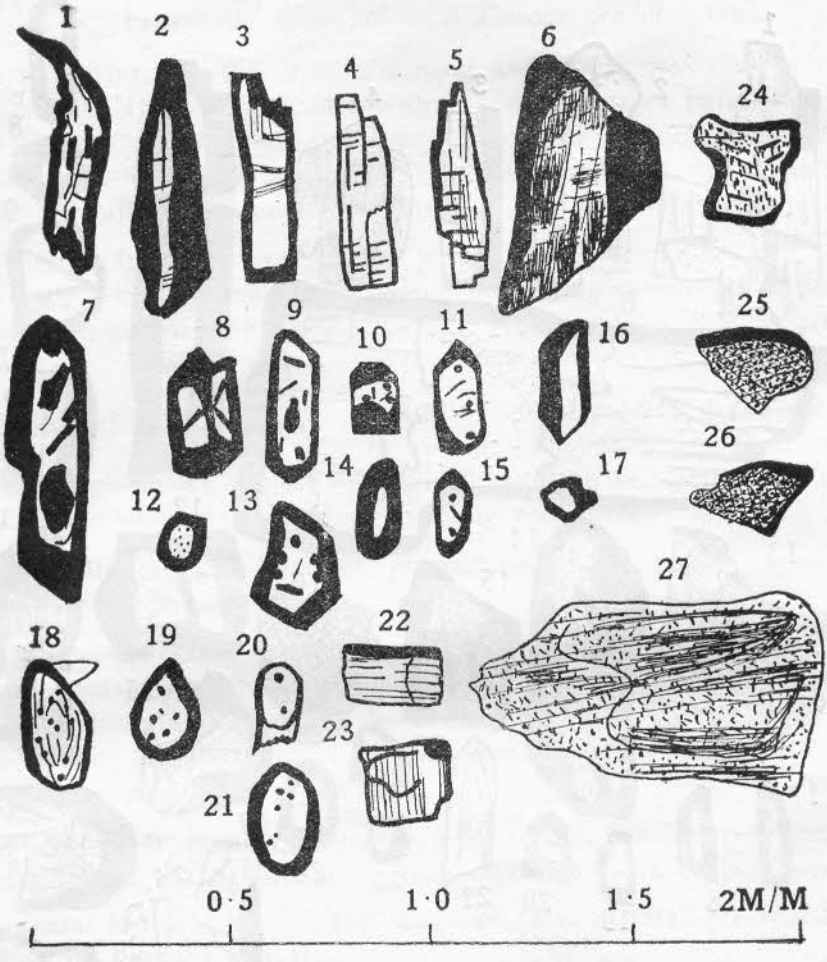

PLATE II. Shows the size and shape of the Heavy Mineral grains in the rocks of the Satyavedu Stage.

1– 6	Kyanite	18–23	Tourmaline
7–15	Zircon	24–27	Andalusite
16–17	Rutile		

(3) One of the specimens S 44 (gritty shale—2½ miles N.W. of Satyavedu) shows a frequency of 3 for both Rutile and Tourmaline in the charts, and is therefore considered as a possible transitory member.

(4) Pink coloured Zircons often showing zoning, and Staurolite are characteristic of Sriperumbudur stage.

(5) Andalusite shows a general decrease from S 9 to S 47 (*vide* Table 1). That is, it is abundant in Sriperumbudur stage, while decreasing towards Satyavedu stage.

(6) The total assemblage generally suggests a mixture of Igneous and Metamorphic complex as a possible source for these sediments.

The results of these studies have been embodied in the accompanying Tables 1, 2 and 3.

TABLE 1

Frequency Chart

After P. Evans, R. J. Haymen and M. A. Majeed, *Quart. Jour. Geo. Min. Met. Soc. of India*, 1934, 6, No. 2.

Minerals	Sriperumbudur Stage				Satyavedu Stage					
	S_9	S_{10}	S_{12}	S_{20}	S_{37}	S_{39}	S_{40}	S_{43}	S_{44}	S_{47}
1. Magnetite and Ilmenite	8+	8–	8	8	8+	8+	8+	8+	8–	8
2. Tourmaline ..		1*	1*	1*	2	1*	3	4	3	5
3. Zircon ..	2	5	4	4	1*	5	3	3	5	3
4. Kyanite ..	3	5	3	4	2	2	3	2	4	2
5. Staurolite ..			1	1		1*				
6. Rutile ..	2	5	2	1		1	1*	1*	3	1*
7. Garnet ..		4								
8. Andalusite ..	3	3	2	3			1*	1*	2	1*
9. Hornblende ..		2	1*						2	

Legend.

8+, 8, 8– : 90 – 100%, 75 – 89%, 60 – 74% = Very Abundant.

5 = 7–13% = Very Common.

4 = 4–6% = Common.

3 = 2–3% = Fairly Common.

2 = 1–2% = Scarce.

1 = ½–1% = Rare.

1* = Represented by a grain or two, or less than ½%.

In the absence of stratigraphical and palæontological criteria, the above observations regarding the nature and distribution of these heavy minerals may be helpful in correlating stray and local exposures of these beds with one or the other of the two stages.

TABLE 2

Graphically Represented Frequency

(After, Neaverson)

Minerals	Sriperumbudur Stage				Satyvedu Stage					
	S_9	S_{10}	S_{12}	S_{20}	S_{37}	S_{39}	S_{40}	S_{43}	S_{44}	S_{47}
1. Magnetite and Ilmenite	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –
2. Tourmaline ..					–		–	– –	–	– –
3. Zircon ..	–	– –	– –	– –		– –	–	–	– –	– –
4 Kyanite ..	–	– –	–	– –	–	–	–	–	– –	–
5. Staurolite ..			–	–						
6. Rutile ..	–	– –	–	–		–			–	
7. Garnet ..		– –								
8. Andalusite ..	–	–	–	–					–	
9. Hornblende ..		–								

Legend.

– – – ——→ Abundant.

– – ——→ Common.

– ——→ Rare.

Blank ——→ One or two grains or totally absent.

Fossils.—The only common fossils that have been reported so far from these rocks are some plant leaf impressions of the upper Gondwana genera, a few shells and some fragmentary Ammonites. In the course of our present studies some of the fine-grained rocks from these two stages were examined in sections under the microscope for the possible occurrence of microfossils. In some of the fine-grained shales of the Sriperumbudur stage a number of rounded oval, or fusiform structures are noticed. These are composed of a clear colourless material and as such stand out very distinctly from the opaque rock matrix which is brown and buff in colour (Plate III, Figs. 1

TABLE 3

Average size of the Heavy Minerals in Millimeters

Minerals	Sriperumbudur				Satyavedu					
	S_9	S_{10}	S_{12}	S_{20}	S_{37}	S_{39}	S_{40}	S_{43}	S_{44}	S_{47}
1. Magnetite & Ilmenite..	0·36×0·26	0·15×0·11	0·19×0·13	0·25×0·16	0·26×0·17	0·33×0·23	0·23×0·14	0·28×0·17	0·17×0·11	0·26×0·16
2. Tourmaline ..	..	0·20×0·13	0·19×0·13	0·21×0·12	0·18×0·13	0·07×0·05	0·16×0·11	0·16×0·12	0·10×0·06	0·17×0·11
3. Zircon ..	0·2 ×0·12	0·13×0·07	0·17×0·09	0·17×0·09		0·21×0·09	0·13×0·08	0·15×0·09	0·1 ×0·06	0·13×0·09
4. Kyanite ..	0·49×0·23	0·31×0·17	0·26×0·15	0·51×0·20	0·43×0·22	0·18×0·09	0·29×0·18	0·29×0·13	0·24×0·10	0·31×0·13
5. Staurolite ..			0·16×0·11	0·26×0·15					0·1 ×0·05	
6. Rutile ..	0·14×0·07	0·14×0·10	0·25×0·14	0·35×0·19		0·08×0·05	0·11×0·07	0·14×0·08	0·11×0·07	0·07×0·05
7. Garnet ..		0·23×0·21								
8. Andalusite ..	0·35×0·22	0·32×0·24	0·21×0·12	0·34×0·14			0·37×0·24	0·25×0·20	0·32×0·20	0·40×0·26
9. Hornblende ..		0·24×0·16	0·16×0·12						0·11×0·06	

and 2). This colourless material, however, becomes dark under crossed nicols and is probably some variety of amorphous Silica. A careful examination of these structures reveals the presence of a definite mesh structure in these bodies recalling that seen in shells of Radiolarians (Plate III, Figs. 3 and 4). Except in one or two cases where there are faint indications of spines, none of the structures show any distinct spines such as those usually associated with Radiolarian shells. A general idea of the size and shape of these structures can be gathered from the following statement of dimensions:

Statement showing variations in shape and size of Radiolarians

(Size expressed in millimetres)

Sl. No	Slide Number	Circular	Oval and Fusiform
1	Sp (A) ..	0·15 0·02	0·22×0·12 0·16×0·06 0·10×0·01 0·08×0·04
2	Sp (B) ..	0·15 0·03	0·25×0·10 0·20×0·03 0·13×0·05 0·10×0·03
3	Sp (C) ..	0·35 0·03	0·36×0·22 0·15×0·09 0·09×0·04
4	Sp (D) ..	0·06	0·18×0·07 0·14×0·06 0·10×0·05
5	Sp (E) ..	0·10 0·05	0·20×0·10 0·10×0·07
6	Sp (F) ..	0·12 0·05	0·25×0·15 0·16×0·14 0·14×0·10 0·10×0·05

In view of the persistent and striking character of these structures they are provisionally identified as Radiolarians, representing some of the simpler types without spines such as Cenosphæra. The accompanying micro-photographs give a general idea of the nature and mode of occurrence of these microfossils. Further examination of more rock types from this area may reveal better preserved and more definitely identifiable forms.

ACKNOWLEDGMENTS

This work has been done in the Geology Department of the Central College under the direction of Prof. L. Rama Rao. We are particularly indebted to him for his guidance in dealing with the microfossils referred to in this paper.

FIG. 1

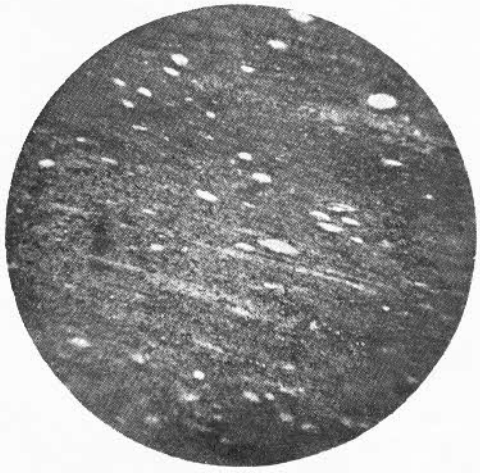

FIG. 2

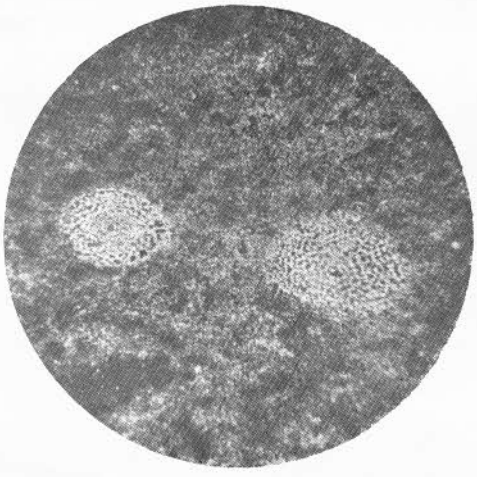

FIG. 3

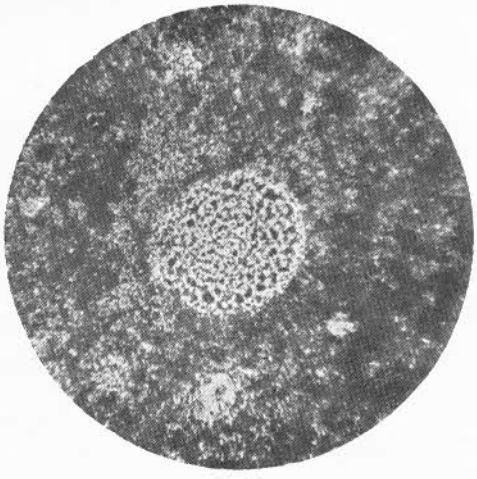

FIG. 4

FIG. 1: Shows the clear and colourless rounded organic structures standing out distinctly in the opaque matrix of the rock. (×40)

FIG. 2: Shows the fusiform shape of these structures in some of these rocks. (×40)

FIG. 3: Shows the mesh structure in these bodies. (×100)

FIG. 4: Shows the mesh structure in these bodies. (×160)